

## CHAPTER I

# Introduction

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This book features contributions stemming from the activities of the ENERIGIC (European Network Exploring Research into Geospatial Information Crowdsourcing: software and methodologies for harnessing geographic information from the crowd) scientific network. Researchers from 23 European countries participate in ENERIGIC. It is funded as action IC1203 by the COST (Cooperation in Science and Technology) programme, which is a European framework supporting trans-national cooperation among scientists, engineers, and scholars across Europe.

The ENERIGIC network was born out of scientific connections in the area of Geographic Information Science and friendships that can be traced back over 20 years ago. Indeed, the first important event was the specialist meeting on Volunteered Geographic Information (VGI) organised in 2007 in Santa Barbara (California) under the auspices of NCGIA, Los Alamos National Laboratory, the Army Research Office and The Vespucci Initiative ([www.vespucci.org](http://www.vespucci.org)). A number of fundamental questions were examined at this meeting and the results showed that VGI was a field of great potential, but lacking methodological and functional developments (NCGIA 2007).

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Five years later, in 2012, the ENERGIC action started exploring new VGI sources, sharing and developing data retrieval software, assessing VGI quality, defining standardization criteria for interoperability with other datasets, identifying applications and transferring them for business implementation (market analysis, risk management, advertising, etc.<sup>1</sup>).

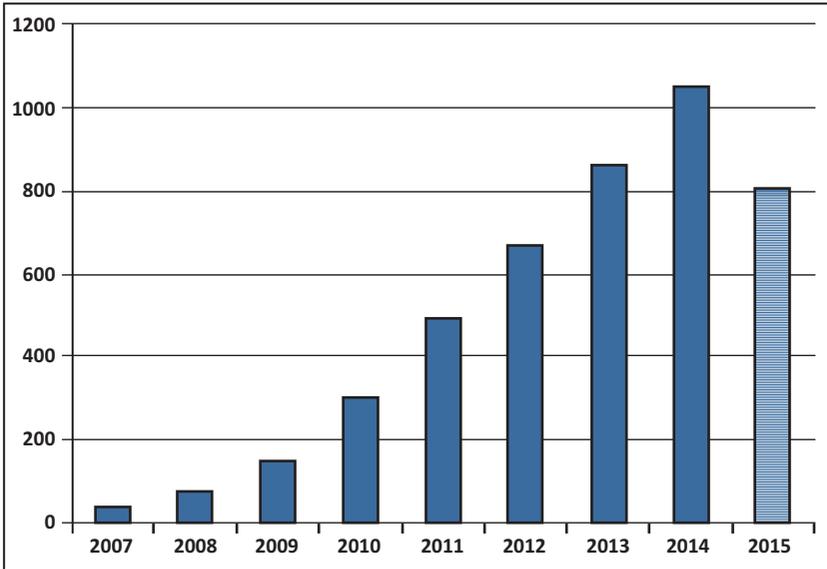
The action is based on the study of the remarkable new source of geographic information that has become available in the form of user-generated content accessible over the Internet. People now consume and produce geographic information on the go via platforms such as Facebook, Twitter, Flickr, Instagram and others. The availability of cheap GPS allows everyone to survey and map and contribute to projects like Wikimapia and OpenStreetMap. The exploitation, integration and application of these sources, termed crowd-sourced or user generated information, offer to multidisciplinary scientists an unprecedented opportunity to conduct research on a variety of topics at multiple scales.

The most popular definition of such content that possesses a geographic reference data is Volunteered Geographic Information (VGI), first coined by Michael Goodchild in 2007: its success is revealed by the growing number of articles published since 2007. By simply searching Google scholar for references which match the term 'volunteered geographic information' from 2007 to 2014 an interesting trend emerges: from 83 articles in 2007 to 1,720 in 2014 (Fig 1)!

The growing volume of scientific production on the topic cover multiple domains but some major threads may be identified, although intertwined and often coexisting, to build a narrative on the development of VGI. After an initial phase concerned mostly with conceptualizing and defining the new phenomenon (Coleman 2010; Elwood, 2008; Capineri & Rondinone 2011; See et al. 2016; Sui et al. 2012) and types of participation (Bonney et al. 2009; Coleman, Georgiadou & Labonte 2009; Haklay 2010; Haklay 2013; Goodchild & Li 2012), a first relevant thread in the literature is dedicated to the critical aspects of quality (Ali & Schmidt 2014; Antoniou 2016; Foody et al. 2013), among which accuracy and precision of geo-location and of observations, completeness and intelligibility of contents, as well as the reliability of information and the trustworthiness of the data source (Bishr & Kuhn. 2007; Bishr & Janowicz 2010) and at the same time, the first applications and experimentations appear and show the use of VGI in natural disaster management (Zook et al. 2010; Goodchild & Glennon 2010; Ostermann & Spinsanti. 2012, Spinsanti & Ostermann 2013), land use (Antoniou et al. 2016; Perger et al. 2012), tourism (Girardin et al. 2008; Sun et al. 2013; Teobaldi & Capineri 2014), environmental monitoring

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<sup>1</sup> [www.vgibox.eu](http://www.vgibox.eu)



**Figure 1:** Articles on Google Scholar on ‘volunteered geographic information’ (2007–2015 January).

Source: Google Scholar (January 2015).

(Gouveia & Fonseca 2008; Connors et al. 2012 ), the integration of VGI and spatial data infrastructures (Craglia 2007; McDougall 2009), the relationship with the GIS world (Kuhn 2007; Goodchild 2009) and mapping (in particular with reference to the OpenStreetMap project) (Neis & Zipf 2012; Dodge & Kitchin 2013) and finally ontology (Tardy et al. 2016). Another relevant thread addresses the role of VGI in the inner worlds of geography such as place (Corbett 2013; Purves & Edwards 2008; Hardy et al. 2012; Hecht & Gergle 2010; Ostermann et al. 2015; Purves & Derungs 2015), the definition of ‘vague places’ like downtown, livelihoods and vernacular geography (Hollenstein & Purves 2010); the dynamics of urban cores (Aubrecht 2011; Jiang & Jia 2011; Sagl et al. 2012) and space-time relationships (Li, Goodchild, Xu, 2013). More recently analysis on the societal implications of ICT have employed VGI to discuss the digital divide metaphor (Elwood 2010; Elwood et al. 2012; Graham et al. 2014).<sup>2</sup>

<sup>2</sup> The references mentioned above are only a small selection and certainly do not pay justice to all the valuable scholars involved in the debate and research on VGI. Apologies for all the authors that have not been quoted despite being relevant. The contents of this essay also draw from the activities of the COST Action IC1203 ENERIGIC, *European Network Exploring research into Geospatial Information Crowdsourcing*, which the authors belong to.

In conclusion, a very wide panorama which proves the broad penetration of VGI in the scientific community and the diverse research paths.

The collection of the papers in this book touch on many of these threads.

## **The Book Structure**

The book includes peer-reviewed chapters, organised in six parts, which try to address some fundamental questions: what motivates citizens to provide such information in the public domain, and what factors govern/predict its validity? What methods might be used to validate such information? Can VGI be framed within the larger domain of sensor networks, in which inert and static sensors are replaced by, or combined with, intelligent and mobile humans? What limitations are imposed on VGI by differential access to broadband Internet, mobile phones and other communication technologies, and by concerns over privacy? How do VGI and crowdsourcing enable innovation applications to benefit human society?

### **PART I: Theoretical and social aspects**

Part I deals with the nature and features of crowdsourced geographic information: the different sources and typologies of VGI, the fundamental aspect of participation. Capineri (Chapter 2) discusses the main features of crowdsourced geographic information by focusing on the components of such data: the geographical reference, the contents and the producers' profile in order to show the potentialities and critical aspects posed by these sources. Haklay (Chapter 3) looks at participation inequality and explains how it emerges in VGI and citizen science projects at both temporal and spatial scales, and also evaluates its implication on the use of VGI and citizen science data. Campagna (Chapter 4) introduces the concept of Social Media Geographic Information (SMGI) as a specific type of VGI for expressing pluralism in such domains as spatial planning and governance.

### **PART II: Quality: Criteria and methodologies**

This part covers issues relevant to the quality evaluation of VGI datasets. The evaluation of spatial data quality elements and the development and adoption of new quality criteria and methodologies for VGI is presented here. Criscuolo et al. (Chapter 5) offer an analysis of strategies for quality control and describe a simple representation of the components of quality in crowdsourced geographic information. Jacobs (Chapter 6) explores methods of (semi)automatic validation of observation data especially in field of citizen science projects. Ballatore

(Chapter 7) provides an overview of the semantic issues experienced in VGI and what potential solutions are emerging from research in geo-semantics and in the Semantic Web. Antoniou et al. (Chapter 8) present how named features in Open Street Map behave and change in terms of type, name and location by analysing the volatility of places and points-of-interest (POIs). Ali (Chapter 9) presents an approach for rule-guided classification for VGI projects which consists in a learning and a guiding phase. Finally, Bucher et al. (Chapter 10) present findings from the literature and from the experience of the French National Mapping Agency, IGN, about quality management of geographical data and focus on the potential of context and tasks modelling to address quality issues

### **PART III: Data analytics**

Part III focuses on data analytics and visualization methods for deriving knowledge from varying VGI sources such as Twitter, Flickr and OpenStreet-Map. Purves and Mackaness (Chapter 11) provide an overview of methodologies used to extract meaning from the analysis of geotagged images based on research in natural language processing and statistical and exploratory techniques. Gennady and Natalia Andrienko (Chapter 12) offer an analysis of geographically referenced posts published in social media, such as Twitter, Flickr and YouTube and an overview of visual analytics approaches to extracting various kinds of information and knowledge. Jiang (Chapter 13) proposes the head/tail breaks is a powerful tool for visualizing city structures and dynamics, and uses social media location data to illustrate its effectiveness in visualization. Lemmens et al. (Chapter 14) present ways to enrich the unstructured nature of VGI through semantic enrichment and explain how folksonomies and ontologies play a fundamental role. Karagoz et al. (Chapter 15) focus on detecting real-world events by following posts in microblogs by employing a process for toponym recognition and location estimation. Song and Xia (Chapter 16) concentrate on spatio-temporal variation of sentiment polarity patterns of georeferenced Tweets, with a view to understanding how opinions evolve on Twitter over space and time and across communities of users. Stojanowski et al. (Chapter 17) present a methodology for detecting and identifying social hot-spots from Twitter stream data and applying sentiment analysis on the data in New York. Finally, Steiger et al. (Chapter 18) provide a state of the art survey on social media data analysis and mining from a GIScience perspective.

### **PART IV: VGI and crowdsourcing in environmental monitoring**

Part IV presents several case studies where crowdsourced geographic information has been applied especially in the field of environmental monitoring. Kettunen et al. (Chapter 19) describe several examples to illustrate the changing

role of citizens in environmental monitoring in Finland. Jokar Arsanjani and Fonte (Chapter 20) investigate the completeness, thematic accuracy and fitness for use of OpenStreetMap features for land mapping purposes in Europe. Lupia and Estima (Chapter 21) evaluate the adequacy of the geotagged photos available at Panoramio for monitoring Land Use/Cover (LULC) in urban areas, taking Rome (Italy) as the study area. Oltra et al. (Chapter 22) introduce AtrapaelTigre.com, a citizen science project focusing on the Asian tiger mosquito in Spain, and describe lessons they have learned. De Albuquerque et al. (Chapter 23) close the section by reviewing the use of crowdsourced geographic information for disaster risk management and improving urban resilience and suggesting future research directions.

## **PART V: VGI in mobility applications**

Part V includes several case studies and research activities of VGI in smart cities and mobility applications. Zipf et al. (Chapter 24) investigate the use of OpenStreetMap for routing and navigation for mobility-impaired persons and describe existing challenges in this aspect. Farkas (Chapter 25) introduces a crowdsourcing based smart timetable service for public transportation. Lendák (Chapter 26) reviews existing mobile crowdsourcing projects in smart city, focusing on environmental monitoring, citizen collaboration, urban mobility, health/fitness and social networking. Finally, Stojanovic et al. (Chapter 27) present a framework and some applications to illustrate how mobile crowdsourcing can be used for enabling smart urban mobility.

## **PART VI: VGI in spatial planning**

Part V includes a broad variety of case studies and research activities of VGI in spatial planning. Huang and Gartner (Chapter 28) illustrate how mobile crowdsourcing and social media data can be used to study people's affective responses to different environments, as well as the potential applications of these affective data. Massa and Campagna (Chapter 29) introduce Spatext, a tool that allows integration of VGI and authoritative data, and present a case study to illustrate its application in urban planning. Basiouka and Potsiou (Chapter 30) investigate the use of VGI and crowdsourcing in Cadastre design, and propose a crowdsourcing cadastral model for official cadastral surveys. And in the last chapter, Fan and Zipf (Chapter 31) investigate the generation of 3D city models by using OpenStreetMap data and introduce the OSM-3D project.

In addition, the book consolidates the references and information from all the chapters in a rich bibliography and a glossary, thereby providing a state-of-the-art of research on crowdsourced and volunteered geographic information, as

well as valuable reference for PhD candidates and senior researchers from many disciplines who aim to tap into the potential of new geographic data sources.

## Concluding Remarks

As this collection demonstrates, research into crowdsourced geographic information or VGI (depending on the definition that the researchers prefer), has made significant inroads in a relatively short period of 7 or 8 years. Yet the book opens questions and points to new research directions, in addition to the findings that each of the researchers demonstrate.

As can be seen from this book, the crowdsourcing techniques and methods and the VGI phenomenon have motivated a multidisciplinary research community to identify both fields of applications and quality criteria depending on the use of VGI. Besides harvesting tools and storage of these data, many research attentions have been paid to these information resources, in an age when information is one of the most important drivers of development. The participation component is a fundamental aspect of crowdsourced information and it reveals both a new way of doing science with a problem-solving approach.

Despite rapid progress in VGI research, this book also shows that there are technical, social, political and methodological challenges that require further studies and research. We hope that the book will spark new research questions and development—and hopefully foster new research collaborations, and friendships.

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