

Authoritative geospatial data and its quality

Joep Crompvoets¹, Stijn Wouters¹, Maxim Chantillon¹, Dominik Kopczewski², Mick Cory², Carol Agius², Stephan Grimmelikhuijsen³

1. INTRODUCTION

Societies are increasingly digitalising more and more aspects of daily life. A basic building block for digitalisation is data. This data is being integrated within and across public administrations, but also across borders and across the public, private and not-for-profit sectors. High quality data is a necessary criterion to ensure the quality of both public and private digital services and to drive innovation (Debruyne et al., 2017; European Commission, 2016).

The recognition and organisation of data as *authoritative* should be vital not only for ensuring the data quality, but also to foster trust between public sector organisations, between different sectors and across borders (European Commission, 2017). Especially in the context of geospatial data, the exchange and integration of authoritative data has advanced significantly. Important challenges however still need to be addressed (Cravens & Ardoin, 2016).

Authoritative is a term that one often hears when someone is describing geospatial data. Many public mapping, cadastral and land registration agencies promote their geospatial data as authoritative or as created from authoritative sources. Although *authoritative data* sounds impressive, it is important to understand what it really means.

In a geospatial context, land surveyors were probably the first to use the term *authoritative geospatial data* and they have been producing authoritative data for some time. Surveyors define *authoritative* as data that contains a surveyor's professional stamp and that the data can be used for engineering design, determination of property boundaries and permit applications. In essence, the term carries a certification of positional accuracy (Plunkett, 2014).

For decades, if not centuries, national mapping, land registries and cadastral authorities (NMCAs) have been recognised as the official source of geographic information. They were established by states to collect and distribute geospatial (mapping) and map-related data, often for some defined public purpose, such as defence, taxation or protection of property rights. The data provided by these public authorities were habitually presented as authoritative data.

Today, NMCAs are not the only ones providing geospatial data, information and related services. A growing number of different producers and providers of geospatial data, information and services are entering the market, serving different purposes and needs vis-à-vis the users, who are both private and publicly oriented. These new data, information and service producers/providers come from the public, private and community sectors. With this development in mind, there is a need for setting a clear understanding of what is meant by *authoritative*. When exploring the meaning of the term authoritative geospatial data, issues related to legislation, trust, and (quality) certification emerge. The term might be applied only to data that is legislated or regulated. If it is necessary to differentiate data supplied by government agencies from other sources of data, then it is suggested that the

¹ KU Leuven Public Governance Institute

² EuroGeographics

³ Utrecht University School of Governance

discussion should be about trusted data, and what gives rise to such trust. The validation of this type of data might be part of the certification of authoritativeness. For most practitioners, the term usually somehow refers to data that was produced or is approved by some authority.

Besides the meaning of the term, there is also no proper understanding what is the added value of authoritative geospatial data in Europe. It is also not fully clear how the term is applied and interpreted across Europe. Under different national conditions 'authoritativeness' can be defined in various ways. Moreover, the link with spatial data quality is also not fully understood. This paper aims to fill these gaps. Therefore, the main objective of this paper is to provide a better and more comprehensive understanding of the definition, nature, governance and future of authoritative data and the links to spatial data quality in Europe.

An online survey was undertaken in the summer of 2018 to get an overview of the definitions, characteristics, governance and future of authoritative data across Europe. A questionnaire was sent to all members of EuroGeographics, who are the national mapping, land registry and cadastral authorities (NMCAs) of Europe. The first results were presented at the General Assembly of EuroGeographics in Prague (October 2018). During the General Assembly, focus group meetings in the form of roundtable discussions were organised that built on the findings of the survey and delved into the definitions, importance and opportunities of authoritative data. This paper presents the results of the online survey as well as the focus groups meetings.

After this introduction, the followed methodologies of the online survey and focus group meetings are described in Section 2. In Section 3, the results of the online survey and focus group meetings are presented. Finally section 4 provides the main conclusions.

2. METHODOLOGY

A two-step methodology was applied:

1. An online survey with the members of EuroGeographics was undertaken to get an overview of the definitions, characteristics, governance and future of authoritative geospatial data across Europe.
2. Focus groups meetings in the shape of roundtable discussions with the members of EuroGeographics were organised that built on the findings of the survey and delved into more detail regarding the definitions, importance and future of authoritative data.

This two-step methodology allowed to have a more comprehensive and detailed view on the topic of authoritative data across Europe.

2.1 Survey

As this research aims to create an overview of the different positions taken by the network members of EuroGeographics, it was decided to conduct an online survey during the 2018 summer. Questions were created on the basis of the insights provided in the academic literature, as well as the specific context in which EuroGeographics and its members find themselves. All members are known to have a strong knowledge concerning geospatial data and relevant policy making. These competences were taken into account when approaching the concept of "authoritative data". The survey therefore included both closed and open questions serving a double goal. On one hand, it allowed the researchers to collect data based on existing views presented in the academic literature, whereas the open questions gave the possibility to gather more specific information on the positions taken by the respondents and the organisations they represent.

Besides some introductory questions, such as the name of the respondent, the name of the organisation and the country, the following 9 main questions were asked:

- 1) What is the definition that your organisation applies with regards to authoritative geospatial data (sets)?
- 2) What is your opinion about the tentative definition of authoritative geospatial data (sets) presented at the beginning of the survey?
- 3) The notion of authoritative can relate to different objects (e.g. a specific category of data, a specific data point, an entire data set) and subjects (e.g. an organisation). In your country, does authoritative point to one of the following situations?
- 4) What are the conditions which define geospatial data (sets) as authoritative?
- 5) What geospatial data (sets) should always be/remain authoritative?
- 6) Are there quality management programs within your organisation that manage the authoritative geospatial data (sets)?
- 7) Which organisation(s) is/are responsible for the validation of authoritative geospatial data (sets)?
- 8) Is your organisation restricted by any of the following issues related to practical management of authoritative geospatial data (sets) in your country?
- 9) How would your organisation like to see authoritative geospatial data (sets) being developed in the next five year?

The questionnaire was sent to the 63 Permanent Correspondents (organisations in 46 countries) of the NMCA members of EuroGeographics.

The data was cleaned and a simple analysis was executed, based on a number of qualitative and quantitative analysis techniques.

2.2 Focus group meetings

A focus group meeting is a good way to gather together people from diverse backgrounds or experiences to discuss a specific topic of interest. In our case, we gathered executives of national mapping, cadastral and land registration agencies in Europe to discuss issues related to authoritative data including definitions, importance and future developments. A focus group is a small but diverse group of people whose reactions are studied in guided or open discussions about a specific topic – in our case a guided discussion about authoritative data – to determine the reactions that can be expected from a larger population (Marshall & Rossman, 1999). This qualitative research approach complements with the survey results and provide more detail. Participants were asked about their perceptions, opinions, beliefs, and attitude towards the topic. Questions were asked in an interactive group setting where participants were free to talk with other group members. In our case the group setting was based on a roundtable construction in which each person was given equal right to participate. The discussion was led by a moderator who was familiar with the topic. During the discussion, another person either took notes or recorded the vital points he or she was getting from the group. Beforehand, a set of discussion questions were prepared. These questions were mainly derived from the survey results that needed further explanation/understanding. The following preparatory questions formed the basis for the roundtable discussions:

1. What is authoritative data for you?
2. How important is it for you that your data is labelled as ‘authoritative’?
3. Do you think that there is a future for authoritative data? If yes, then what needs to be done to sustain the usage of authoritative data in the future?

The focus group meetings took place in the afternoon of 8 October 2018 as part of the annual General Assembly of EuroGeographics. An important event in which the executives of most European national mapping, cadastral and land registration agencies participate. Before the focus group meetings, the topic authoritative data was briefly introduced and the preliminary survey results were presented. In total, 94 people participated in one of the 10 arranged roundtable discussions. All the notes of each roundtable were collected and analysed afterwards.

3. RESULTS

The results are presented in the following two sub-sections: 3.1 Survey and 3.2 Focus group meetings.

3.1 Survey

3.1.1 Response and organisational characteristics

The online survey was launched on 26 June 2018 and remained open until 25 October 2018. A first reminder was sent in the week of 25 July 2018, and a second one in the week of 9 August 2018. In addition, an oral reminder was given during the General Assembly of EuroGeographics (8 October 2018) followed by a fourth reminder that was sent 12 October 2018. In parallel, several Members were individually reminded. Overall, 37 responses from 31 countries were received. In terms of organisations, the response rate was 37/63 (59%). In terms of countries, the response rate was 31/46 (67%). In comparison with similar online studies, these responses rates are very high.

The countries that responded were: Croatia, Cyprus, Czech Republic, Denmark (2), Estonia, Finland, France, Georgia, Germany (2), Hungary, Iceland (2), Ireland, Italy, Latvia (3), Lithuania, Luxembourg, Macedonia (FYROM), Moldova, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom (3). Between brackets the number of responding organisations per country can be found in case that two or three organisations per country responded.

3.1.2 Definitions

Four survey questions referred to the definition of authoritative data and their coverage.

Respondents were asked the following question: *‘What is the definition that your organisation applies with regards to authoritative geospatial data (sets)? (Q1)’* From the 37 respondents, 21 respondents were able to give a definition (60%). From the 21 definitions, 13 definitions made reference to legal/official aspects of authoritative data, 12 definitions made reference to the provision by a public authority, and 3 definitions referred to reference data. 4 definitions were exactly the same as the definition presented in the introductory text of the survey. Only 5 respondents mentioned that their given definitions were officially approved by their organisation.

At the start of the survey, a tentative definition for authoritative data (sets) was presented: “Data provided by or on behalf of a public body (authority) which has an official mandate to provide it”. This definition was introduced in the European Location Framework (ELF) project. In this context, the following question was asked: *‘What is your opinion about the tentative definition of authoritative geospatial data (sets) presented at the beginning of the survey? (Q2)’*. From the 35 responses, 30 (strongly) support the tentative definition (86%).

The next survey question was the following: *The notion of authoritative can relate to different objects (e.g. a specific category of data, a specific data point, an entire data set) and subjects (e.g. an*

organisation). *'In your country, does authoritative point to one of the following situations? (Q3)'* The respondents could tick all the relevant options. From the answers, it appears that authoritative data can relate to a variety of objects and subjects within and across countries. For almost half of the respondents, it is the data or part of the data in the dataset (44%). For more than half of the respondents (56%), it relates to the dataset as a whole. For almost 60%, it relates to all data that is collected and/or managed by the authoritative organisation. The results clearly indicate that authoritative data cover different objects and subjects and so the coverage is not straightforward.

The fourth question referred to *'the conditions which define geospatial data (sets) as authoritative (Q4)'*. Respondents were in the position to tick all the relevant options. Concerning the conditions which define data as authoritative, almost all respondents indicate input legitimacy as a prominent factor (i.e. 'Supplied by a recognised public authority' (94%) and 'Derived from a trusted source' (71%). 'Having a high quality' (47%), 'Being institutionalised' (44%), and 'Existence of licensing agreements' (38%) are indicated by a significant number of respondents, while all other conditions appear of less importance.

3.1.3 Characterisation of Authoritative datasets

Two survey questions referred to the characterisation of the key authoritative datasets (being type and quality). Respondents were asked to answer the following question: *'What geospatial data (sets) should always be/remain authoritative? (Q5)'* Respondents were allowed to tick all the relevant options. Many members agreed on a wide set of necessary authoritative datasets, with 'Cadastral parcels' (94%), 'Administrative boundaries' (92%), and 'Addresses' (92%) as the most listed datasets. In addition, it is notable that the percentage for each of the presented datasets was above 50%.

The next question was: *'Are there quality management programs within your organisation that manage the authoritative geospatial data (sets)? (Q6)'*. Most respondents answered this question with 'Yes' (82%). This strongly indicates that quality is a very important aspect in the management of authoritative geospatial data. If the answer was 'Yes', then the respondents were able to comment on their response. A number of comments provided by the respondents were the following:

- 'Data coming from the private sector are automatically verified and randomly tested. Quality indexes are produced and continuously monitored. Several projects to enhance quality are ongoing';
- 'We run quality checks continuously';
- 'Applying validation rules that can be expanded';
- 'The Centre of Registers validates the data (vertex points of surveyed land parcels) provided by surveyors before entering in the cadastral map';
- 'Compliance with standards for data updating and validation';
- 'Each provider is responsible to manage the quality of their data';
- 'Specific requirements are included in law regulations'.

3.1.4 Governance

The next two questions are associated with issues related to the governance of authoritative geospatial data. The first governance question was the following: *'Which organisation(s) is/are responsible for the validation of authoritative geospatial data (sets)? (Q7)'*. Most respondents answered that it is the authority defined in the law or mentioned the name of their own organisation. A few respondents explicitly referred to the organisation that provides the data (sets). In most federal

countries, the responsibilities are allocated to authorities operating at different levels of administration.

The next governance question was: *'Is your organisation restricted by any of the following issues related to practical management of authoritative geospatial data (sets) in your country? (Q8)'*. From the results it was clear that the organisations face a variety of restrictions in the practical management of authoritative data. 56% of respondents point out 'National security', while 47% indicate 'Privacy' and 'Licensing' as a restriction. Other factors (e.g. IPR (41%), Funding (35%), Access (35%), Quality (32%), Authority (18%)) are much less prominent.

3.1.5 Future developments

The last survey question dealt with the future developments of authoritative geospatial datasets: *'How would your organisation like to see authoritative geospatial data (sets) being developed in the next five years? (Q9)'* Respondents had to answer this question both from their country as well as the European perspective. The responses at the country level were diverse, some respondents had no specific expectations for the developments in the next five years whereas others referred to a number of potential developments. The most frequently mentioned answers referred to developments related to data quality, data quality management control, legislation, governance (in terms of strategy development, structure, coordination, and responsibilities), open data, data accessibility, standardisation/harmonisation and user-centricity. The responses towards the potential developments at the European level were less diverse. A similar picture as the one at country level appeared. The answers of those who have clear expectations were however less diversified. Developments related to data harmonisation/standardisation, governance (in terms of a coordination body or cross-border management), and INSPIRE implementation/usage stood out. A few respondents referred to developments related to data quality, data accessibility, open data, and legislation.

3.2 Focus group meetings

After an introductory session about authoritative data (including the presentation of the preliminary survey results), a number of focus group meetings in the shape of roundtables were organised in Prague at the EuroGeographics General Assembly on 8 October 2018. In total, 10 roundtables were set up whereby 94 participants joined the discussions. Most of the participants were executives of national mapping, cadastral or land registration agencies across Europe.

The participants came from the following countries: Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Iceland, Ireland, Italy, Kosovo, Latvia, Lithuania, Macedonia (FYROM), Moldova, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom.

Before the discussions started the procedure was explained and the discussion questions were introduced. The duration of the focus group meetings was around 1.5 hours.

3.2.1 Question 1: What is authoritative data for you?

A similar question was asked in the online survey. From the survey it became clear that authoritative data needs somehow to be linked to the provision of data by a (public) authority which is legally binding. In some countries, the term *reference data* is used as an alternative. The discussions in focus

groups complemented the answers of the survey as the outcomes give a much more comprehensive and detailed picture about the meaning of authoritative data.

From the discussions, numerous characteristics of authoritative data emerged. These include: legally binding, accountability, uniqueness, mandatory use, liability, (public) authority provision, trusted, standardised, continuity, high quality, quality management system, certified, traceability, maintained, and accessibility. Each of the terms will be briefly introduced and/or explained. It is worth noting that the terms legally binding, accountability, uniqueness, mandatory use, liability refer somehow to the legal aspect of authoritative data. Meanwhile high quality, quality management system, certified, traceability and maintained refer to the quality aspect. In addition, it is good to mention that authoritative data cover most of these characteristics but does not necessarily have these all at the time. Moreover, there are strong dependencies among the characteristics. One characteristic could be a vital condition for another.

Legally binding

Many participants strongly stated that authoritative data has to be legally binding. According to several participants, the term authoritative should only be applied to data that is legislated or regulated. It has to be officially recognised by a reference in law. If authoritative data is not embedded in legislation, it can never be labelled as authoritative. Many participants stated that authoritative should mostly be produced and collected by legal obligation. In addition, several participants mentioned that the usage of authoritative data should be legally regulated enforcing stakeholders to use it. This legally binding characteristic is a vital condition for authoritative data that to become trusted by society.

Accountability

Some participants referred to the need that there is somehow an organisation that is legally accountable for the data production, provision, high quality, and/or maintenance of authoritative data. Few participants stated that organisations should be accountable but not necessarily be liable.

Uniqueness

The uniqueness refers to the authoritative data as an object as well as the role performed by the organisation which provides the data. According to the respondents, a dataset that stands out from other datasets by its characteristics is 'unique'. Unique is also the provision of authoritative data by giving one organisation the sole rights to produce and/or provide for a wide use

Mandatory Use

This characteristic refers to the mandate that other (public) authorities (and other stakeholders) are legally obliged to solely use authoritative data and no other data. As such, authoritative data has been given a higher usage priority.

Liability

The participants did not fully agree if liability is a full characteristic of authoritative data. Most of the participants agreed that authoritative organisations should be accountable for the data production, provision or maintenance. The participants are less clear about the liability issue. Some participants strongly stated that their organisations are liable for their 'authoritative' actions and products with all the consequences, meanwhile others are not. The implementation of quality management systems enhances the assurance of liability in many organisations. In this context, few participants underlined that authoritative data is not about quality but more about liability.

(Public) Authority provision

Authoritative data refers to data provided by or on behalf a (public) authority body. A few participants added that authoritative data should be also produced, maintained and/or certified by the authority body. It is hereby however not fully clear if authoritative data also has to come from a public entity or not. Some participants stated that authoritative data could be also provided (produced, maintained) by private companies (e.g. by means of outsourcing), however private companies are not in the position to officially certify data as authoritative data. Moreover, many participants agreed that not every dataset provided (produced, maintained) by a public entity should be labelled as authoritative. Some participants asked themselves if the discussion should be about the necessity to differentiate the source of data provision (production, maintenance) by public agencies from other sources of data.

Trusted

Although trust did not appear in the online survey, it formed an important topic in the roundtable discussions. Trust is a rather vague topic that is difficult to grasp in its full extent. In order to be widely used in society and to be applied in essential public tasks, it is important that the authoritative data can be trusted. Several characteristics that have already been mentioned are a key condition to reach trust (e.g. characteristics such as legally binding, accountability, off, authority provision, standardised, high quality, accessibility of authoritative data). It is crucial to provide data that can be trusted by the users in the long term or to build a lasting organisational trust. However, this is a long and complicated process that has to address validation and correction of existing data, implementation of standards and quality control instruments in the collection, production, maintenance and updating processes as well as securing access to the data in future.

standardised

In order to enhance trust and usage, it is important that authoritative datasets are harmonised and the production and maintenance processes/procedures/protocols are specified according to international standards that are defined in relevant regulations.

Continuity

It is important that authoritative data has a long lasting trust. This could be achieved by having building up a tradition in the production, maintenance and/or provision of highly qualitative data that are backed up by legislation. Many datasets of NMCA's have been successfully institutionalised during the years. This recognition can be a guarantee that the NMCA's are able to produce, maintain and provide authoritative data well.

High Quality

It is assumed to be one of the critical attributes of authoritative data that the quality of authoritative data is higher than the quality of competing data and that correct data enhances the appetite for more quality of data. Data quality is a wide topic and includes issues related to geometric accuracy, precision, updates, and reliability. All these issues have to be taken into account when dealing with the high quality and reliability of authoritative data. Users need reliable data to sue in the business processes. They need to have a guarantee that the data used is good or certified for their activities and/or products. Moreover, users do not want to be liable for their data and prefer to shift the responsibilities to recognised authorities as they are obliged to keep the data updated and accurate. Finally, it is important that the quality of authoritative data is defined in the relevant regulations (e.g. frequency in delivering updated versions).

Quality management system

It is important that the validation of high quality of authoritative data is assured as authorities are often liable for their data produced, provided or maintained. This could be achieved by establishing a quality management system specifically developed for securing validation processes of certain authoritative datasets. These validations must be part of the certification of authoritativeness and should be made as transparent as possible.

Certified

Authoritativeness is a kind of status. Therefore, this authoritativeness needs to be defined and validated. When data are produced by third parties, the data needs to be validated on the basis of a set of standardised criteria. As a recognition that all the criteria are achieved, the dataset can be certified as authoritative.

Traceability

According to several participants, an important condition for data to be labelled as authoritative is that the data generation has to be fully traceable with clear documentation of the process of how the data has been created and/or maintained. It is an important quality specification.

Maintenance

Several participants strongly stated that the data does not only need to be produced by a (public) authority but also needs to be maintained in order to fully receive the label of authoritative data. It is therefore crucial to communicate how the authoritative data are maintained and how it is updated in the future.

Accessible

In order to provide trusted data, participants mentioned that authoritative data also needs to be accessible to users. When the authoritative data is accessible, the usage of the data could be significantly increased and become more trusted. Accessibility could be enhanced by providing authoritative data via geoportals or other relevant platforms. Important to underline is the fact that the participants gave very conflicting responses on whether or not the data needs to be open and/or free.

3.2.2 Question 2: How important is it for you that your data is labelled as 'authoritative'?

One roundtable described "authoritativeness of data" as a label meaning that an organisation is granted a legal mandate to collect and maintain certain information which serves a concrete purpose or a task within the public administration. This relates to several responsibilities of public authorities, including: securing legal rights and ownership of lands, proper and actual addressing, zoning and planning, administrative divisions, public infrastructure and other aspects that have to be taken into consideration in the decision-making processes within the public administration. In other words, authoritative decisions can be (only) made based on authoritative data.

According to most participants, it is very important that some of their data is labelled as authoritative. NMCA's might lose part of the 'market' if their data is not labelled as authoritative. In general, it can be assumed that the user will likely give higher credits for authoritative data, compared with other data; e.g. the use of authoritative data would potentially lead to the avoidance of conflicts by citizens as they are/feel more (legally) secured. In order to be labelled authoritative data, agreed (quality) rules and/or protocols need to be followed and independent entities need to check if these rules and/or

protocols are respected. It is very likely that governments will invest more in updates and other kind of support related to authoritative data than to data that are not labelled as authoritative. This all means that data labelled as authoritative will likely be more used by public authorities and other stakeholders and that their demand will be higher when the data are not labelled authoritative. In this context, investments in the improved accessibility of data is a must to facilitate the usage of the authoritative data.

3.2.3 Question 3: Do you think that there is a future for authoritative data? If yes, then what needs to be done to sustain the usage of authoritative data in the future?

The participants strongly stated that there is definitely a future for authoritative data, but only for a limited number of datasets (at least for addresses, cadastral and administrative boundaries). If NMCAs would have no future, then they do not have a purpose. Authoritative geospatial data are core business and a unique selling point of NMCAs. There will likely always be a need for public authorities to provide and use authoritative data as they are the only ones required to be used in numerous key public policy and delivery processes. It is likely that authoritative data will become even more important when more public processes will be more automated in which there will be less opportunity to intervene in the processes. This means that data in these automated processes will strongly depend on standardised, high quality and legally binding datasets – so authoritative data.

The participants also indicated that there might be a need to distinguish two types of authoritative data; a core set of datasets that always have to remain authoritative (e.g. for military or national security reasons) vs. a set of associated datasets. This set of core datasets can only be provided by public institutions. To a certain extent, topographic data can be collected by companies or citizens, however the authoritativeness of topographic data can be important when associated with (administrative) boundaries.

Some of the key responsibilities of modern welfare states include military, social welfare, justice, or spatial planning tasks. These tasks strongly demand authoritative data and moreover, citizens assume that these public tasks are simply executed by default, but they will however not be executed (correctly) if there is no authoritative data.

Authoritative data have a cost for data acquisition, collection, storage, maintenance and distribution, and cannot simply compete with data provided by private companies. A question that does arise is the conflict that arises when public authorities are required to sell their data to third parties. The participants underlined that there is no such conflict as it is just a discussion of funding policy. In this context, it is also important to underline that non-public authorities are able to provide authoritative data, see PSMA in Australia⁴. It is as such not the sole tasks of public authorities.

In response to the second part of the question, participants gave a set of recommendations to sustain the usage of authoritative data in the future. The first recommendations refer to the legally oriented recommendations:

- Authoritative data needs to be registered in laws and regulations in order to ensure that this data is available into the future and is not manipulated. If someone would like to change it then they need to legally challenge and/or question it.

⁴ Although PSMA Australia Limited is a company, it has to be underlined that it is owned by all the governments of Australia.

- Ensure the legally binding aspect of authoritative data. A citizen can decide if he/she uses data from the state, or another source, but if a judge needs to make a verdict he will always refer to authoritative data, because the law states it.
- Validate crowdsourced data by an expert in order to be certified as an authoritative source.

Several recommendations also refer to trust as an important future element.

- Open authoritative data in order to enhance public transparency and allow users to give feedback;
- Focus on the public values of authoritative data serving the general public interest;
- Do not focus only on the possible profits;
- Be persistent in order to guarantee that the data will be kept available and provides continuity.

It is also strongly recommended to make the existing authoritative data to be used as widely as possible to ensure it meets future needs. This could be achieved by opening the data and by improving its accessibility, for example via popular platforms and/or one-stop shops.

Other given data quality-oriented recommendations were:

- Invest in the high quality of authoritative data (in terms of accuracy, frequent updates);
- Have a strong data quality management control system in place in order to ensure the data integrity.

4. CONCLUSION

The main objective of this paper was to provide a better and more comprehensive understanding of the definition, nature, governance and future of authoritative data and the links to spatial data quality in Europe.

To better understand authoritative data, this study applied a two-step methodology, making use of an online survey, and focus group meetings based on roundtable discussions, both with the members of EuroGeographics. Both steps were followed by a triangulation with the academic literature surrounding the subject. The focus group meetings confirmed the main conclusions of the surveys and provided complementary information about authoritative data in Europe. The focus groups underlined that several additional conditions and characteristics of authoritative data were added to the (existing) organisational conditions for authoritative data mentioned in the survey: Legally binding, accountability, uniqueness, mandatory use, liability, (public) authority provision, trust, standardisation, continuity, high data quality, adequate quality management system, certification, traceability, and maintenance.

The results of this paper underline the need for a systematic and harmonised approach towards authoritative data. The survey revealed that there is a variety of definitions and approaches applied by the different member organisations of EuroGeographics, as well as different opinions on which data should be considered as authoritative. Through the focus groups, the results of the survey were corroborated and several additional elements could be added on the topic of authoritative data.

The research shows that spatial data quality is an important element to be included in a definition for authoritative data but is not the most prominent one. Based on the findings of this this research, we have tried to integrate all relevant elements and aspects into one single overarching definition: "Data likely provided by or on behalf of a public body (authority) which has an official mandate to provide and sustain it, that is based on a set of known criteria to ensure (inter alia) high data quality, and that is required to be used or aimed towards extensive use and reuse within the public sector and society

as a whole". This new proposed definition could be the basis for further discussion on the meaning of authoritative data.

Other conclusions of this paper are that NMCA's underlined that data that is validated as authoritative data is considered to be of very high quality. This does, in turn necessitates adequate resources for ensuring data quality and up-to-dateness. The paper also underlined that the obligation to use authoritative data depends on the situation at hand. More effort should be put in making authoritative data available and recognisable by other public organisations as well as private actors. Finally, the participating NMCA's underlined that there is a need for organisations within the public sector to take up a central role in the governance of authoritative data.

ACKNOWLEDGMENTS

The authors of the report would like to express their sincere gratitude to all members of EuroGeographics who provided input to the survey and/or roundtable discussions.

REFERENCES

- Cravens, A. E., & N. M. Ardoin. (2016). Negotiating credibility and legitimacy in the shadow of an authoritative data source. *Ecology and Society*, 21(4).
- Debruyne, C. et al. (2017) Ireland's Authoritative Geospatial Linked Data. In: C., d'Amato et al. (Eds.), *The Semantic Web – ISWC 2017* (pp. 66-74). Cham: Springer.
- European Commission (2016). *EU eGovernment Action Plan 2016-2020 – Accelerating the digital transformation of government*.
- European Commission (2017). *Annex to the communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions European Interoperability framework - Implementation strategy*.
- Marshall, C. & G. B. Rossman (1999). *Designing Qualitative Research*. 3rd Ed. London: Sage Publications, p. 115.
- Plunkett, G. (2014). *What does the term "Authoritative Data" Really mean?* Environmental Systems Research Institute Canada.