UN Committee of Experts on Global Geospatial Information Management

**Future trends in geospatial information management:
the five to ten year vision**

Background

At the inaugural meeting of the Committee of Experts on Global Geospatial Information Management (GGIM), held in Korea in October 2011, it was decided that there was a need to document the thoughts of leaders in the geospatial world as to the future development of this world over the next 5 years and then looking further out, to thoughts as to its development over the next 10 years. In particular, the Committee was interested in how these developments will contribute to the local, national and global strategic agendas of economic growth, social cohesion and wellbeing, environmental sustainability, disaster management, public safety and good governance.

A number of experts and visionaries across a wide range of aspects of the geospatial community – from data collection experts, academics and major users of geospatial information, through to leading figures from the private sector and the Volunteer Geographic Information (VGI) movement – have been invited to contribute their views on the emerging trends in the geospatial world. Responses have now been received from individuals across the broad spectrum of the geospatial community.

This paper briefly summarises the main themes and trends identified in these responses. It is designed to inform further discussion to take place alongside the Geospatial World Forum in Amsterdam in April 2012. Output from that session will then be used to develop further iterations of the document to be presented to the Committee for review at its second formal meeting in New York in August (13-15th August 2012). Final editing will take place based on the content of the discussions at this meeting and a final paper will be presented at the Second High-Level Forum on GGIM in Qatar in 2013.

Executive Summary

The use of geospatial information is increasing rapidly. There is a growing recognition amongst both Governments and the private sector that an understanding of location and place is a vital component of effective decision making. Citizens with no recognised expertise in geospatial information and who are unlikely to even be familiar with the term are also increasingly using and interacting with geospatial information, indeed in many cases they are contributing to its collection.

As with all technology-driven sectors, the future is difficult to predict. However, this paper takes the views of a recognised group of experts from a wide range of fields related to the geospatial world and attempts to offer some vision of how this is likely to develop over the next 5-10 years.

This paper will look at a number of aspects of the geospatial world in order to attempt to provide a tangible vision of where this community, providers, practitioners, and users, are heading. Based on contributions received, these trends have been broken down into broad themes covering major aspects of the geospatial world, as follows: data creation, maintenance and management; uses of geospatial data; trends in technology; legal and policy developments; skills requirements and training mechanisms; the future role of National Mapping Agencies; and the role of the private sector and volunteer geographic information.

Future direction of data creation, maintenance and management

Contributors noted the exponential growth in capture methods – the volume of data that will flow in, the increased potential of "traditional" positioning and capture methods such as the use of Satellites, but also the introduction of new (to geospatial information) methods such as Unmanned Aerial Vehicles (UAVs) and Social Media. The responses considered the challenges of bringing these datasets together into manageable environments, particularly as the capture, processing and distribution of this data becomes more "real-time".

Uses of geospatial data

The experts' view is that geographic information will become ubiquitous in almost every aspect of government and of citizens' lives. In its most positive aspects, crisis response will be greatly enhanced through the wide availability of more accurate, timely and accessible data – satellite flight paths can be changed, UAVs launched, and crowdsourced data ingested in real-time. This data will not only assist immediate response but facilitate better planning and long-term recovery. The data will also facilitate better governance by providing citizens with richer information and will support economic growth through enhanced resource planning, and therefore improved decision-making. However, this does come with risks as the pervasive availability of information, especially where citizens act as passive and even unwitting data providers, does increase the potential for misuse by both state and private organisations. Hence there is a need for vigilance and appropriate ethical standards, and accountability in this area.

Trends in technology (including future of delivery mechanisms for geospatial data)

Responses received from contributors have emphasised that technological evolution will continue to accelerate, with a key trend being the way that previously niche geospatial information technologies will become mainstream, whilst at the same time mainstream technologies such as the Cloud and Software as a Service are absorbed into geospatial information. Data will be increasingly interconnected through the web via capabilities such as Linked Data and this will challenge current standards methods. Contributors highlighted that technology will enable rapid distribution and absorption of information, and also accelerate responses to that data to the extent that location devices will be pervasive – everything and everyone will be locatable. Alongside this, respondents noted the emerging trend towards the provision of 3D and even 4D geospatial information. Responses emphasised these major technological developments and considered how this potential can be exploited to meet global goals.

Legal and policy developments

There were a myriad of legal and policy issues highlighted by contributors that are likely to impact the geospatial world over the coming five to ten years. The trends identified include issues related to the increasing demand for free and open access to geospatial data; the privacy challenges related to the growing number of devices that act as geospatial sensors; the potential gap between legal and policy developments in the geospatial world, and developments in the legal and policy frameworks of interrelated issues such as privacy, national security, liability and intellectual property; the potential legal status of national spatial data infrastructures; and other governance roles expected to be required in relation to geospatial information.

Skills requirements and training mechanisms

Understanding what the skills requirements and necessary training will be in the next five to ten years will be an important component of ensuring the value of geospatial information is maximised. Responses discussed the likely changes that will take place as interaction, analysis and use of geospatial information continues its shift from the domain of a relatively small group of experts to the wider populace. Respondents also gave consideration to the likely impact of the transformations and intersections between geospatial information in what may be viewed as its traditional form and geospatial information as data, particularly in light of the expected proliferation of this data over the coming five to ten years.

The future role of the National Mapping Agencies

Contributions have highlighted that, as in the last five to ten years and the decades prior, the role of National Mapping Agencies will inevitably continue to evolve over the next five to ten years. Responses suggested that Governments are likely to continue to play a major role in securing and guaranteeing the quality of the fundamental geospatial information base, and in overseeing the principles and arrangements required to ensure authoritative frameworks are maintained. Contributors also highlighted the challenges and opportunities that will develop as a result of the increasing availability of crowdsourced data and the involvement of the private sector in the geospatial world, particularly in 'competitive' geographies. Consideration was given to how these trends will impact the role of National Mapping Agencies, and how these different data providers can complement each other.

The role of the private sector and voluntary sector

In addition to considering how the private and public sectors can work together to benefit the citizen, respondents explored a wide range of trends in the private sector and within the volunteer geographic community and discussed how these will evolve, Ten years ago few would have predicted that Google would be a large provider of location information to the citizen, or that most citizens would be buying location services and devices. Respondents noted that we have also seen the private sector begin to challenge the National Mapping Agencies in data collection and maintenance, especially for cross-border solutions, where the national remit of traditional providers is a barrier to users. Contributions also discussed the other extreme, where citizen and voluntary groups have seized the opportunity of new technology to develop initiatives such as Open Street Map and Map Action to complement and even challenge traditional data providers.

Annex A: Future trends

Key emerging trends identified as a result of the input received include:

- The growing number of sensors in everyday devices, which collect and provide geospatial information, will increase and alter the dynamic of data collection. This will also increase the role of geospatial data creation and collection by citizens, both active and passive.

- New data will be created on top of accurate geospatial data using real-time user information available through social media and other web uses.

- There will be an increased demand for applications to be used with high-resolution imagery.

- The use of Unmanned Aerial Vehicles (UAVs) as a tool for rapid geospatial data collection will increase.

- 3D and even 4D geospatial information, incorporating time as the fourth dimension, will increase.

- Developments in technology mean that collaboration on data collection and management will increase, with different aspects carried out in different parts of the globe.

- The emergence of new independent Global Navigation Satellite Systems (GNSS) will require a concomitant system for unification.

- Demand for geospatial data will increase, particularly in developing countries, as they look to develop different sectors of their economies.

- Education and broader capacity building will play a vital role in this field, ensuring that both the skills required to make best use of spatial information are available and that key decision-makers are aware of the value of this information.

- Citizens' familiarity with information that has a spatial aspect to it, particularly through the use of Location Based Services, will continue to increase.

- People will change and adapt as they become more familiar with technology and handling of data streams, and will become increasingly adept at recognising trends (spatial, temporal and causal) within the vast quantities of data that will likely be available.

- Analysis and reasoning based on data may start to form part of Spatial Data Infrastructures, as the concepts of *infrastructure as a* service, IaaS, *platform as a* service, PaaS, and *software as a service*, SaaS, evolve further on to *model as a service*, MaaS.

- The provision of data as Linked Data, similar to the www where documents are linked together, will increase and will be widely implemented within the next 5 years, replacing current exchange standards (e.g. GML).

- There will be a dramatic push to give access to both imagery and applications to end-users anytime, anywhere.

- The cloud will become increasingly important as a delivery mechanism for geospatial data. It will also have a significant impact on current business models.

- Technology will move faster than legal and governance structures.

- Low-cost low tech sensors will proliferate.

- Gaming may inspire new developments as opposed to traditional geospatial information.

- The link between geospatial information and social media, plus other actor networks, will become more and more important.

- Real-time information will enable more dynamic modelling and response to disasters.

- Metadata and other ways of dealing with the increasing amounts of data that will be available will be increasingly important.

- Free and open source software will continue to grow as viable alternatives both in terms of software, and potentially in analysis and processing.

- Earth observations systems will be increasingly improved and make the satellite imagery of any place at any time available.

- Geospatial computation will increasingly be non-human consumable in nature, with an increase in the number of fully-automated decision systems.

- Businesses and Governments will increasingly invest in tools and resources to manage Big Data. The technologies required for this will enable greater use of raw data feeds from sensors and other sources of data.

- Global demand for Location-Based Services will continue to rise and should lead to geospatial information achieving ubiquity.

- The widespread use and creation of geospatial data will lead to the establishment of a geospatial infrastructure. Society will increasingly rely on this infrastructure, much as it has become dependent on other, more traditional forms of infrastructure, such as electrical grids or highway networks.

- Within five years GNSS modernisation will have a significant effect on all classes of positioning – from high end, geodetic quality applications such as orbit determination of low earth orbiting satellites and warning systems for earthquakes and tsunamis, down to consumer grade devices in phones and PDAs. Positioning will be more accurate, with lower latency and greater integrity. Integration with other sensor sets (typically low cost MEMS devices and compasses) will also have developed significantly. Positioning devices will work reliably in far more places than they currently do, and because of this, applications enabled by the technology will spiral upwards in terms of volume and sophistication.

- In ten years time it is likely that all smart phones (or whatever replaces them) will be able to film 360 degree 3D video at incredibly high resolution by today's standards, and wirelessly stream it in real time. Such devices would likely be carried or worn by workers in situations where it would be useful for their colleagues (back at the office

or in the field) to be able to see what they are seeing – for example police officers, firefighters, utility workers, etc. They would also be mounted in many vehicles, at street intersections, etc. This network of devices will provide data that can be merged in real time to give an immersive video view of the world.

- Augmented reality applications will be pervasive, with the ability to view a whole range of data overlays on top of the real world.

- We will see significantly more diversity in the geospatial market than we have had over the past couple of decades. We are likely to see much more influence from video games, in terms of dynamic graphics and 3D visualization. This will be another driver for a new generation of software to replace today's incumbents.

- There will be a need for geospatial use governance in order to discern the real world from the virtual/modelled world in a 3D geospatial environment.

- Free and open access to data will become the norm and geospatial information will increasingly be seen as an essential public good.

- Funding models to ensure full data coverage even in non-profitable areas will continue to be a challenge.

- Privacy will continue to be a major battleground.

- Rapid growth will lead to confusion and lack of clarity over data ownership, distribution rights, liabilities and other aspects.

- Protection of data from processes like data 'scraping' will be an issue.

- Legislation will increasingly recognise digital signatures as digital cadastre/deeds will become the norm.

- In five years, legal and policy communities in most parts of the world will be getting to grips with the power of geospatial technology and some of the unique aspects of geospatial data. However, in many areas of the world a consistent and transparent legal and policy framework will not have developed with regards to such matters as privacy, national security, liability and intellectual property. This will cause a number of issues.

- In ten years, there will be a clear dividing line between winning and losing nations, dependent upon whether the appropriate legal and policy frameworks have been developed that enable a location-enabled society to flourish.

- Some governments will use geospatial technology as a means to monitor or restrict the movements and personal interactions of their citizens. Individuals in these countries may be unwilling to use LBS or applications that require location for fear of this information being shared with authorities.

- Supervision and regulation of geospatial information according to law will prevail, with governments paying increasing attention to the authoritativeness and accuracy of geospatial information.

- National geospatial data infrastructures will be planned, developed and maintained as statutory infrastructures.

- The deployment of sensors and the broader use of geospatial data within society will force public policy and law to move into a direction to protect the interests and rights of the people.

- Location awareness should form a core component of the Internet of Things.

- Capacity development and educational programmes will need to be tailored to individual country needs.

- Spatial literacy will not be about learning GIS in schools but will be more centred on increasing spatial awareness and an understanding of the value of understanding place as context.

- Staff at National Mapping Agencies will have to be rationalized and retrained to acquire multidisciplinary skills.

- As well as playing a major role in securing and guaranteeing the quality of base geospatial information, governments/National Mapping Agencies will take on an additional role as geospatial information manager, and playing a guiding role in guaranteeing the quality and reliability of software used in creating user specific geospatial realities.

- Government's roles may increasingly be one of compensating for market failure as opposed to providing the complete geospatial framework.

- The role of National Mapping Agencies as an authoritative supplier of high quality data and of arbitrator of other geospatial data sources will continue to be crucial.

- National Mapping Agencies set up with large numbers of staff within individual specialist units will change.

- Monopolies held by National Mapping Agencies in some areas of specialised spatial data will be eroded completely.

- More activities carried out by National Mapping Agencies will be outsourced and crowdsourced.

- Crowdsourced data will push National Mapping Agencies towards niche markets.

- Government should provide leadership and establish/oversee frameworks.

- National Mapping Agencies will be required to find new business models to provide simplified licenses and meet the demands for more free data from mapping agencies.

- The integration of crowdsourced data with government data will increase over the next 5 to 10 years.

- Crowdsourced content will decrease cost, improve accuracy and increase availability of rich geospatial information.

- There will be increased combining of imagery with crowdsourced data to create datasets that could not have been created affordably on their own.

- There will be no more than ten global providers of geospatial information services in the world.

- Progress will be made on bridging the gap between authoritative data and crowdsourced data, moving towards true collaboration.

- There will be an accelerated take-up of Volunteer Geographic Information over the next five years.

- In all geographies without market failure, the private sector will wish to compete with traditional players.

- Crowdsourced sensoring will emerge.

- Within five years the level of detail on transport systems within OpenStreetMap will exceed virtually all other data sources and will be respected and used by major organisations and governments across the globe.

- Community-based mapping will continue to grow.

- There is unlikely to be a market for datasets like those currently sold to power navigation and location-based services solutions in 5 years, as they will have been superseded by crowdsourced datasets from OpenStreetMaps or other comparable initiatives.

- National Mapping Agencies are likely to find it difficult to justify the costs of traditional data maintenance mechanisms as their products are used in increasingly niche areas.