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# Crowdsourcing in National Mapping

Peter Mooney, Joep Crompvoets, Rob Lemmens

Workshop Report

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“Crowdsourcing in National Mapping – A workshop report”

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## ABSTRACT

The usage of crowdsourced geographic data and information and Volunteered Geographic Information (VGI) by National Mapping and Cadastral Agencies (NMCA) and the Geomatics Industry is a very current, challenging and topical subject. Many NMCAs in Europe are actively using these sources of spatial data within their processes and workflows in the production, management and distribution of national geographical data and associated products. One of the major obstacles in the wider adoption or even investigation of crowdsourcing in national mapping results from the lack of collaborative projects or studies between the crowdsourcing community and the NMCAs. Wider scale collaboration has not happened. This report outlines the outcomes from a workshop “Crowdsourcing in National Mapping” organised and held in Leuven, Belgium in April 2017, and funded by EuroSDR. The workshop follows on from a similar, inaugural event, held in Nottingham, UK in 2013, also co-funded by EuroSDR. The overarching goal of this workshop event in 2017 was to bring crowdsourcing projects from the spatial domain, academics/researchers, SMEs and NMCAs together for 1.5 days of debate, discussion, planning, networking and collaboration on ways to move forward in more integrated approaches to Crowdsourcing in National Mapping in Europe.

The report outlines a number of key outcomes for the stakeholders involved. EuroSDR should consider providing funding to ensure future workshops of this type take place. This will help ensure all stakeholders in this domain continue to interact, collaborate and learn from each other. In particular academic research could provide an important future role in understanding how crowdsourcing and VGI is affected by policy changes such as GDPR. The answer to how the Crowdsourcing communities and NMCAs can work together will emerge from further understanding how to define the role of NMCAs into the future. There is also still much work left to do in understanding the legal and ethical frameworks for working with VGI/Crowdsourcing from the NMCA perspective. Finally, a clear opportunity for VGI/Crowdsourcing going forward is identifying niche or new data streams to focus on.

## 1 Introduction

Crowdsourcing, understood as outsourcing tasks or data collection by a large group of non-professionals, is increasingly used in scientific research and operational applications (Minet et al, 2017). The term “crowdsourcing” was progressively assigned to many scientific and operational initiatives aimed at collecting contributions from a large group of people. Volunteered contributions from non-professionals has been used in the scientific research area for a long time before the internet era (Franzoni and Sauermann, 2014). However, current crowdsourcing initiatives are always mediated by internet platforms and one cannot be analysed without considering the other. Crowdsourcing has steadily grown in popularity within the spatial domain including cartography, spatial data gathering and earth observation (See et al, 2016).

This is an exciting time in the development of Volunteered Geographic Information (VGI), Crowdsourcing, and Citizen Participation. The use of crowdsourced geographic information and VGI and crowdsourced spatial data and information by National Mapping and Cadastral Agencies (NMCA) and the Geomatics Industry is a very current, challenging and topical subject. There appears to be increasing interest from NMCAs in Europe regarding the possibilities offered by VGI and Crowdsourcing. Many experts (Olteanu - Raimond et al, 2018) see very rich potential for collaboration and integration of NMCAs, the Geomatics Industry and citizen-based crowdsourcing (such as OpenStreetMap, Ushahidi, Geonames, Galaxy Zoo, GeoWiki, Flickr, GeoWiki, etc). There have been some limited examples of where collaboration and integration has happened (Mooney et al 2017). However, for a myriad of reasons realising this potential for collaboration is not very easy. Where NMCAs have initiated projects to explore citizens’ participation to improve the quality of various spatial databases. One of the most frequent conclusions from these initiatives was that the data coming from crowdsourcing initiatives is not always uniform and not homogeneous across a whole country or territory. On the other hand, VGI and crowdsourcing initiatives have worked on their own projects rather than with NMCAs for a number of reasons. These include: differences and complexities in licensing and data ownership, methods and modes of data collection and the motivation and engagement of citizens to take part.

Upon issue of the workshop announcement and the call for participation a number of topics for discussion in the workshop were set out. The idea behind this broad spectrum of topics was twofold:

firstly to ensure that the workshop attracted a wide variety of stakeholders and secondly to provide a working context for the workshop itself. Some of the topics were taken from the outcomes and future work possibilities from the report of the previous Crowdsourcing in National Mapping workshop (Mooney and Morely, 2014)

- What are the key sources of VGI and how do they complement each other? How are they relevant?
- How can these sources of VGI be successfully combined?
- How can VGI and crowdsourced spatial data compliment or assist in the work of NMCAs and industry?
- How do we then improve/measure the quality of VGI for NMCA and industry applications?
- European-wide SWOT analysis of VGI in NMCAs – by survey? Interview?
- What can VGI be used for (and not used for) in NMCAs or in Industry?
- Investigation of Geographic Information services for facilitating VGI
- What are the precise needs of NMCAs for VGI?
- What are the precise needs of the VGI community from NMCAs?
- In practical terms how can NMCAs and the VGI community work together?
- What are the key issues in semantics and interoperability of VGI for use by NMCAs and Industry?
- How can business models for VGI in NMCAs be developed?
- What are the privacy, legal and ethical issues related to the use of crowdsourced information and VGI by NMCAs and industry?
- What are the most pressing issues for the future of VGI – sustainability, attracting contributors, etc?

There were over 60 delegates in attendance at the workshop. With the support of EuroSDR we were able to offer complimentary registration to all of the delegates. Ordnance Survey (OS), the national mapping agency of the United Kingdom, also provided sponsorship of this event. No financial support was provided for individual delegate travel and subsistence. Lunches and coffee breaks were provided to all delegates.

This workshop follows on from a very successful workshop and short funded projects (funded at short internship level) in 2012/2013 managed by Peter Mooney (Maynooth University, Ireland) and Jeremy Morley (currently Ordnance Survey GB, formerly University of Nottingham UK at the time of reporting writing) with the support of EuroSDR, AGILE, ESRI Europe, and several participating National Mapping and Cadastral Agencies. The full report of this workshop is available at Mooney and Morely (2014). The primary motivation of the first workshop was to carry out a preliminary investigation into the scope for crowdsourced geospatial data and VGI to be used by NMCAs. The first workshop was successful in establishing a small number of research internships which were based upon collaboration between academic and NMCA partners. Crucially in the workshop report Mooney and Morely set out a plan for further collaborations and engagements on this topic with NMCAs and the crowdsourcing communities. “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 NMCAs and Government Agencies in Europe and beyond”. This will be a long journey, but it is very important that steps are taken to begin this journey. Olteanu-Raimond et al (2016) close their paper with the belief “that NMCAs will exploit the potential of VGI in order to reduce their production costs and improve currency by defining new workflows for VGI integration and quality assurance on the one hand and building trust and cooperation with VGI communities and citizens on the other hand”. This is a very promising outlook.

It is hoped that this report can provide a stimulus for further research and discussion on the topic of Crowdsourcing in National Mapping. A workshop spread over 1.5 days can only scratch the surface of the issues facing NMCAs and Crowdsourcing projects and initiatives. This report can act as a snapshot in time and a valuable point of reference for future research work in this area.

### *1.1 Structure of this report*

The challenge in writing this report was in trying to capture the wide ranging and deep discussions between delegates in break-out groups and open floor sessions while coupled with the invited

presentations from a small number of invited speakers. Subsequently the report is structured a series of summaries of each of the main sessions in the workshop. We have purposely avoided attributing specific statements, opinions, discussions, etc to a specific delegate except where necessary or unavoidable. Rather these summaries are our interpretation of the presentations and discussions over the 1.5 days. All presentations are available on the workshop website<sup>1</sup> and we refer the reader to these for more specific details.

We are very grateful to those delegates who volunteered to act as rapporteurs and take notes during the Group Discussions. The summary of discussions are written and compiled purely out of community goodwill and are intended to represent the views and opinions discussed within the discussion groups. They are of high value for research discussions. The difficult task of being rapporteur in fast paced discussions is acknowledged. Where possible we have left out specific names of people and companies/organisations.

## 2 Workshop Timetable

The table below outlines the list of activities in the workshop over 1.5 days. The active hyperlinks have been maintained in the document to allow direct access to downloadable content such as presentations or outputs from the breakout groups.

### DAY 1

TIME	ACTIVITY
09:00 – 09:10	Peter Mooney Official welcome to the workshop, aims for the two day, planning etc. Short overview of the key issues for consideration in VGI and Crowdsourcing of Spatial Data.
09:10 – 09:35	Joep Crompvoets Overview of EuroSDR (10 minutes). Rob Lemmens. A general overview of the plans for the Hackathon breakout sessions
09:35 – 10:00	NMCA viewpoint or overview. - The Netherlands' Cadastre, Land Registry and Mapping Agency, Ms. Magdalena Grus (20 minutes + 5 minutes questions) (Presentation for Download)
10:00 – 10:25	Industry viewpoint - ESRI Mr. Nick Land - Business Development Manager, National Mapping and Cadastre, Esri Inc (20 minutes + 5 minutes questions)
10:25 – 10:50	Academic Research Viewpoint: Dr Vyron Antoniou - Hellenic Army Geographical Services, Athens, Greece
10:50 – 11:30	Coffee break and networking
11:30 – 11:55	The VGI or Crowdsourcing Viewpoint #1: Mr. Joost Schoupe, OpenStreetMap, Belgium
12:00 – 12:25	The VGI or Crowdsourcing Viewpoint #2: Mr. Maarten Van Der Veen, Initiator @ 510.global, Netherlands Red Cross

<sup>1</sup> <https://www.cs.nuim.ie/~pmooney/eurosd2017/>



12:30 – 12:45	The VGI or Crowdsourcing Viewpoint #3: Dr. Mari Laakso, Finnish Geospatial Research Institute, National Land Survey of Finland Bringing the local knowledge in to the NLS/NMCA maps. Piloting a VGI map service for topographic data collection. Development of the service and first experiences
12:45 – 13:00	Peter Mooney - Brief summary of the morning's activities and presentations.
13:00 – 14:15	Lunch and networking (Lunch is sponsored by EuroSDR)
14:15 – 15:30	Breakout Session 1: RESEARCH SESSION, Session Leader Peter Mooney In this session we move away from presentations and shall organise all delegates into groups. We will create small groups with a specific leader for each group. Group leaders will be assigned, and these individuals asked to perform these duties before the workshop begins. Each group with a challenge, research topic or problem to consider for open discussion. In this session the NMCAs, Industry, Academic or VGI partners can propose some VGI research, Crowdsourcing or operational problems they are interested in. We will attempt to assemble groups (with a good mixture of delegates from diverse backgrounds). These groups will breakout into other rooms within the workshop venue.
15:30 – 16:00	Coffee break and networking
16:00 – 16:15	Breakout Session 2: Hackathon Challenge Introduction Session Leader - Rob Lemmens This session will provide an introduction to the Hackathon principles and planning. This introduction can extend beyond this time slot if required. Delegates should be prepared to be active again in this session. There will be a focus on the development of software for VGI within NMCAs.
16:15 – 17:30	Breakout Session 2: Hackathon Challenge Proposals Session Leader - Rob Lemmens The idea of the continuation of this breakout session is to discuss the merits of proposals for hackathon challenges. Ideally NMCAs or Industry partners can propose hackathon challenges which they are interested in. The VGI, Academic, Research partners can then also provide their input. In terms of an actual hackathon this session will lead directly to a separate follow-up event after this workshop
17:30 – 18:00:	Summary - What has happened today? Peter Mooney and Joep Cromptvoets. A summary of the first day What has happened, what are the initial outcomes of the afternoon sessions, etc. What has been the reaction to the workshop so far, etc.
18:00	Close for Day 1
Evening of Day 1	Group Dinner

## DAY 2

TIME	ACTIVITY
09:00 – 09:05	Peter Mooney: Welcome to Workshop Day 2 Short overview of the plans for the second day
09:05 – 09:30	What is in the VGI Research Agenda? - Dr. Frank Ostermann, Faculty of Geo-Information Science and Earth Observation (ITC) of the University of Twente, The Netherlands  This presentation will outline some reflections from a research focus on “objective” quality measurements instead of fitness-for-use and a lack of longitudinal studies in the VGI domain. Dr. Ostermann will suggest some ways of moving VGI research forward (beyond OpenStreetMap, beyond reduction to a single version of “the truth”, and beyond disciplinary boundaries).
09:30 – 09:55	NMCA Challenges in Crowdsourcing and VGI #1: Dr Tobias Kellenberger, Swiss Federal Office of Topography
09:55 - 10:20	NMCA Challenges in Crowdsourcing and VGI #2: Jeremy Morley, Ordnance Survey UK
10:20 – 10:55	Coffee break + Group Photographs.
10:55 – 12:00	Breakout Session #3: Session Leaders: Joep Cromptvoets and Peter Mooney. The Crowdsourcing in National Mapping Future Research Agenda  Summary: The delegates were split into two groups A and B simply based on which table they were sitting at in the main meeting room. Both groups worked independently with the question: What are the relevant research areas and/or research questions for VGI/Crowdsourcing in the future ?
12:00 - 12:35	Breakout Session #4: Session Leader: Rob Lemmens. The VGI Knowledge Portal  During this breakout session Rob Lemmens will introduce delegates to the <a href="#">VGI Knowledge Portal</a> . This portal provides information about the whole domain of Volunteered Geo-Information (VGI) by presenting its relevant concepts, products and their relationships. It represents a very important information resource on the Semantic Web. Rob will assist delegates in providing their own information to the VGI Knowledge Portal.
12:35 – 12:55	Informal Summary of the Workshop
12:55 – 13:00	Official Closing of the Workshop: Peter Mooney - closing remarks and thanks to sponsors and of course the participants.
13:00 – 14:00	Lunch and networking and departures (Lunch is sponsored by EuroSDR)
14:00 – 15:00	Further informal discussions and networking by participants

### 3 Overview of key points for discussion from invited speaker presentations

Crowd or citizen feedback to NMCAs is not new. swisstopo described examples from the mid 1800s where map sheets were returned with corrections to place names marked on to them. A lesson learned from crowd feedback is that almost every message must be considered for transparency purposes. VGI could be considered as being used as ‘hints’ to where there may be potential errors or inaccuracies. However, for the most part, these ‘hints’ are not usually integrated into NMCA workflows. In some cases there may be too few of these hints and in other cases too many. NMCAs find it difficult to provide resources to deal with these type of feedback mechanisms in addition to provision of other data quality or maintenance services.

OpenStreetMap (OSM) is a dominant project on the VGI and Crowdsourcing landscape. The OSM community feels that they can work with government agencies such as NMCAs but need to ensure that there is a ‘give-and-take’ approach. The key items which the OSM community consider as necessary for a partnership with government agencies are:

- Top quality basic data which is openly accessible with a flexible license
- These data stores should have a User Interface and a machine-readable interface (API)
- There should be sufficient metadata
- The potential for co-created services.

The idea of co-creation is an interesting one. A little government involvement could see datasets created that could then be reused by government themselves. To support co-creation we must try to introduce structures which encourage integration. One of the fundamental ways that this can be achieved is to build personal contacts between the VGI communities and NMCAs.

The sustainability of VGI projects is something that is difficult to forecast. One of the key components of sustainability of VGI projects is how long can it remain to be “fun” for contributors to be involved? One of the important tasks will be trying to ensure that contributors will ‘like’ to fix errors or maintain/update data into the future.

In terms of Disaster Relief and Disaster Management VGI and crowdsourcing has still untapped potential to improve logistics and navigation in these situations. VGI and crowdsourcing can contribute quickly and successfully to resources such as damage estimation models. But there are a number of things needed required by VGI and crowdsourcing for continued, and improved, success in these situations. The requirements include:

- Road classification and tagging guidelines
- Coordination between government and authoritative agencies and locals (who is mapping where and who is responsible)
- Local coordination is essential. There is a limit to what can be achieved remotely. Remote interest in mapping can be variable. It can be very intense during the event but can quickly fade soon after the disaster event itself (Granell and Ostermann, 2016)
- High-resolution (30cm) up-to-date imagery would help both local and remote efforts.

In regards to academic research on VGI there is always the need to have a problem with VGI to solve. The focus in VGI-related research is still very much data centric. Results and methodologies are mostly not reproducible. Frank Ostermann asks the following questions:

1. Are we asking the correct questions in VGI research?
2. Are we looking at VGI in the right way? Focus on single events, short timeframes, comparing areas, comparing features, etc.
3. Are we talking to the right people?

Academic research may consider a change in focus in how they carry out their research in VGI. Volumes such as Foody et al. (2017) outline the state-of-the-art in academic research on VGI. However the focus of academic research must continue to adapt and change namely:

1. Consider ‘fitness of purpose’ instead of a focus on quality
2. Shift the focus – people, longitudinal studies over time, faster outputs, living documents, open, collaborative. Become more sustainable and reproducible.

VGI as a formal academic research topic is about 10 years old. It is a "disruptive innovation". Despite this relatively short lifespan VGI has found support in places like the EU via COST Actions. The fundamental assumption is that NMCA produced spatial data is of better quality than VGI produced data. Many academic studies have shown this not to be the case. However, many different methods have been used and there is not really, yet, an agreed upon set of VGI quality indicators. Some assessments of VGI data quality involve comparison with authoritative datasets while other involve intrinsic approaches.

There is a cross domain question of how could crowdsourcing and VGI have effect on the workflows within NMCAs? The VGI continuum is as follows (from 1 to 6) where 6 provides the most control for the VGI or crowdsourcing project: VGI/Crowdsourcing can act as:

1. Passive data provider
2. Crowd-based data uploader
3. Crowd sensor
4. Crowd visual sensor
5. Crowd scientists/analysts (Citizen Scientists)
6. Crowd defines the problem and owns the data.

In reality there is much we still do not really know about VGI and Crowdsourcing of spatial data.

1. How many contributors are actually needed in crowdsourced projects? Is there any way of knowing this?
2. What value do "social spaces" such as online chat rooms, discussion boards, etc. have in terms of interacting or interfacing with contributors?
3. Tasked contributors – do approaches where a clearly defined outline of tasks is provided to contributors actually work?
4. Where does VGI position itself if in the next few years all of the data will be freely available in many countries? What role does VGI then try to fill or address?
5. In this Big Data era there is still a place for the human eye to consider data, as the crowd visual sensor. But this type of crowd interaction can be resource intensive: technically for setting up systems and possibly financially for providing incentives and rewards for participation.

## 4 Breakout sessions – Summary of discussions

As outlined in the workshop timetable we had several breakout sessions during the workshop. The sessions were driven by a set of pre-defined questions for discussion where these questions sought to consider the different scope, needs and interests of the workshop delegates. These sessions generated a large amount of very interesting discussion material. We have divided up the outputs from the breakout sessions into four different topics namely:

- **Requirements Gathering:** What is necessary for more integration between VGI/Crowdsourcing and NMCAs?
- **Communication and Collaboration:** How can collaboration be established and maintained between VGI/Crowdsourcing and NMCAs?
- **Operationalizing VGI and Crowdsourcing in NMCAs:** What steps, processes, etc are required to integrate VGI and Crowdsourcing into NMCAs?
- **Research Agenda and Way Forward:** What are the key research questions which require exploration in this area?

Under each of these topics we provide the specific question or statement supplied to the breakout group sessions followed by a summary of the remarks and discussions. We have tried to retain as much of the commentary in verbatim in order to retain the atmosphere and feelings of the discussions.

### Requirements gathering

QUESTION: How can sources of VGI be successfully combined with NMCA/government/other data?

- The risks associated with crowdsourcing data must be calibrated. Combining the data is one of the biggest problems in the future. There are unintended consequences of the combination of data which are not easy to predict or understand.
- Ethics are not clear. Do we need ethical or legal frameworks? Do they need to be introduced? It is still hard for non-legal people to make the link between the consequence and the linkage of datasets.
- NMCAs need to be very careful about which data they combine themselves with.
- Would this be going too far? Do we censor what happens to data? We should not restrict the information gatherer. There are restrictions on crowdsourced data - national security, public security, etc. There are deep issues concerned with the restriction of access to data or the recreation of data. Who is making the rules then? If there are serious consequences for data usage then few would consider being part of the crowd.
- Should the goals change for NMCAs? Should they become a gatherer of all crowdsourced data or VGI? Now that NMCAs are not necessarily the sole producers of data - should their role change? Should they take a role of quality assessment of this crowdsourced data or VGI.
- Completeness, coherence, actuality, etc - these are all needed by NMCAs. Why is the crowd producing data which NMCAs are actually producing? Is this not replication of effort? Wasted effort? NMCAs have been caught in between what they can do and what the crowd or public are requiring? Perhaps in the terms of open data - NMCAs may not be able to provide certain data as open data.

QUESTION: How do we improve (or measure) the quality of VGI data for NMCA needs?

- The size of the crowd is very important. It is a deciding factor. Low numbers of feedback in crowdsourcing scenarios is often the result of low number of users or contributors: “You cannot have crowdsourcing without a crowd”
- Médecins Sans Frontières use the missing maps and map-swipe (pre-selection) systems; explains the set-up with crowd-sourcing. Quality assurance in validation steps (of remote mapping, by expert mappers), and then validation on the ground (by volunteers as well as professionals); There have been research projects into the quality (Ballatore and Zipf, 2018) (e.g. comparing with machine learning) but very often these have found that human crowdsourcing is better.
- There is no clear-cut line between volunteers and professionals. There are lots of professionals who are involved as members of crowdsourcing projects.
- Do NMCAs measure the quality of their data? How do they do this? Would it be possible for these quality tests or procedures to be made more accessible? Then they could be used on VGI datasets as tests.
- Do OSM (and other VGI data sets) suffer in quality because their data model is not fixed? E.g. difference between paths and roads?
- Are semantic problems such as ‘what is a path’ only theoretical problems? Is this different for NMCA data. For example, is there an accepted definition of a ‘path’ between all Federal and Regional mapping agencies in specific countries?

QUESTION: What are the needs of Industry and National Mapping and Cadastre Agencies (NMCA) from Volunteered Geographic Information?

In this breakout group the delegates chose to expand the initial question that only focuses on NMCA to also focus on industry and academia because the needs might be different according to the perspective.

NMCA Perspective

- Data Quality is a key need from all stakeholders. However, the conception/demands of quality by stakeholders are maybe different, depending on the context. There are clearly different ‘types’ of quality (for some cases, it is more relevant than other).
- NMCAs clearly need the data that is modelled. That is why they offer “fields” (non-mandatory but as checks) to build formal maps. The INSPIRE Directive focuses more on

compliance than on actual use. The NMCAs focus on potential use instead of compliance. This is an area of collaboration with users and stakeholders. Thus, VGI is an opportunity to re-connect with the end-users and subsequently to determine their needs.

- An additional need from NMCAs of VGI would be to have assistance with the completion of the data (ex: tracks, speed limit, etc...) A consideration for non-terrestrial VGI should also be considered for the future. The NMCA needs other sources of data collection because they may not be able to offer it in another way.
- When one talks about collaboration then we must consider collaboration among levels and among organizations. When an NMCA offers Open Data this can feel like creating one further step away from the users. The question is which is the optimal level (Federal? Regional ? Local ?) to enable VGI and interactions with VGI. Sometimes, it is more helpful to use “specialists” (forest keepers to map forests instead of random citizens).
- A repository of citizen profiles with their interest in VGI would be helpful for the future. Furthermore, it is also necessary to identify good practices to collect data. The advantage of VGI as data collector is that it is done at a cheap cost.
- Furthermore, there must be a reflection about a sustainable business model which can integrate open data and VGI. When there is less political and financial support the current business model is not sustainable if NMCAs open the data.
- A legal view on VGI regarding intellectual property rights (who is the owner?) is missing from research. Furthermore, a clear role structure must be formalised. This will help to find out who is responsible for what in terms of map updates or map creation.

#### Industry Perspective

- Industry want reports to state when a map is wrong on all features in order to have the best quality of data. From the industry perspective there is also the question about how to stimulate citizen participation?
- Some industry players do not know why people contribute to their VGI projects because they do not really motivate them to do so. Regarding this motivation of users, it appears that people are motivated by having useful information and good representation.
- But industry does not reward the users. Are the problems of motivations similar in NMCAs as in industry and the private sector? From an industry perspective there is a need to move to more advanced crowdsourcing (for ex: mapping of polygons rather than just a point)

#### Communication and Collaboration

QUESTION: How do NMCAs see their changing role?

- Do NMCAs become data brokers in the future? Become less traditional? The NMCA still has to produce something that is authoritative - it must be trusted.
- The crowd is local and international - the crowd is losing trust in experts - there is a general global distrust atmosphere. So who do they trust? “The people” - who are these people? Who are these as customers?
- NMCAs can give away data as open data - and then other customers can map on it what they want? They can add on crowdsourced layers. If this is something that the public is looking for - then the NMCAs can consider actually making resources available to try to provide these data.
- The *easiest thing* is gathering data for the first time. There is no glamour in maintaining data after and into the future. Who will do all of the updates? Passive groups and passive crowdsourced data could be used - but how? OSM and NMCAs agree that updating a map and keeping it current is resource intensive. It is difficult to do. A future potential role is looking at other sources of data as a means of updating the current datasets.
- NMCAs - long lasting things are the focus and always have been. Short term things such as fires, innovations, flood, etc. are not. In these situations, then the best group is the crowd. Can the crowd be available? The crowd does not have the same view of the map as a NMCA. The crowd are looking for something more instantaneous.
- Cross-national and global datasets - are usually basic data - not very advanced data or parameters. Some countries do not have these fundamental datasets - for most of the African

countries. In some cases, authorities do not want to map locations because they will give them some type of “formality”. What then if a company comes along and then takes the crowdsourced data and then creates a product?

Question: In terms of collaboration - what are the needs of the VGI community from NMCAs?

In the discussion from this breakout group it was decided that VGI is in a great part equal to OSM. Therefore, OSM was used as the focus for discussion. VGI needs from NMCAs can be easily summarised as follows:

- To work together with NMCAs, constructing a win-win situation.
- Both VGI (here OSM) and NMCAs have the same attitude and need for completeness and quality. They are not different in this regard.
- Transparency is an issue. There must be a clear feedback mechanism for any VGI integration with NMCA. The types and levels of transparency depends on the project. Small projects do not need complicated feedback systems.
- Open data. The NMCA must provide open data when working with VGI. Some NMCA are not sure about the return on investment of open data.
- Clear data license (creative commons license). There must be a strong agreement on the license. In many ways this is more important for the NCMAs. VGI projects will want guarantees that the created data will stay free. However, there is not a one-size-fits-all solution. There is significant difference in licenses between countries.
- Logistical and financial support to get started (it can be hard for individuals that want to start mapping).
- Data quality needs and requirements. How can the NMCA communicate these to the VGI project. There will need to be information about the quality requirements. It is necessary to communicate what kind of quality is needed and what is the quality of the authoritative data? These types of requirements might not be very easy to communicate. For some NMCAs 50% of work resources is needed for quality checking.
- Perhaps VGI projects could seek collaboration? Collaboration between OSM and government can happen, but both must think about the end-product together. Governmental data can relatively fast be integrated in OSM but there is a need for support from the NCMA's. Can NMCAs provide support for VGI tools?

QUESTION: What would a common feedback chain or channel between NMCAs and VGI look like?

- How could NMCAs and VGI/Crowdsourcing actually work together? It is very different to the channels of communication between, for example, an NMCA and their client/customer/stakeholders or the VGI project and their community. Any feedback chain or channel of communication between NMCAs and VGI projects will most likely be something very new and innovative.
- Feedback processes do exist within private companies. Feedback is also part of the process in VGI and NMCAs.
- Semantics is a common issue between the two sides
- VGI and NMCA are trying to understand and represent the same "concepts". The major difference is in how the two sides manifest this representation of concepts.
- This shared problem opens the opportunity to work around license problems. Errors do not have any particular license! Errors can be considered as shared work. For examples the challenge of geospatial semantics is license independent and progress on problems in this domain would benefit everyone.
- Is the research focus on VGI too narrow at the moment? One could argue that there is a North-West VGI - but is this representative of a Global VGI?
- Which application areas or policy areas could be addressed to deliver more innovative solutions if we compliment or combine NMCAs and VGI? This is a very interesting question - but not such an easy one to answer.

- Looking forward - we need to find use-cases where VGI and NMCAs can work together on NEW problems. Think about this situation with the perceived boundaries of NMCAs. Think about the roles of the NMCAs.
- There are opportunities here for input from experts in human factors. How do we go about resolving disputes in crowdsourced mapping? What about the signal to noise ratio of the data which is generated?

### **Operationalising VGI and Crowdsourcing in NMCAs**

Question: Practically, how do NMCAs and VGI communities work together? Tools, processes, procedure

The following is a summary of the key points of the discussion from this breakout group.

- What is crowdsourcing? active, passive? Definition difficult but differences are important. In VGI and crowdsourcing there have been lots of discussion on terminology for the past years and this is not always very helpful. In VGI sometimes community members cannot download their own data, so you cannot demand an upload
- NMCAs need to adapt because working together with VGI is a two-way street. But who takes initiative to build this collaboration? Indeed, NMCA budget cuts may actually need crowdsourcing. But the integration of crowdsourcing requires change of thinking. This may indicate that more 'give' is required from NMCAs.
- Open data is seen as threat by some NMCAs. Open data is completely different market. There are different user groups and different requirements. Business models vary greatly across countries and NMCAs.
- Perhaps the answer to how VGI and NMCAs can work together comes down to answering the fundamental question on the role of NMCAs. Are NMCAs there to provide a public good or to service commercial interests? What can the crowd in VGI do to enhance the publicity and image of the NMCAs? Promoting themselves is important but some shared sense is needed if these two communities are working together.
- Getting involved in a competition with VGI, such as OSM, from an NMCA perspective is not a promising idea. Could the role of NMCAs be as facilitator, mediator, expert, deliver mechanism, for working with crowdsourcing initiatives and projects. NMCAs must respect the feeling of ownership in VGI, Crowdsourcing and in NMCAs themselves. There will be no new money for NMCAs in the future so there is a need to do more with less. This brings about the need for a sustainable perspective.
- Most people realise that there is a need to work together to tackle the big problems (e.g. resilient and energy-efficient cities). For example, do NMCAs use crowdsourced data as cheap alternative to e.g. LIDAR data. What is the intention of NMCAs? Is the intention to use crowdsourced data for validation only? NMCAs are in a difficult position because they have to do more with less. Both Google Maps and OSM are competitors for public attention and potential users that question somewhat the legitimacy of NMCAs requiring constant funding.
- This is the one big question: What is the role of the NMCAs in the future? The answer to this question will go a long way to determining the relationship with VGI and crowdsourcing. If the NMCAs need to have a business model that generates profit, then the relationship may not ever work. If the NMCAs can act as mediators and facilitators, then the NMCAs can be much more open, give away open data and then gain the advance of expertise from VGI communities.

Question: How can VGI and crowdsourced spatial data assist in the work of NMCAs?

- Why are NMCAs interested in VGI? Not because it is about spending less money, but to make their data more accurate, to achieve higher levels of engagement of users and get more exposure among the general public.
- Open data is an important precondition for VGI in NMCAs. Only other companies like Google and navigation companies with high usage, can afford to make it proprietary, but this does not seem viable for NMCAs. There are companies who are reselling open data. This is in most cases allowed but does not seem a sustainable business model.



- Should contributors approve the modification of their own contributed data by changes? Putting your data in OSM can be done instantly, because you can overwrite other things.
- NMCAs are interested in national coverage, not in boundaries. Now all changes are captured in 98% of the time within 6 months with many NMCAs. To most GI experts this indeed sounds fast but is nowadays it is considered slow.

QUESTION: Can there be a Return on Investment (ROI) in Crowdsourcing of Spatial Data

- The best ROI may come from the long tail or peak contributors to a project. With these contributors you might get as good an ROI as involving a very large number of contributors. A small number of very dedicated people can be very effective. But this will always depend on the task(s). Depending on the task(s) it might be necessary to involve large numbers of contributors.
- Perhaps the best approach might be to consider small tasks/challenges with some type of reward system in place. This could encourage contributors to map or collect something "new" or "rare" or to "go somewhere new" to map.
- Where does Remote Sensing/Satellite Imagery have a role to play? Consider the potential of a daily return of one satellite every day on a continuous basis. There will be new training challenges. However, it could also allow for new forms of feedback - VGI could verify the classification of an image (for example)
- The ROI will be related to the amount of training resource costs. The more difficult the tasks or processes involved the more training and education is required. This, of course, will absorb resources.

### Research Agenda and Way Forward

QUESTION: What are the relevant research areas and/or research questions for VGI/Crowdsourcing in the future?

#### NMCA VIEWPOINT

The following is a summarised version of the key points in replying to this question where the members of the break-out group were asked to consider themselves as NMCA stakeholders.

- How will it be possible to generate savings from the VGI?
- How can NMCA involve the crowd in new products? In 15 years, the crowd will probably not read any maps and will only need information at the right place. They will need location-based services without the traditional map interface. These changing models must be considered.
- We could potentially divide VGI practitioners in two different thematic groups namely: kids and citizens for education and then professionals and citizens as special interest groups. It would be nice to have a labelling of the data quality. Ex: for the professionals, 80% quality is sufficient. There is a connection with the "Fit-for-purpose" quality. What are the different labelling of data quality according to the categories of practitioners?
- Is it possible to employ methods to validate (automatically) the data that is generated by VGI? There must be a means of distinguishing the production cycles of data and the integration of core datasets with the VGI.
- Another key problem is to sustain engagement. There is the potential for research with social psychologists to find out what drives the practitioners to contribute? What are the cognitive triggers of engagement?
- There can be an avalanche of data and it is not always possible to understand what function different pieces of this data can fulfil. How can one distinguish the new data for existing layers or new data for new layer? How to manage the processing of data and distribute it into new or existing layers? This is linked with the quality of data with different validation mechanisms in regard to the function of the layer.
- There is a need for guidelines about the ownership of VGI Data. Furthermore, the specific question of "How to handle personal data" is also essential. (ex: images of people on photos).
- Motivation also works in the other direction. How can the government agencies be motivated to be part of the crowd? This is relevant for national or local datasets.

- Are the ISO standards applicable of data quality assessment of VGI? There is a need for external measures. Then this brings about the question of how can VGI be impacted by standards?
- How can NMCA's develop more generic methods to adapt to different types/applications of VGI? Many academic papers are suggesting conceptual models but in reality, these do not really address anyone's needs. These conceptual models are often too theoretical and not practical.
- Raising quality of data is a problem for land cadastres. VGI is a contributor to improve the data. In the Netherlands and Finland, they are working with landmarks between parcels and sensors to sense the quality of measurement.
- We should have taxonomy of stakeholders that are interested in VGI and have different motivations depending of the category of stakeholders (and thus take actions accordingly).
- How can we, as in the NMCA's, continue to motivate those 'ultra enthusiastic' VGI contributors after all empty spaces are filled or the 'interesting' mapping has been carried out? Are these contributors interested in the maintenance work?
- Completeness: partial sampling is not good. It is important to look at the "mapping curve" and see what has been done or what is being done. Where can you actually trust this graph?
- Consistency: when representation is not uniform over space, where only zones of consistency exist. This can be tolerated in VGI/crowdsourcing projects and applications but in reality it cannot be tolerated by NMCA's.
- Could we teach machine learning algorithms to consider some of the "C" (Consistency/Completeness) parts of this problem? The outputs from machine learning could then be verified by people against the actual mapping work carried out. However, this is not an easy task. We will need: sufficient amounts of data, to trust the people doing the mapping, to be able to measure or ensure consistency, and allow for multiple languages in our machine learning algorithms.

QUESTION: What are the relevant research areas and/or research questions for VGI/Crowdsourcing in the future?

#### Non-NMCA VIEWPOINT

The following is a summarised version of the key points in replying to this question where the members of the break-out group were asked to consider themselves as non-NMCA stakeholders.

- The difference between NMCA and Non-NMCA is that NMCA have a regulation that forces them to process a set of data. Depending on the layer, the influence of the law is different.
- Take the example of "Médecins sans frontières": working between official maps and other sources. This is also related to transitional mapping
- Identify which crowdsourced data can calibrate the algorithms. In that regard, we don't need high quality data or high volume, but we need access to specific information.
- Composition and dynamics of national, building stocks. They have little information about age, history and morphology of buildings because they are owned by the tax office.
- Using VGI is making the parallel between administrations that do not want to open their data and VGI that provides data of high quality about similar areas.
- We also need a platform to share and integrate the appropriate data for the determined question. This platform can be used to refine the algorithm before an emergency happens.
- How would we increase resilience and minimizing the risk using VGI? (ex of application: risk management).
- How can we represent the current geo-localized data to the crowd (that are not specifically professionals)? Possible lead: switch from 2D to 3D. What is the ideal representation/facility management for each situation? (ex: for blind peoples?)
- VGI in emergency situations: Would it be possible to share geo-spatial data from drones? Satellite data is already in the public domain.
- The overlap between using social media, collected data, and VGI. The interaction between these interests are interesting to tackle in the future.

QUESTION: Use-cases – What are the shared NMCA and VGI problems

Rather than considering places where NMCAs and VGI are different - are there use-cases where both NMCA and VGI could work together? These use-cases would be of mutual benefit to both sides while at the same time addressing issues which are of value to wider society, government, etc. The following is a listing of the ideas which were suggested. Indeed, this was one of the most interesting break-out sessions. There are lots of interesting ideas here. Certainly, these ideas can form the starting points for collaboration and research.

- End-to-end journey patterns, multimodal transportation systems, multimodal journeys
- Demographics. Who maps? What do they do? Is the profile the same within the VGI projects and the NMCAs? What are the common attributes?
- Identification and quantification of Fluxes - social fluxes, Urban fluxes
- Population: We have things like very good building descriptions but not very good information about the population inside those buildings. Think about a night vs. day time census. Could VGI and crowdsourcing help supply accurate information and data on this problem?
- Urban Forms and Functions - some cities have actually no data on this. But VGI could actually supply something here!
- Resilience: Response to emergencies - this is something that will affect everyone. Shared work on 'how' we respond.
- Agriculture: Issues such as precipitation coverage
- Place verse Location - informal geographies
- Points of Interest, neighbourhood scales
- Visualisation - both sides understand the value of good visualisation, 3D, moving processes, multidimensional, etc.
- Missing Buildings, Demolished Buildings, Illegal settlements. What are the consequences for illegal settlements in flood prone areas for example?

QUESTION: Is there a way forward for NMCA collaboration with VGI/Crowdsourcing?

- The crowd must have the possibility to take part - if you build it they will come. So, if this opportunity comes from a commercial company then the crowd might go and join up and partner with these companies? There is a Google example for Google Maps.
- It is certainly good to combine NMCA and VGI - but what about the usefulness of the data combinations. There are opportunities to generate generic approaches to data combination.
- Can the crowd go where the NMCA cannot go? Building heights, urban environments, rural environments? Can the NMCAs generate approaches, rather than their formal ways (LIDAR, Radar, etc)?
- Protocols are leading to a waste of time and effort ... People get frustrated ... People go out and do this for themselves.
- Crowdsourcing could do 80% of what NMCAs would want. The 20% is the most expensive bit (completeness, temporal, etc.) - the crowd map where they live or where they are - the NMCAs must produce their product consistently across their entire territory. So then alerting and change detection is used in a passively harvested way - they are used as a "hint".
- How does this work for SDIs? National Geoportals? INSPIRE is there - but it doesn't link to other countries. There are really only a few products which are European wide and do not stop at the border.
- If you start a new crowdsourcing activity - perhaps you could avoid problems before you start? Setup a structural system for the collection of crowdsourced data. For example - if staff or university people went out and crowdsourced data - who would be responsible for the data? Is it still crowdsourcing if there are serious restrictions? Is it still crowdsourcing if it is an expert crowd? We have a lot of expert crowds.

### **Report on Hackathon challenge session**

This part of the workshop aimed at preparing for a hackathon (to be held as a separate event after this workshop) by formulating ideas for implementing relevant software for VGI within NMCAs. This

part of the workshop was split into an introduction, a short work session on Day 1 and the presentation of results on Day 2.

An introduction was provided to the participants on the principles of hackathons and the aims of this hackathon in particular: the development of software for VGI within NMCAs; desktop, web-based or mobile apps. A hackathon is an event in which software developers and subject-matter-experts collaborate on a software project by either creating new software or combining existing software. At the workshop, NMCAs or Industry partners were asked to propose hackathon challenges which they are interested in. The VGI, Academic, Research partners were also asked to provide their input. Challenges are comprehensive ideas for software applications which can be implemented by a small team of software developers over a period of 2-3 months.

These challenges should have the following structure:

1. Title
2. Authors
3. Background and problem
4. Objective
5. Data needed
6. Intended users
7. Software guidelines

The hackathon challenge session resulted in the following challenges, created by 12 groups (more details descriptions are available):

Group	Title
1	The Postman always checks twice
2	Comparison of OpenStreetMap road data and official data for annual updating
3	A VGI application for alternative energy
4	Where is the door?
5	OS Routes
6	Improving the timeliness of NMCA basemaps using VGI through trustworthy check algorithm
7	What does your place sound like?
8	Automated Change detection of buildings
9	To your doorstep
10	Platform for sharing and integrating 3D geodata for emergency purposes
11	VGI application for flood map validation
12	A VGI application for quality improvement of cadastral parcel data

Group	Abstract
1	NMA field checks by postmen
2	Automatic geometric and topological comparison of OSM and government data
3	Volunteers indicate wind turbines and solar panels present based on aerial images
4	Map all entrances of buildings with possibility to add photos
5	Improvement of OS core content (better path networks)
6	Citizens perform field checks of spatial changes through geo-localised photographs and textual descriptions
7	Pronunciation of place names
8	Citizens detect illegal and missing buildings
9	Producing an accurate map of the footpaths that connect the road-network to the actual doorstep

10	App providing 3D info for Emergency responders
11	Validation of flood maps. Citizens are informed about flood events.
12	Mobile App to collect and improve the parcel data as a proposal for later legal approval

A typical schedule for follow-up after the workshop is envisaged as follows:

1. Invitation of additional ideas
2. Call for Hackathon – invite software developers to select a challenge and implement the ideas in a software application
3. Submission by teams (2-3 months after call)
4. Selection of winning team(s)
5. Presentation of results at EuroSDR meeting

## 5 Conclusions and Way Forward

This report has summarised the discussions, activities and outcomes of the 2<sup>nd</sup> workshop on Crowdsourcing in National Mapping, funded and supported by EuroSDR. This workshop followed on from a very successful inaugural workshop held in 2013 and summarised in Mooney and Morely (2014). This workshop considered an approach where there were only a small number of PowerPoint presentations leaving much more time for delegates to work in smaller focus groups, network and consider joint problems and challenges on crowdsourcing in National Mapping. As the organisers of this workshop we believe that the event was a great success. Of course success is a difficult metric to measure. The immediate feedback from delegates of the workshop was one of great satisfaction and motivation to see a follow-up event of a similar nature in the near future.

### 5.1 Take Home Messages

To try to compress the information in this report we provide five take home messages from the workshop.

- The sustainability of VGI projects is something that is difficult to forecast. One of the key components of this sustainability is predicting or understanding how long the project can remain “fun” for contributors to be involved? One of the most important tasks in the future will be ensuring that contributors to VGI projects are interested and motivated to fix errors, update data and metadata, etc into the future. There is potential for research with social psychologists to find out the true drivers of contribution. This is an area of research being tackled by academics such as works outlined in Capineri et al (2016)
- How do NMCAs see their own role in the future? Should NMCAs become the gatherer of all crowdsourced spatial data or should the role of NMCAs adapt to taking a responsibility in the quality assessment of relevant. crowdsourced spatial data.
- Should NMCAs strive to become ‘less traditional’ in the future? It is likely that legislation in the future will retain the requirement that NMCAs produce data and information which is authoritative.
- For VGI/Crowdsourcing and NMCAs to work successfully together there will need to be clear agreement on the licensing of the spatial data generated and managed. It will be necessary to communicate what kind of quality is required and expected from both the VGI/Crowdsourced data and that of the NMCAs. Realising these requirements could be very challenging.
- Looking forward one of the ways where VGI/Crowdsourcing and NMCAs could collaborate is on mutually beneficial or interesting use-cases. Consider ‘new’ problems of interest. Perhaps this involves considering where the current boundaries of NMCA remit lies. This links nicely to the discussions within the Hackathon session. It might be possible to convert some of these ideas about ‘new’ problems of interest into hackathon challenges.

### 5.2 Implications for key stakeholders in Crowdsourcing and National Mapping

There are some excellent points and opinions in this report and many of them lend themselves to deeper exploration and research. It is at this very point that we find ourselves. It is important to build

upon this great ‘potential energy’ and enthusiasm from the workshop in April 2017. Inertia is not a future work option. We feel that the opportunity and interest is there amongst delegates (and those who did not attend but communicated with us) to hold future workshop events. In this light we decided the best way to outline some steps for future work or steps forward was to try to outline some implications from the workshop for the four ‘stakeholder’ groups: EuroSDR, Academia/Research, National Mapping and Cadastral Agencies, and VGI/Crowdsourcing projects. We realise that these stakeholders are not mutually exclusive or independent of each other. However, we feel it allows us to outline some of the implications for these stakeholders in a clearly and more directed manner.

### *5.3 Implications for EuroSDR*

On a personal level we, the authors, wish to extend our thanks and gratitude to EuroSDR for their support (financial, structural and intellectually) of this workshop. This support is manifested in a tangible way through outputs such as this report and the outputs from the workshop itself. However, we feel it is equally important that EuroSDR have shown their support for this research and associated activities at this time.

EuroSDR is formed by a combination of academic research and NMCAs. They understand each other in terms of their modes of operation. Both parties have different levels of understand and interaction with VGI and Crowdsourcing. EuroSDR has a fantastic opportunity to drive the Crowdsourcing and National Mapping agenda forward in Europe. The key to this is events like this workshop. There are many papers written about Crowdsourcing of Spatial Data without any interaction with the VGI projects which generate the actual data. This workshop event brought together ALL of the stakeholders for frank, open and interesting discussions. Funding should certainly be provided for future workshops. In an ideal scenario financial funding to support some actual research or integration activities (as outlined in many of the breakout sessions above) would be provided.

### *5.4 Implications for Academia/Research*

During this workshop and the first workshop (Mooney and Morley, 2014) academics were by far the largest representative group in attendance. Academics and researchers are naturally interested and drawn to the scientific value in research into crowdsourcing structures, projects, processes in the context of National Mapping (and other areas, of course). There are obviously many areas for further and future academic research identified in this report. Some of the issues are probably sufficient for small projects within a research group whilst other problems and issues will take a more large scale, multi-stakeholder approach.

Feng et al (2018) argue that previous crowdsourcing research has been mainly limited to study the impacts of different motivations on contributors’ participation in crowdsourcing projects/problems. They suggest that work should be undertaken to extend our knowledge on how crowdsourcing platforms can be designed to be an intrinsically motivated place for participation.

The study of the actions, preferences and activities of contributors to VGI, Crowdsourcing and Citizen Science will be potentially subject to the GDPR regulations<sup>2</sup> which will come into force in May 2018. The introduction of the European Union (EU) General Data Protection Regulation (GDPR), 2016/679/EU, which comes into force on the 25th May 2018, has caused much discussion on how this regulation will affect research (Cornock, 2018). Cornock argues that "a lot of this discussion has been negative, and angst ridden; focusing on what will not be allowed after GDPR comes into force". However, he suggests that "it is incumbent upon all researchers to ensure that their research processes will be compliant with the GDPR on that date". Kindt (2016) urges caution and reflection from the research community stating that “the risks of research with personal data include the use and availability of massive amounts of data about individuals without appropriate safeguards for the right and freedoms of the data subjects and proper (data) protection leading to risks of re-identification (because insufficient protective measures or safeguards were taken) and reuse by different stakeholders for different than the initial purposes of the collection”. The full discussion of GDPR is certainly beyond the scope of this report. However it is an issue which must be addressed by future research and potentially future workshops on Crowdsourcing and National Mapping.

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<sup>2</sup> <http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A31995L0046>

## 5.5 *Implications for National Mapping Agencies*

The last number of years, since the time of writing, has been a time of great change for most National Mapping and Cadastral Agencies (NMCA) in Europe. Increased pressures on financial budgets, changes in working practices, the increasing influence of automation technologies, etc. has seen these agencies undergo rapid change and transformation in a relatively short period of time. The emergence of a ‘disruptive technology’ such as crowdsourcing or VGI has had an impact. Disruptive technologies are those that cause an upheaval in the existing market structure and dominant firms by being cheaper, simpler, and more convenient than the dominant technology (Schuelke-Leech, 2018). However NMCAs have found that there are many costs associated with integrating crowdsourcing or VGI into their existing structures and workflows. Subsequently crowdsourcing and VGI are not ‘free’ even if they are considered from a purely financial or budgetary perspective. There may also be lack of alignment with the technologies used. VGI is not a recent technology or idea but past efforts have been hampered by available technologies (McCartney et al, 2015).

NMCAs can be proactive in this space. As discussed in many of the breakout sessions which party will lead the initiative for greater integration and collaboration with VGI/Crowdsourcing? NMCAs are in a difficult position. Most NMCAs must “do more with less” and there is a need for changes in thinking and changes in approaches to doing their every day business. Perhaps NMCAs need to take ‘the first step’? Could they fulfil the role of facilitators or mediators when working with VGI/Crowdsourcing projects? As discussed in the workshop, VGI and NMCAs are trying to understand and represent the same “spatial concepts”. The major difference is in how the two sides actually manifest these conceptual representations.

Any collaboration with VGI/Crowdsourcing will require NMCAs to provide open data. Some NMCAs are unsure about the actual ROI on open data. ROI is then in turn related to the amount of training and resource costs. The more difficult the tasks and processes are for VGI/Crowdsourcing then the more training and education will be required. This could absorb already scarce resources.

Perhaps the answer to how VGI and NMCAs can work together will emerge from understanding the answer to a fundamental question of defining the role of the NCMA. Are NMCAs there to provide a public good or to service specific commercial needs? Could a collaboration or working relationship with VGI/Crowdsourcing enhance the role of the NCMA? If the NMCAs need to adhere to business models which generate profit, then this relationship may never work.

Finally, there is still much exploration required to understand the legal and ethical frameworks for working with VGI/Crowdsourcing from the NMCA perspective. There are legal consequences to using spatial data produced by NMCAs. NMCAs will need to consider these legal consequences carefully as combination of datasets can change the license/usage agreements of the data. There are potentially many unintended consequences of the combination of NMCA and VGI/Crowdsourced data which are difficult to explore or plan out in advance of distribution.

## 5.6 *Implications for Crowdsourcing/VGI projects*

One of the key issues which emerged time and time again during the workshop was one of data quality. Data quality is indeed a multi-faceted issue with a very wide spectrum and remit. Assis and Santos (2018) emphasise the regardless of the problem or task under investigation an important concept is that a crowdsourcing project should define activities to manage quality in the crowdsourcing process.

There is a need to find use-cases where VGI and NMCAs can work together on. Perhaps these use-cases might be “new problems”. There should be less replication of efforts. In many of the discussions above it was pointed out that NMCAs and Crowdsourcing are in many cases producing the same data. Is this wasted effort? Gradually as VGI becomes more mature the line between volunteers and professionals become less clear. There are many professionals who are involved as members of crowdsourcing projects.

A clear opportunity for VGI/Crowdsourcing going forward is identifying niche or new data streams to focus on. Crowdsourcing appears to be, in many cases, producing the same types of data as NMCAs. Is this not a duplication or waste of effort? The breakout session on shared research projects indicated many places where VGI/Crowdsourcing could provide new knowledge and data rather than replicating the work of NMCAs.

With the impending arrival of GDPR the need to properly handle personal data from contributors to VGI/Crowdsourcing projects will become even more important. VGI projects will need to provide specific guidelines around this. Indeed, in the setup phase of a VGI/Crowdsourcing project many problems such as these could be avoided with good training, documentation and guidance (Mooney et al, 2016).

It is not easy to chart the way forward for crowdsourcing in national mapping because the underlying technological and sociological platforms upon which this phenomenon relies are changing rapidly. Almost as soon as a 'state-of-the-art' report on crowdsourcing is written and published it finds itself out of date. Some researchers speculate that the rise of social media may accelerate the growth of disruptive innovations or technologies which can, in turn, reduce the window for response (Millar et al, 2018). Everyone will always be playing catch-up with cutting edge technologies whilst trying to work with the technologies that best fit their workflows, skillsets, budgets, missions, etc.

## **ACKNOWLEDGEMENTS**

The success of this workshop is more than the sum of its individual parts. The support of our sponsors, EuroSDR and the Ordnance Survey, is greatly acknowledged as well as the participation of those delegates who delivered excellent and thought provoking invited presentations over the two days. To several delegates who volunteered to chair some breakout sessions and act as rapporteurs. These are very often the roles that no one really wants to be given during a workshop or conference. However, volunteering to take on these roles is a great service to the event and to your fellow delegates. Finally, to all of the delegates who contributed in sessions, conversations and discussions. Your participation was instrumental in the overall success of the workshop. We look forward to meeting you in future workshops and meetings.



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