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1. Scope and objective

The objective of this paper is to stimulate discussion about the changing role of the National Mapping and Cadastral Agencies in Europe (NMCAs) within the context of the UN-GGIM goal[1] of realising a fully spatially-enabled society[2] - One of the reported trends is the challenge for NMCAs to adapt to the alternative sources to NMCA data collection that are emerging.

On the basis of this objective, this paper seeks to answer the following question: *How should the NMCAs adapt to alternative sources for NMCA data?*

The paper briefly introduces the problem behind this question followed by the presentation of alternative sources and an overview of suggestions for adaptation. It ends with a set of conclusions.

2. The problem

The proliferation of alternative sources of location-based data challenges the role of the NMCA as the sole supplier of, and authority for, national geographic information. Considerable public funds are channelled into the collection by public authorities of data that may already exist in the private sector or other parts of government, or may be better collected by means other than the traditional methods of the NMCA.

More and more data sources are becoming available with many at zero or low cost; however the maintenance of such data is seldom guaranteed. The principle of continuous revision of real world change into the master database, which has been the core task for NMCAs over several decades, seems to be losing importance.

NMCAs face the danger of becoming less relevant in an era in which the sheer abundance of geospatial data and collectors attest to the increasing relevance of the data itself. At the same time the value of quality and correctness of the data seems to be not fully understood by society, where the pure existence of geographic information is assumed as being correct.

NMCAs have to find ways to adapt themselves to deal with alternatives sources for collecting the relevant data.

3. Alternative sources

Before considering options to adapt, it is necessary to give an overview of the alternative sources by first identifying the new technologies that are emerging and secondly by considering the sources of relevant groups of alternative geospatial data originators.

3.1 New Technologies

New technologies provide ways to collect location-based data differently.

- Sensors. The low-cost, low-tech, networked-enabled sensor – be it in mobile phones, computers, energy meters or any other everyday devices are enabling previously unimaginable amounts of data to be created.

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[1] John Carpenter and Jevon Snell, *UN-GGIM: Future trends in geospatial information management: the five to ten year vision*. The review of this report formed the starting point for this paper.

[2] Defined as societies in which 'location and spatial information are regarded as common goods made available to citizens and businesses to encourage creativity and product development' in J Wallace, I.P. Williamson, A Rajabifard, and R Bennett "Spatial Information Opportunities for Government," *Spatial Science Vol. 51, No. 1,* (June 2006): 79-80

- Optical imaging sensors. The proliferation of low-cost launch systems and affordable satellites with enhanced geometric, spectral and radiometric resolutions will lower cost and greatly increase the volume of high quality imagery and the frequency of data collection.

- Unmanned Aerial Vehicles (UAV) and mobile mapping systems. These low-cost sensor platforms are emerging as alternatives to more traditional platforms such as satellites, airplanes and helicopters.

- LiDAR, Radar. These alternative sensors are becoming more common and are already delivering the next generation of spatial datasets.

- Social Media. Users of social media such as Twitter® and Facebook® generate vast amount of spatially-related information as a by-product of everyday activities, without ever being particularly conscious of the fact they are doing so.

- 3D data and 3D technology. The user requests for spatial information in all dimensions will increase fast. Developments in the gaming industry offer insights and possibilities that 2D 'maps' cannot provide.

- Indoor positioning. A number of new technologies exist that provide widespread coverage including ultra-wideband, accelerometers and radio-frequency identification (RFID).

3.2 Relevant Source Groups

The reduction in barriers to entry, the growth of web and mobile mapping and the enthusiasm for crowdsourced geospatial data have massively increased the role of data creating entities that are not NMCAs.

This paper distinguishes three groups as alternatives to NMCAs:

1) **Private sector.** The private sector has always been involved in collecting basic information for NMCAs (e.g. aerial imagery, satellite imagery, terrain data) and by distributing the national geographic information though different channels. The fact that Google and Bing Maps are global brands highlights that it is the private sector that has made digital mapping accessible to the masses. The private sector plays a vital role in providing the technologies identified earlier in this paper to enable stakeholders to produce and collect vast quantities of data. They offer the technologies to manage and make sense of this data as well as providing access to the skills to maximise its value. In addition, the private sector already plays a key role in interpreting and analysing the vast amounts of information that are created and in using this information to offer enhanced services to consumer, business and government users of geographic information. This new role, combined with reduced funding for many government entities involved in the collection and provision of geospatial information, could lead to a greater number of public-private partnerships.

2) **Citizens.** The use of crowdsourced geospatial information has the potential to enrich other sources and fulfil the need for data. In some cases the availability of crowdsourced data will be an addition to a wider range of other sources of geospatial information; in others it may be the essential ingredient of social and economic development, particularly in areas where no, or only limited, other data is currently available. The generation of such data could become an initial source layer and, in time, be used to complement any further information that may be collected by a NMCA. It appears that crowdsourced data tends to be limited in its coverage and, without a scheduled maintenance regime, not widely recognised by major users of geospatial information. Today, crowd sourced information is widely used on an operational basis in order to detect changes in existing databases.

3) **Public authorities that are not NMCAs**. NMCAs are not the only public entities that need to collect reliable, trustworthy, and well-maintained geospatial information. NMCAs are likely to become more closely aligned with other 'official' governmental bodies for example statistics, economy or land. It is important that frameworks are in place that enable the effective cooperation and collaboration between the plurality of public actors. These need to ensure that the potential benefits that a spatially-enabled society has to offer, are realised. Moreover, such a collaboration framework could also contribute to the interoperability and integration of different types of public sector and other geospatial information. The integration and maintenance of different geographic datasets generated

on behalf of the government must be the primary task of a national government. New technologies for data integration and data fusion make this task feasible.

3.3 Implications

The use of these alternatives sources require strong management of large amounts of structured and unstructured data. The ability to create and collect data is ahead of the current ability to use that data effectively. There is no doubt however that there is a huge amount of residual value to be gained from information that is being generated. However, the effective integration of these big datasets often from multiple sources is a major challenge.

On the other hand, there also has to be investment in an efficient method of allowing an incremental updating of existing national databases, as these are often the only sources, which allow for a substantial monitoring of the spatial development of the national territory.

Another challenge refers to the need for sustainable funding to maintain data accuracy while integrating the data from numerous sources. Despite the fact that technological developments that are likely to reduce some of the data capture and maintenance costs, there will continue to be a need for these investments. In addition, there is an increasing demand for free and open data content that the internet and the presence of organisations such as Google® and MicroSoft®/Bing ® has brought. This will affect those NMCAs that cannot adapt.

The drive for cheaper access to geospatial information and the increasing richness of the information available means that there is pressure to monitor and license information at the feature level rather than at local or national level bringing with it new challenges.

Data ownership is also an issue. The growth in the amount of data, the number of actors in the data creation processes and the interconnectivity of these parties can pose great challenges regarding knowledge of data ownership.

The introduction of new technologies and social media has transformed attitudes towards privacy in many societies. Many people are comfortable with broadcasting information about themselves and their activities however others are not so willing to be open about their personal information and preferences. Given the number of devices emitting and recording information that can be carried, individuals become visible as they move. Aside from the moral aspects of a 'surveillance society', individuals will be the focus of targeted messaging. Consequently, consumer protection, marketing laws and policies will need to evolve to enable the citizen to enjoy appropriate protection.

Finally, liability for the quality and accuracy is an issue, as it will not be feasible for data providers, including NMCAs, to check each piece of data.

4   Suggestions for how NMCAs can adapt

In order to answer the ways of how NMCAs should adapt to alternative sources of data a list of adaption suggestions is presented below. Each suggestion might contribute to an effective adaptation for NMCAs.

1. Use 'Big Data' technologies. It is strongly recommended to make use of Big Data technologies that enable the analysis of vast quantities of information within and practical timeframes.

2. Apply semantic technologies (e.g. Linked Data). These types of technologies offer the opportunity to create rich machine-'processable' data descriptions from numerous sources. This will enable knowledge sharing and re-use in addition to data sharing and re-use.

3. Cloud computing. The management and hosting of vast amount of data requires significant investment in infrastructure and software. These costs are not always viable for those managing geospatial information. Use of the 'Cloud' however provides a means to host significant volumes of data without the accompanying investment cost required to own the technologies necessary to do so independently.

4. Invest in enhanced database management systems. The huge quantities of data now generated, and the increasing amounts of data that are likely to be created, will bring a requirement for enhanced data management systems.

5. Adopt open-source solutions as viable alternatives to proprietary software suppliers – although the issue of security has to be seriously taken into account when adopting. Adoption of open source solutions has economic benefits and facilitates the building of common user communities.

6. Explore possibilities for strengthening partnerships with relevant players in the private sectors in order to have an efficient and/or effective means for managing the geospatial information, possibly through public-private partnership (PPP) agreement.

7. Identify which data types (and for which areas) can be acquired by volunteers or the crowd – It has to be assumed that the acquisition of this potentially valuable information can be inconsistent and unpredictable making it unsuitable for a wide range of government and emergency management purposes.

8. Try to work in partnership with active members of a Volunteered Geographic Information (VGI) community to help identify those geographic areas and information types for which there are data deficiencies.

9. Develop quality standards and assurance mechanisms for VGI Data so that a level of authority can be included with such data. The provision of methods that include some quality assurance measures, such as consistency checking and the tracing of revisions, could increase the levels of trust in VGI and make it easier to incorporate it into government-assured geospatial information bases with confidence.

10. Identify the key stakeholders and their demands. NMCAs need to adapt their business models in such a way that it continuously meet the changing expectations of ever more demanding stakeholders.

11. Make your data sets usable by Digital Natives. Their approach to consuming geographic information is completely different than what we know from traditional map sheet production.

12. Set up accustomed access regimes allowing key stakeholder to have easy access to online mapping in a user-friendly environment.

13. Develop governance frameworks for effective cooperation and collaboration between the plurality of public actors. Such framework could also contribute to the interoperability and integration of different types of public geospatial information. Moreover, the partners of the framework could also commission the data from the most appropriate and suitable source, be that the local government, the private sector, or potentially, a VGI source.

14. Define and maintain quality standards and the data currency regimes for data that governmental authorities require for their operations

15. Build Policy and legal frameworks. The significant growth in deployment of geospatially-enabled devices and the increasing use of geographic information in everyday life will bring with it a need for stronger policy and legal frameworks to manage privacy concerns and protect the interests of those who are providing this data.

16. Demonstrate to key stakeholders the values that can be gained from using high-quality, authoritative and trusted geospatial information and the values that can be brought to effective decision-making.

17. Invest in building capacity and expertise regarding big data. Even at the most advanced NMCAs, the number of experts who truly understand the interrelationships between data models and data flows is generally quite low.

18. Develop effective license agreements in order to ensure that the quality of the geospatial information can be maintained and used with confidence.

19. Address the issue of data ownership through effective use of metadata and adherence to standards.

20. Respect privacy when collecting and integrating geospatial information from multiple sources. Ensure high levels of cybersecurity are in place to counter the threat to privacy by unauthorised data breaches

21. In the face of this challenge, the NMCA must acknowledge the changing marketplace and view the proliferation of data, not as direct competition, but as an opportunity to improve the overall quality, coverage and richness of geographic datasets.

5 Conclusions

The increase in the number of sources of geospatial information will challenge NMCAs, possibly leading to a reconsideration of the traditional role they play in geospatial data collection and provision. This means that NMCAs must continue to adapt their role to the needs of society, as they have done for many years.

The aim of this paper is to answer the question: *How should the NMCAs adapt to alternative sources for NMCA data?* The paper identified the relevant alternative sources in Section 3 where these alternative sources were grouped into New Technologies and Relevant Source Groups. On the basis of this information, a list of adaptation suggestions for NMCAs was provided in Section 4. It was not the intention to have a complete list, but more a list of suggestions that opens the debate about the changing role of NMCAs in Europe in particular referring to the future needs regarding the use of alternative sources. In addressing the question, we did not attempt to initiate a European unified approach to an agreed set of guidelines (as NMCAs across Europe have very different business models and the legal requirements can be very different from country to country), but the presented content could feed the discussions about the importance of maintaining 'authoritative' data at a national level.