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Change Detection in High-Resolution Land Use/Land Cover Geodatabases (at Object Level)

Emilio Domenech, Clément Mallet

A survey on state of the art of 3D Geographical Information Systems

Volker Walter

Dense Image Matching Final Report

Norbert Haala

Crowdsourcing in National Mapping

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Crowdsourcing in National Mapping

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Abstract

Crowdsourcing of geospatial data and information has become a very popular topic of research in GIS and related disciplines over the past few years. In 2007 Goodchild coined the term "Volunteered Geographic Information" or VGI (Goodchild, 2007) which represents the concept of citizens collecting and recording geospatial information using their own devices with specially designed software and web-services such as Wikis. Since 2007 there has been considerable research carried out by the academic community into understanding different aspects of crowdsourcing of geospatial data. The emergence of VGI and crowdsourcing was coupled with this dramatic increase in interest from the academic community. At the same time, the economic climate was changing. Many National Mapping Agencies have been finding their budgets and resources under increased pressure with many being required to *do more with less*. Could crowdsourced collection of geospatial data and VGI be used by NMAs? Under which conditions could geospatial data collected by citizens be used by NMAs? The primary motivation of this project has been to investigate the scope for crowdsourced geospatial data and VGI to be used by National Mapping Agencies. The project secured the joint support of AGILE and EuroSDR so as to engage both the leading research agencies and national mapping agencies within Europe. The project established a number of research internships based on collaboration between academic and NMA partners which investigated tasks and problems specified by NMA partners. Overall the project was very successful. The internship projects investigated a range of issues such as conflation of VGI and authoritative spatial data, semantic interoperability, and gamification as a means of updating spatial databases. The projects are outlined in detail in this report. Our report closes with a summary of the key findings of these projects and a list of reference material produced by those projects.

Acknowledgement

The authors of this report would like to acknowledge the collaboration, assistance, and efficiency of a number of people who played a role in making this project a success. While our list contains a long list of people we would like to single out the following for special acknowledgement: Prof. Mike Jackson, Prof. Hardy Pundt, Prof. Lars Bernard, Prof. Dieter Fritsch, Prof. Mike Gould, Mr. Paul Hardy, Dr. Kevin Mooney, Ms. *Anneke* Heylen and Dr. Joep Crompvoets. We extend our thanks to Martijn Rijsdijk, Manager R&D, Kadaster Netherlands who performed a review of this report and supplied us with very helpful and insightful feedback. We are grateful to EuroSDR, AGILE and ESRI Europe for the funding to date. Any errors or omissions in this report are certainly of our own making.

Preface

In 2011 we proposed a joint-collaborative project between EuroSDR and AGILE which would support NMA-driven research into using crowdsourcing in national mapping. This proposal was accepted by both EuroSDR and AGILE who agreed to provide funding for internships following an international workshop on the topic. This proposal was also a contributing catalyst for the first major collaborative venture between EuroSDR and AGILE which eventually lead to the signing of a formal Memorandum of Understanding between the two organisations in October 2013. The primary motivation of this project was to investigate the scope for crowdsourced geospatial data and Volunteered Geographic Information to be used by National Mapping Agencies. Seeking the joint support of AGILE and EuroSDR would give us the platform to engage both the leading research agencies and national

mapping agencies within Europe. Upon acceptance of the proposal the project established a number of research internships based on collaboration between academic and NMA partners. Our report outlines the very successful implementation and outcomes from these internships. We both enjoyed managing this joint-collaborative project and watching the initial idea and concept grow into a fully fledged research project. We hope that you will enjoy reading this report and find some helpful information contained with its pages. Moreover we intend this report to be the first point of reference on a longer journey towards establishing the technical, legal, and social infrastructures necessary to promote crowdsourced geospatial data and VGI as a potential partner with National Mapping Agencies and Government Agencies in Europe and beyond.

Peter Mooney and Jeremy Morley

April 2014

1 Introduction and Motivation

Crowdsourcing of geospatial data and information has become a very popular topic of research in GIS and related disciplines over the past few years. In 2007 Goodchild coined the term "Volunteered Geographic Information" or VGI (Goodchild, 2007) which represents the concept of citizens collecting and recording geospatial information using their own devices with specially designed software and web-services such as Wikis. Since 2007 there has been considerable research carried out by the academic community into understanding different aspects of crowdsourcing of geospatial data. The key areas of research investigation include: comparison of the geometrical and semantic accuracy of VGI or crowdsourced datasets with gold-standard datasets such as those produced by National Mapping Agencies; analysis of the contributors to VGI projects and the characteristics of their contributions; the role of VGI in supplying geospatial data where there is no authoritative agency, such as in the developing world; and understanding the strengths and weaknesses of these crowdsourced datasets and databases in terms of being either a complement or a competitor to commercially produced geospatial data or National Mapping and Cadastral Agency geospatial data products.

The emergence of VGI and crowdsourcing was coupled with this dramatic increase in interest from the academic community. At the same time, the economic climate was changing. Many National Mapping Agencies have been finding their budgets and resources under increased pressure with many being required to *do more with less*. Could crowdsourced collection of geospatial data and VGI be used by NMAs? Under which conditions could geospatial data collected by citizens be used by NMAs?

The primary motivation of this project has been to investigate the scope for crowdsourced geospatial data and VGI to be used by National Mapping Agencies. The project sought the joint support of AGILE and EuroSDR so as to engage both the leading research agencies and national mapping agencies within Europe. The project sought to establish a number of research internships which would be based on collaboration between academic and NMA partners.

EuroSDR and AGILE have both been active in understanding and promoting VGI and crowdsourcing of geospatial data. AGILE have supported a number of workshops and presentation/paper sessions at their annual international conferences over the past few years. In 2013 Peter Mooney co-chaired the ACTIVITY Workshop (Action and Interaction in VGI) at the AGILE Conference in Leuven, Belgium. The workshop attracted 30 participants including some of the projects funded under this initiative. The number of full and short papers with VGI and Crowdsourcing as central themes which have been accepted for publication and presentation at the AGILE conference is steadily growing every year.

During 2009 André Streilein from Swisstopo organised and hosted the 1st EuroSDR Workshop on Crowd Sourcing for Updating National Databases. The workshop meeting was held at the Federal Office of Topography (Swisstopo), Wabern, Switzerland on August 20-21, 2009. There were participants from different backgrounds (e.g. Academia, public sector, National Mapping Agencies etc) which gave a valuable insight on their thoughts about crowdsourced spatial data, early efforts from National Mapping Agencies to build Geo-Web 2.0 applications and more importantly what the main problems are in regards with this new type of spatial data. Ideas from this workshop were instrumental in setting the stage for the development of this joint EuroSDR/AGILE project. The final report of the workshop, which includes an overview of the presentations and discussions, is available to download at the following URL:

http://www.eurosdr.net/workshops/crowdsourcing_2009/eurosdr_crowdsourcing_2009_report.pdf

In 2011 we proposed a joint-collaborative project between EuroSDR and AGILE which would support NMA-driven research into using crowdsourcing in national mapping. This proposal was accepted by both EuroSDR and AGILE who agreed to provide funding for internships following an international workshop on the topic. In the next section we outline the brief timeline of the evolution of the project idea and it's subsequent implementation. During the project development stage ESRI Europe expressed their interest and willingness to participate and subsequently provided additional top-up funding to the project budget.

2 Project Development Timeline

In this section we provide a listing of key events and dates in the project timeline from the project's initial formulation through to actual implementation and reporting of the first phase of internships.

Jan – March 2011: Initial formulation of the concept and idea for “Crowdsourcing in National Mapping”. PM visited the Centre for Geospatial Science in Nottingham in February 2011 and delivered a seminar titled “Establishing a research agenda on Volunteered Geographic Information and Open Data”.

May 2011: PM makes presentation to the bi-annual meeting of the EuroSDR Board of Delegates in Vienna, Austria proposing a project called “The Use of Crowd-sourced data for Update Intelligence and Metadata Erichment of National Mapping”. The proposal outlined a joint collaboration between AGILE and EuroSDR.

June 2011: Prof. Mike Jackson makes presentation to the bi-annual meeting of AGILE in Zurich, Switzerland. Project contribution agreed by AGILE.

October 2011: JM makes presentation, with implementation plans, to the bi-annual meeting of the EuroSDR Board of Delegates in Udine, Italy. Project contribution agreed by EuroSDR.

November 2011: ESRI Europe makes additional funding available to the project

January 2012: International Workshop on Crowdsourcing and National Mapping at the Nottingham Geospatial Institute (successor to CGS), University of Nottingham, UK. The workshop was organised and chaired by JM & PM. The workshop focused on open discussion and break-out sessions with discussions to develop project ideas. The workshop attracted about 30 participants including representatives from 6 National Mapping and Cadastral Agencies (OS GB, OS Ireland, SwissTopo, Kadaster NL, Norweigan Mapping and Kadaster, IGN France). Academic and industrial representatives made up the remainder of participants. This workshop was held over 1.5 days and was used as the platform for discussions about potential projects and research themes for consideration in the AGILE/EuroSDR project. There were a number of key themes which emerged from the workshop presentations, open-floor discussions, and focus-groups as these are summarised as follows:

- **Crowd Attention:** Crowds or citizens interested in collecting geographic information are deviating towards products created by "the crowd" and away from commercial and traditional mapping products.
- **Crowd Type:** Who are they? What is the experience level of the crowd in areas such as surveying, cartographical, GIS, etc? Are members of the crowd displaying characteristic attachment to their local geography and environment?
- **Crowd Retention:** "Retention of Attention" - in urban areas there now seems to be "too little work to go around"
- **OpenStreetMap** – can be very like NMA datasets in urban areas but lack the overall coverage of themes such as land-cover, waterbodies, etc that NMA datasets provide
- **Crowdsourcing Spatial Data from Imagery** – there were discussions about extraction of geospatial data from imagery such as CycloMedia which is a market leader in large-scale systematic visualisations of the environment by means of Cycloramas (360-degree panoramic photographs) or Google Streetview
- **Quality/Validation** – In crowdsourcing and VGI there is a lack of rigorous attribution, lack of quality methodologies . What are the effects of this? Is the data usable for the same types of problems and functionality which NMA datasets are currently used for?
- **Data Conflation –** This is potentially good middle-ground for crowdsourced geospatial data and NMAs. This can facilitate interaction with the crowd in a controlled way. Data conflation is a very well studied problem in GIS.
- **Triggering crowdsourcing?** – How can established crowdsourced spatial data, such as OpenStreetMap, Flickr, etc be combined with approaches such as Cycloramas, Google StreetView, Mechanical Turk, Zooniverse etc to trigger further interest and increase participation in crowdsourcing activities for spatial data. There is no direct answer for this yet but this would make a very interesting point for research and investigation.

April 2012: Calls for Participation. A general call document was written and distributed widely on academic mailing lists, Internet discussion groups, etc. One of the key aspects of

the call documentation was the emphasis on the building of a collaborative relationship between academic partners, industrial partners, and national mapping and cadastral agencies in Europe. At minimum a project should include at least one academic partner and at least one national mapping agency. We felt that this was crucial in making this initiative as mutually beneficial to both academia and national mapping agencies. We encouraged applicants that national mapping agencies take a lead role in the formulation of the problem or project specification. Priority was given to winning topics from the January workshop if they had been developed further into workable project plans.

May 2012: Presentation on progress and plans to the AGILE Conference and AGILE committee in Avignon, France

May 2012: 9 proposals submitted for consideration

September 2012: Evaluation of submissions

October 2012: Notification of outcome of submissions to applicants

October/November 2012: Commencement of projects.

March 2013: At this stage most of the projects had completed. Project 5 had some initial difficulties in recruitment of a suitable candidate and consequently commenced their project during March 2013.

May 2013: Presentation to AGILE Conference and AGILE annual meeting at Leuven, Belgium. Progress report to EuroSDR Board of Delegates in Copenhagen, Denmark.

August 2013: Presentation in the 25th International Cartographic Conference in Dresden, Germany during the EuroSDR session on Conference Day 1.

October 2013: Preparation and delivery of phase 1 report of this project.

October 2013: Oral presentation of final report to the 123rd bi-annual meeting of EuroSDR Board of Delegates at Gävle, Sweden.

The funding agreed with AGILE and EuroSDR was for two phases of internship. This report and the EuroSDR Board of Delegates meeting in Gävle marks the half-way review point. It is intended that a further phase of internships will follow, leading on from the initial projects.

3 Projects selected for funding

Five projects were chosen from nine submissions. The projects were evaluated by an external expert and the final decision was made by a selection committee. The following is a list of the five projects chosen. The title of the project, the academic PI, and the funding sponsor is outlined in the listing.

1. **Project 1:** Collection and visualization of alternative tourism sites and objects in Lithuania
   National Participation: Lithuania
   Academic PI: Dr. Giedrė Beconytė, Centre for Cartography of the Faculty of Natural Sciences at Vilnius University, Lit**huania**
   Sponsor: EuroSDR (50%) and AGILE (50%)

2. **Project 2:** Incidental Crowdsourcing
   National Participation: Spain, United Kingdom

Academic PI: Dr. Joaquín Huerta Universitat Jaume I of Castellón, Spain
Sponsor: ESRI Europe

3. **Project 3:** Ontology based Authoritative and Volunteered Geographic Information (VGI) integration
National Participation: Canada, Spain, The Netherlands
Academic PI: Prof. Rodolphe Devillers, Memorial University of Newfoundland, Canada
Sponsor: AGILE

4. **Project 4:** Conflation of Crowdsourced Data
National Participation: Germany, United Kingdom
Academic PI: Dr. Volker Walter, Institut für Photogrammetrie, Universität Stuttgart, Germany
Sponsor: ESRI Europe

5. **Project 5:** Characterising the use of vernacular placenames from crowd sourced data and a comparison with NMA Data
National Participation: Switzerland, France
Academic PI: Dr. Ross Purves, University of Zurich Switzerland
Sponsor: EuroSDR

4 Details of Individual Project Reports

After each project had commenced we kept in regular contact by email to ensure that the project was progressing as expected and on time. Projects were requested to provide progress reports at the half way point in their project and at the conclusion of their project.

When we began planning the writing of this final report it was agreed that it would be best if the projects were involved in the writing process. This would have many benefits, none more so than ensuring that the precise details of the projects were captured by those with the closest involvement to the research work. In September 2013 all of the projects were asked to provide a brief overview of their project. This overview required information under the following headings:

1. Final Project Summary (maximum one page)
2. Key outcomes and deliverables (half page maximum)
3. Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project (half page maximum)
4. Final list of project participants as this would allow credit for the interns who worked on the project as well as other academics and NMA representatives who provided input and assistance to the project.

We felt that it was important that the NMA or industrial partner commented on the success of the project. This ensured that we obtained a balanced overview of the success of the project and if the NMA or industrial partner felt that they had got value out of their

participation in the project process. It was the responsibility of the project to contact the NMA or the Industrial partner for their final official comment on the success of the project.

The following sections therefore comprise the reports received from the individual projects.

4a: Project 1: Collection and visualization of alternative tourism sites and objects in Lithuania

The project is taking place since Autumn 2013. The aim of the project is to collect and spread information on diverse sites and objects that are of interest to various groups of visitors, but are not included in official information sources and do not belong to the tourist infrastructure network ("undiscovered objects"– abandoned fortifications, caverns, sites of extinct villages, graffiti walls, places mentioned in fiction etc.). The main goals of the first stage that we report on were: 1) to perform a research on existing objects and geographic information available; 2) to prepare a study answering the questions about uniform typology of undiscovered objects, describing methods of collection and visualisation of information; 3) to prepare methodology and plan of crowdsourcing of such objects; 4) to design conceptual and logical database model and 5) to develop and launch a Web GIS application allowing for input, editing and download of information.

The research revealed interesting problems and possibilities of use of collected information, including actions related with identified dangerous or sensitive objects, development of new specific tourist routes, participation of local communities etc. The system is working and can be developed. Collected information will be periodically revised and published as at the national SDI portal www.geoportal.lt.

Project 1: Key Outcomes and Deliverables

Analysis of state of the art and feasibility study.
Original classification of objects and sites by appearance, possibility to analyse the collected data by subtypes and
Unique cartographic symbols for each subtype of objects and sites.
Methodology for crowdsourcing and detailed project of application.
Database of undiscovered objects and sites. The table of attribute data of objects and sites consists of name, type, subtype, primary purpose, age, condition, hazardousness for the environment or visitors, photos and/or video.
Web mapping application at http://www.nemasinis.lt was created using web browser native technologies such as HTML, CSS, JavaScript and SVG. This application is still in Lithuanian language. It includes web services of undiscovered objects and a tool for route planning.

Published research paper:
J. Jasiūnas, E. Maneikaitė, P. Venckus, D. Romanovas & G. Beconytė (2013) Mapping the undiscovered objects and sites in Lithuania, Geodesy and Cartography, 39:2, 64-71, DOI: 10.3846/20296991.2013.807960. http://dx.doi.org/10.3846/20296991.2013.807960.
Presentation at ESRI users' conference „GIS for education 2013" (October 16) in Lithuania.

Project 1: Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project

State Enterprise National Center of Remote Sensing and Geoinformatics "GIS-Centras" has supported the project of "Collection and visualization of alternative tourism sites and objects in Lithuania" within the internship funding programme „Crowd Sourcing in National Mapping". It provided the technological platform and consulting. All project activities were supervised by employees of "GIS-Centras". I officially state that the project was successful and very much appreciate the outcomes: a published research paper and Web application that has been launched for crowdsourcing of alternative tourism sites and objects in Lithuania thus creating new cartographic web content and promoting use of geographic information technologies. I believe the participating students have very much increased their qualification thus developing potential to continue their career at the "GIS-Centras". I believe in great value of co-operation between "GIS-Centras", academics partners and international geoinformation organisations and assure that in case of similar initiatives in the future the enterprise will provide all possible technological and methodological support.

Mindaugas Pažemys

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Project 1: List of Project Participants

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4.b Project 2: Incidental Crowdsourcing

The aim of this project is the validation of a toponyms database provided by the Spanish Instituto Geográfico Nacional with 136.454 entities which haven't been validated yet.

The process to validate toponyms is time-consuming and tedious. In Spain it has taken over 10 years to implement a model to standardize the nomenclature of municipalities, yet today there are still conflicts with the names of some places, especially in regions with two languages.

Our research considers an innovative and different way of data validation based on crowdsourcing. The massive and persistent participation of the public is crucial to achieve a complete validation of the current toponyms database. However, editing names of municipalities is not a motivating task at first sight, so users might need additional motivation.

In this project we are developing an application that applies Gamification techniques to encourage users to contribute their validations while playing a game. This novel approach of collecting data provides a mechanism to motivate users to revise names by turning a demanding and repetitive task into an engaging and enjoyable one. From the users' point of view, they will be playing a game while contributing transparently with a toponyms repository whose data can be later used by the administration and for scientific purposes. Users can obtain recognition by the community, prizes and a way to practice geography as a hobby.

We followed a multi-layer architecture that could be implemented and extended by other applications with a similar purpose. The first layer is the user interface where the users can play the game so called "Town Conquer" on their Android smartphones to provide their validations of toponyms. The second layer contains web services for processing the collected data and communicates with the database. When the process ends, the result is communicated to the user. On the third layer there are a Map Server and a Data Server. The first provides users basemaps layers, the geographical situation of the toponyms, the name that is currently stored. The second one has all geographical data, user profiles, game scores, logs, etc.

Project 2: Key Outcomes and Deliverables
The key outcomes from the project are:

1. A location based game for android smartphones that collects toponyms validations. The application will be released to the public at the *Jornadas Ibéricas de Infraestructuras de Datos Espaciales* in Toledo (Spain), on November 13-15, 2013.
2. Conference paper presented at AGILE 2013. "Towns conquer: a gamified application to collect geographical names"; J .Castellote, J. Huerta, J. Pescador and M. Brown, Leuven 2013. http://www.agile-online.org/index.php/conference/past-agile-conferences
3. Conference paper to be presented at the *Jornadas Ibéricas de Infraestructuras de Datos Espaciales (JIIDE)* in Toledo on November 13-15, 2013 http://www.jiide.org/

The application will be available for download from GEOTEC web site (http://www.geotec.uji.es) and from Google Play store.

Project 2: Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project

This project is supported by the Spanish Instituto Geográfico Nacional.

The contact point at the IGN is

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Project 2: List of Project Participants

Universities:

- University of Nottingham, United Kingdom
- Universitat Jaume I of Castellón, Spain

National Mapping Agencies:

- Ordnance Survey, United Kingdom
- Instituto Geográfico Nacional, Spain

4.3: Project 3: Ontology based Authoritative and Volunteered Geographic Information (VGI) integration

This project started with the idea of developing a method to handle semantic heterogeneity when integrating Volunteered Geographic Information (VGI) and authoritative datasets. The original idea was to use a common domain ontology as a pivot (based on the General Feature Model[1]) and then to match different datasets with different data models to this ontology, using R2RML[2] standard. This will allow the integration of different geographic information sources under the same conceptualization (Figure 1).

The method overcome some problems present in semantic similarity and ontology matching techniques, such as the impossibility of reusing the mappings or the fact that the user needs to build an ontology for each dataset.The main problem of this method was building the

1 http://www.iso.org/iso/catalogue_detail.htm?csnumber=39891

2 http://www.w3.org/TR/r2rml/

common domain ontology based on standard guidelines when VGI, such as OpenStreetMap (OSM) datasets, is involved. Further research showed us that we needed to face semantic heterogeneities within VGI before trying to integrate it with other sources. This way, many other projects dealing with geographic information integration and quality of VGI would be benefited as well.

Our ongoing research is focused on characterizing semantic heterogeneities in VGI, looking at its evolution through time and space. Quantifying semantic heterogeneity in VGI will lead to better decide about the semantic quality of datasets for a specific purpose or application, and will thus lead to a better integration with authoritative datasets. Our first results are not published yet, but we are currently working on how to quantify semantic heterogeneities based on specific concepts or terms in the OSM project, depending on the number of tags that users assign to the same real world phenomenon.

Project 3: Key Outcomes and Deliverables

The outcomes of the project were a short paper which was presented as a poster in AGILE 2013 Conference, and a presentation on the ACTIVITY Workshop, held in the same conference. The presentation, short paper and poster can be found online.

First results of our ongoing work are still unpublished, but a Semantic Heterogeneity map regarding the concept "platform" in Europe OSM datasets can be seen online.

Project 3: Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project

As a private company working in the Geomatics sector, the availability of semantically enhanced Volunteered Geographic Information (VGI) is a powerful tool for achieving our business goals. Nowadays there are many developments dealing with the quality of VGI as OpensStreetMap (OSM) datasets as a key issue for launching new geo-location based applications, using free and open data as a source of geodata. Semantic quality of OSM is a basic issue to solve, besides positional accuracy and completeness, in order to be able to use OSM in the market.

We, as a company, are really interested in the way VGI can be integrated with other geodata sources, as well as on the use of VGI for specific applications in order to develop our business model. For doing that in a realistic way, improved and high quality VGI datasets are needed, and we are pleased to support research, such as this project, on that direction.

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September, 2013

Project 3: Project Participants

Academic Partner

TU Delft (OTB Research Institute). From the beginning of the project to January 2013.

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Memorial University of Newfoundland (Marine and Geomatics Lab). From January 2013.

Contact: Rodolphe Devillers *[rdeville@mun.ca]*

National Mapping Agency

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Industrial Partner

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4.4 Project 4: Conflation of Crowdsourced Data

Along with the increasing power of Geographical Information Systems (GIS) there is an increasing demand for spatial data. Public and private institutions collect spatial data in different data models and scales in order to meet this demand. Additionally, huge amounts of spatial data are collected in Web 2.0 mapping portals. The result is a multiple representation of the same topographic objects of the landscape.

The aim of this project is to investigate the integration of such datasets. The integration will be done with conflation techniques. Conflation is a kind of spatial data processing that combines multiple layers of spatial data into one common layer.
We will use datasets from the German Mapping Agency (ATKIS BasisDLM: Authoritative Topographic Cartographic Information System in a density of 1:10,000) and from a Web 2.0 mapping portal (OSM: OpenStreetMap). In this project we will restrict on objects of the road traffic network. At first we want to identify the differences and similarities of ATKIS and OSM. The geometrical and topological data modelling has to be compared. The data sets will be superimposed on orthophotos and the different modelling of the road network will be examined and documented with examples.

Two different software systems will be used for the conflation of ATKIS and OSM. The first system is a prototype that was developed by Hainan Chen within the scope of a PhD at the Institute for Photogrammetry. The other system is 1Integrate from the company 1Spatial. In the ifp conflation program, the datasets are first manually matched and then automatically conflated. 1Intergrate is a fully automatic rule-based spatial data evaluation and processing software. The reference and target datasets are imported into the system. Then predefined rules and actions are executed to conflate the data.

In a first step, the datasets have to be pre-processed in order that they can be inputted into the systems. Then, the working processes of the different software systems have to be compared and documented and the conflation strategies have to be evaluated.

Project 4: Key Outcomes and Deliverables

Datasets of two test areas (Stuttgart and Calw) with a size of 2×2 km² were conflated with the two software packages. Stuttgart is the capital (population about 600,000) of the state Baden-Württemberg. The test area is located in the downtown of the city with a complex street network. The other test area is Calw, which is a smaller city (population about 25,000) in the southwest of Stuttgart with a less complex street network.

A comparison of the datasets shows that the data collection in inner-city areas is more detailed in OSM whereas the road network in rural areas is collected mostly similar in ATKIS and OSM. Four kinds of differences could be identified: data completeness differences, endpoint differences, differences because of different collection accuracy, and semantic differences.

Both software systems were able to match the data. The main difference between the systems is that the ifp software needs manual input for the matching (which is very time intensive) whereas the 1Integrate software is fully automatic. This restricts the use of the ifp software to smaller areas.

Z. Liu and V. Walter and D. Fritsch **Conflation of National Mapping and Crowd-Sourced Data – A Comparison of Two Different Approaches.** *Proceedings of 26th International Cartographic Conference 2013* at Dresden, Germany, August 2013 http://www.icc2013.org/_contxt/_medien/_upload/_proceeding/450_proceeding.pdf

Project 4: Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project

1Spatial is proud to support this type of innovative research project which further proves our capabilities for applying rules-based automation to the management of spatial data. Our 1Integrate product is part of a suite of products to efficiently and consistently plan, maintain and publish data, whilst also automating production workflows to some of the world's largest National Mapping Agencies.

The main task of LGL is keeping the digital landscape model ATKIS-BasisDLM up-to-date in a specified quality for all of Baden-Württemberg. In order to provide this coverage for all objects fully automatic processes are required. The results of the project are demonstrating that Radius Studio is the appropriated software which meets these conditions and is also able to take over up-date information from various data sources and to integrate into our BasisDLM. In this way the quality and currency of our data could be improved significantly.

Project 4: Project Participants

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4.5 Project 5: Characterising the use of vernacular placenames from crowd sourced data and a comparison with NMA Data

Gazetteers, directories assigning coordinates to placenames, play an important role for the querying and retrieval of geographic information. According to [1] 13% of all search queries contain a placename. But often gazetteers only contain official toponyms in the language(s) of the providing national mapping agency (NMA). Alternative or vernacular names often used in daily language or even translations are rarely found. User-generated content provides potential to identify and extract vernacular placesnames and to enhance and extend classical gazetteers of NMAs (e.g. [2–4]). Between 28% and 35% of all tags to describe photos on Flickr are placenames and 70% of all images contain at least one placename [5, 6].

Thus this work tries to identify, extract and characterise the placenames people use as tags to depict their photos on Flickr using a simple approach based on tag frequency and user characteristics [7, 8]. Further we compare the extracted placenames with toponyms from an NMA sourced gazetteer.

To build a representative dataset we filtered tags for bulk uploads, multiple uploads of the same tagset and to include only those used on at least four occasions and by 2 users. After filtering only 180’569 or 8.3% of the initial 2’177’947 images remain in the dataset. This confirms that such datasets can be heavily influenced by prolific users and bulk uploads as proposed by [4]. Approximately 35% of the toponyms listed in the gazetteer could also be found in the extracted tags that describe the location of grid cells [7]. Conversely, only about 1% of all extracted tags are official toponyms. Our analysis pointed to different reasons, why those tags describe a location without being an official toponym and showed their potential to enrich gazetteers with more content. In our case, it is unlikely to cover a big city like Paris completely and satisfyingly with only 496 toponyms provided by the IGN.

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Project 5: Key Outcomes and Deliverables

- List of tags, filtered for bias, and allocated to geographic footprints, in Paris
- Comparison of tags with official toponyms from the IGN
- Classification of toponym types which commonly occur in user generated content
- Planned publication (e.g. AGILE full paper) describing the methodology applied and our results

Project 5: Official comment on the success of the project from the National Mapping Agency (NMA) partner or Industrial partner on the project

It is impressive to see the rise of Flickr content which makes it possible to mine Paris flickr tags and compare them to IGN gazetteer. Using IDF, TF and UF criteria indeed reveals interesting things, some of which have been discussed in the report and others are more perspectives. This work especially yields interesting results regarding a new kind of geometry for a feature of interest that is not its classical geometry (the footprint in a gazetteer or topographic database) but that is its area of perception. This may have consequences on interpreting names into location. As you pointed out, it would be useful to use polygonal footprints for places like parks. Some features like France or Seine are not considered to be large scale features so that their names do not belong to this gazetteer. Topographic data would be useful also to analyse the "area of perception" of a feature by comparing its geometry and the flickr footprint, and analysing the spatial context. Obviously, in Flikr perception is related to being visible but is that all?

The IGN was very eager to see what additional words could emerge, thanks to this original method, to be characteristics for places other than names in classical gazetteers. In the top 50 words that reveals characteristics for place and that cannot be found in IGN gazetteers, most are related to topographical features except for two : night and art. It would be interesting in future work to investigate how these two words come to be characteristics of specific places and to try the same experiment in other cities.

Besides, we wonder if it is possible to identify communities of users based on the kind of tags they use, to see if there are some cultural biases in characterising places with words.

Last, we have a concern for evaluating and documenting the "validity" of a toponym and would be interested to see if it is possible to use the frequency values and user profiles to come to a trust value.

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Project 5: Project Participants

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5 Conclusions and Recommendations.

In 2011 when the first ideas about a project on "Crowdsourcing and National Mapping" were being formulated one of the principal goals was to ensure that any project proposal would include a collaboration between academic partners and a National Mapping Agency and optionally an industrial partner. The project sought the joint support of AGILE and EuroSDR so as to engage two of the leading research organisations within Europe. The project sought to establish a number of research internships which would be based on collaboration between academic and NMA partners. To this end the project has been an outstanding success.

We would like to emphasise that in all of the five projects described above the National Mapping Agency partners were not just collaborators but active participants, providing leadership, research vision and technical expertise. We emphasised from the outset of this programme that maximum added value would be only be gained from the establishment of projects where the National Mapping Agency partners were active participants. All of the five projects outlined in this report have significant potential to carry out future work on the specific problem(s) they dealt with and also continue an active research collaboration with the corresponding National Mapping Agency and/or Industrial partners. The academic partners in the five projects provided the research skills and infrastructure necessary to treat these projects as special incubator projects whereby the National Mapping Agency could test or investigate some aspects of crowdsourcing geospatial data or VGI without a significant drain on their resources.

In the final section of the report we provide a listing of the publications arising from this project. Overall, there are 9 peer-reviewed international conference/workshop publications arising directly out of the five funded projects. The authors of several of these papers have indicated that these will eventually be extended to full peer-reviewed journal papers in the future.

To summarise the following is a list of the key outcomes from this project:

1. A collaboration between EuroSDR and AGILE on Crowdsourcing and VGI
2. There were 8 academic institutions involved
3. There were 2 Industrial partners in the projects
4. There were 5 National Mapping Agencies involved as collaborators in the project
5. There were 9 peer-reviewed international conference/workshop publications produced

6. ERSI Europe provided funding for two projects
7. AGILE and EuroSDR provided funding for 1.5 projects each

What are the next steps?

The five projects which have been described in this report are part of Phase 1 of this EuroSDR and AGILE collaboration. In October and November 2013 we shall be making presentations and proposals to both EuroSDR and AGILE for their funding support of Phase 2 of this project. The structure of Phase 2 will be similar to that of Phase 1. We have plans to hold another International Workshop event for Phase 2.

While we will not be prescriptive of what project themes the next phase should seek to fund and support we feel there are a few issues which should be considered closely. In the next phase of this project some of the National Mapping Agencies involved (for example Kadaster Netherlands) felt that there will need to be more focus on the social aspects of crowdsourcing of spatial data. What is the correct type of communication for the crowd? What are the best channels to engage the crowd?

Crowdsourcing of spatial data must not be focused on maps alone. The opportunities for using photographs, video, text, social media, etc to higher the overall quality of crowdsourced spatial should be explored. Understanding how to integrate crowdsourced spatial data into the workflow and quality control/quality assurance processes of NMAs is a very important step in the overall vision of crowdsourcing as a complimentary activity. How does this integration conflict with the NMAs legal mandate to supply topographical and cadastral mapping products?

Overall we feel that this collaboration was a great success. Our vision was to begin with small self-contained and easy to manage projects which would generate interesting results and insights whilst building a network of collaborative links between academic, industrial, and NMA partners. This report is an output of the overall project itself and we feel that it will be benefit to many researchers, academics, professional GIS practioners, etc beyond EuroSDR and AGILE. The report shall be made publicly available [URL to Follow after final acceptance of this report] so as to ensure the widest possible dissemination of the information and experiences contained within it. It is our aim to reflect further on the outputs and experiences of Phase 1 and Phase 2 at the conclusion of Phase 2 and produce a peer-reviewed journal paper which describes the projects, their successes, and the opportunities which will be available based on the collaborations which are formed in the two phases. We hope that this paper will provide an important contribution to the state of knowledge in the areas of Crowdsourcing Geospatial Data and Volunteered Geographic Information.

The authors of this report would like to acknowledge the collaboration, assistance, and efficiency of a number of people who played a role in making this project a success. While our list contains a long list of people we would like to single out the following for special acknowledgement: Prof. Mike Jackson, Prof. Hardy Pundt, Prof. Lars Bernard, Prof. Dieter

Fritsch, Prof. Mike Gould, Mr. Paul Hardy, Dr. Kevin Mooney, Ms. *Anneke* Heylen and Dr. Joep Crompvoets. We extend our thanks to Martijn Rijsdijk, Manager R&D, Kadaster Netherlands who performed a review of this report and supplied us with very helpful and insightful feedback. We are grateful to EuroSDR, AGILE and ESRI Europe for the funding to date. Any errors or omissions in this report are certainly of our own making.

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