Looking Back on SDI Developments with an Eye to the Future

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By way of introduction, I began life as a geographer and planner and became an academic more than fifty years ago. Since then I have held senior positions at the University of Liverpool, the State University of Utrecht, the University of Sheffield and ITC in the University of Twente in the Netherlands. I became directly involved in GIS in 1986 when I was seconded by the University of Sheffield to the UK Economic and Social Research Council to coordinate the Council's Regional Research Laboratory Initiative. This path breaking initiative played a major role in the establishment of GIS based research across the whole country. Its success led to my appointment as Co Director of the European Science Foundation's GISDATA scientific programme which helped to establish a European GIS research community. As an academic I have always been involved practice and was elected President of the European Organisation GI (EUROGI) in 1999 and in 2002 became the first President of the newly founded GSDI Association.

The emergence of the SDI phenomenon

The timing of my involvement could not have been better. The following year saw the publication of the Chorley report to the UK government which claimed that 'Geographic information was the biggest step forward in the handling of geographic information since the invention of the map' (Department of Environment, 1987: para 1.7). It also set out their concern that information technology must be regarded as 'a necessary, though not sufficient condition for the take up of geographic information systems to increase rapidly' (Department of Environment, 1987: para 1.22). To facilitate the rapid take up of GIS the committee argued that

it would be necessary to overcome a number of cultural and organisational barriers to effective utilisation.

The research potential of GIS was quickly picked up by the Research Councils in the United Kingdom and the United States. In the UK the Economic and Social Research Council set up the Regional Research Laboratory Initiative in 1986 and in 1988 the US National Science Foundation set up a National Centre for Geographic Information and Analysis in the US.

The next step forward occurred two years later when the United States Office of Management and Budget's (OMB) created an interagency Federal Geographic Data Committee (FGDC) to coordinate the development, use, sharing, and dissemination of surveying, mapping, and related spatial data. This mirrored similar ideas that were already prevalent in Australia following the establishment of the Australian Land Information Council in 1986. Three years later these ideas were further developed by the United States National Research Council's Mapping Science Committee in their report on 'Toward a coordinated spatial data infrastructure for the nation' which defined a spatial data infrastructure as 'the means to assemble geographic information that describes the arrangement and attributes of features and phenomena on the Earth. The infrastructure includes the materials, technology, and people necessary to acquire, process, and distribute such information to meet a wide variety of needs" (National Research Council, 1993, 16). This definition is still appropriate today.

The SDI concept was further developed the following year with the publication of Executive Order 12906 signed by President Clinton entitled 'Coordinating Geographic Data Acquisition and Access: the National Spatial Data Infrastructure'. This set out the main tasks to be carried out and defined time limits for each of the initial stages of the National Spatial Data Infrastructure.

The publication of President Clinton's Executive Order had a major impact on the diffusion of SDI thinking throughout the world. For example, it prompted the Information Society Directorate of the European Commission to publish the first of a series of draft papers outlining its ideas for a European SDI in February 1995. Economic and social matters rather than environmental considerations were the driving forces behind this initiative. These drafts, collectively known as GI 2000, were the subject of extensive consultations with the European geographic information community between 1995 and 1999 and helped to create a climate of opinion favourable to the idea of a European SDI. An important by product of this debate was the decision to hold the first of what subsequently became a regular series of Global Spatial Data Infrastructure conferences at Bonn in Germany in September 1996 (incidentally the GSDI Association was set up in 2004 and I was its first President). This conference brought together representatives from the public and private sectors and academia for the first time to discuss matters relating to SDIs at the global level.

Brave new GIS worlds

I was actively involved in these exciting developments academically as well as professionally. With our academic hats on Michael Wegener and I published a paper in 1998 entitled 'Brave New GIS Worlds in 1996 (Wegener and Masser 1996) which explored four contrasting scenarios of developments over the next twenty years and with my professional hat on I published two works comparing SDI experiences in the US, UK, Australia and the Netherlands

in a book entitled 'Governments and Geographic Information' in 1998 (Masser 1998) together with a review of eleven NSDIs around the world entitled 'All shapes and sizes: the first generation of national spatial data infrastructures' in1999 (Masser 1999).

The Brave New Worlds paper tried to capture the range of perceptions of the impact of geographical information systems on society in different countries by developing four scenarios of GIS diffusion: a *Trend* scenario characterised by incremental diffusion of geographic information systems along the lines experienced in the recent past, a *Market* scenario based on the commodification of information which restricts access to the more powerful, a *Big Brother* scenario in which surveillance and control by fully integrated omniscient system pervades all aspects of life, and a *Beyond GIS* scenario in which information in the public domain contributes to greater democratisation and grassroots empowerment.

In a recent paper with Michael Wegener (Masser and Wegener 2016) we considered our speculations of twenty years ago with actual developments. We feel that in 1996 we gave a reasonably accurate outlook on the advances in information technology that have happened since then: we correctly anticipated the unprecedented levels of miniaturisation, memory and computing speed of all kinds of electronic devices possible today and we predicted the emergence of transnational media conglomerates integrating telecommunications, cable and computer companies.

Looking back with hindsight we can see that our Technology scenario did not anticipate the explosive growth in volume of volunteered geographic information (VGI) or the universal diffusion of mobile phones with GPS location capability. We also underestimated the availability of satellite navigation and the amazing improvements in sensor technology in all fields of life. In addition, we underestimated the immense privacy problems connected with big data based technologies.

In our Market Scenario we assumed that by 2015 the information industry will be the largest and most powerful economic sector. That may be a bit exaggerated. But a 2013 study carried out for Google by Oxera (2013) that the geoservices industry provides some four million jobs world-wide and that its turnover is at least five times the size of the global video games industry and about one third that of the global airline industry.

Our Big Brother scenario foresaw that the potential of geoinformation networks is exploited by private companies and the corporate state to protect themselves against crime and subversive activities. However we did not fully appreciate the extent of the widespread invasion of personal privacy that follows on from the big data holdings created by large private companies and public bodies.

The Beyond GIS scenario correctly reflected the broad movement towards grass-root democracy which has led to a more critical attitude regarding the information society. Some of the elements of this scenario can already be seen in the notion of the spatially enabled society that is outlined in the last part of my speech.

Overall we feel that our four scenarios would not change much if they were defined now as the reality of today contains elements of all of them and may even underestimate the changes lying

ahead. Comparisons of our speculations of twenty years ago with actual developments are the point of departure for our speculation about trends over the next twenty years. However we need to consider some key questions

- What new, still unknown technological advances appear possible?
- How may they be exploited by private stakeholders and public institutions?
- Will this lead to further growth of the global geo services economy?
- Will there be a solution to the conflict between the goals of open access and privacy?

Implementing INSPIRE

Figure 1 National SDIs throughout the world (Source Ali, A. and Munir, A., 2016)

SDI developments, particularly after 2000, have resulted in a proliferation of initiatives all over the world, in many cases in less developed countries (see Figure 1 and Masser 2005). In many of these countries they also stimulated research on the organisational and institutional issues involved in SDI development and implementation. One of the most interesting SDI developments has been the development and ongoing implementation of Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) to create a Spatial Data Infrastructure (SDI) for improving environmental data management in the European Community by 2021. INSPIRE is a legally mandated programme managed by the European Commission's Environment Directorate General together with its Joint Research Centre and the European Environment Agency which brings the 28 Member States together to build a SDI based on 34 related data themes. The European Commission (EC) began working on the Directive in 2001 and it was approved by its Council of Ministers and the European Parliament in 2007.

Between the approval of the Directive in 2007 and 2014 the Commission, with the help of large numbers of stakeholders, developed Implementing Rules that spell out in some detail the technical requirements for each of the main components of the Directive; ie. metadata, interoperability of spatial data sets, network services, data and service sharing and monitoring and reporting. Each of them went through various stages of public consultation prior to their approval by the INSPIRE Committee. Once approved, these Decisions and Regulations are legally binding on each of the 28 Member States.

In many respects the development and implementation of the INSPIRE Directive be a useful model for other SDI developments. One of the most important features of this initiative has been the participatory approach developed by the European Commission during the both the initial development and the implementation process. As a result, Craglia (2014, p32) has described it as 'an infrastructure built on those of 28 different countries in 24 languages by a truly democratic process, INSPIRE is a role model not only in relation to the developments of SDI but more generally to the formulation of public policy at the European level.'

Towards a spatially enabled society

I have been following the whole implementation process with a great interest and some of its outcomes have been described in my book on 'Building Spatial Data Infrastructures' (Masser and Crompvoets 2015). The main lessons that emerge from this analysis can be regarded as an important step towards the notion of a spatial data infrastructure for a spatially enabled society which incorporates elements of the Beyond GIS scenario. This reflects the emergence of a new generation of SDIs that take account of the needs of a spatially enabled society where the vast majority of the public are users, either knowingly or unknowingly, of spatial information. They generally lack an awareness of spatial concepts and principles while many are willing to make use of commercial products such as satellite navigation systems and Google Earth. This presents several important challenges for the small elite of spatially aware professionals who have so far dominated the development of the spatial related fields of geography, land administration and environmental science. They must develop spatial data infrastructures to provide an enabling platform in a transparent manner to serve the majority of society who are not spatially aware (Masser et al 2008).

Despite these developments many national SDI initiatives throughout the world still seem to abide by the principle, 'one size fits all', and envision a relatively uniform product. However, operational SDI development has both top-down and bottom-up dimensions. National SDI strategies drive regional ones, and regional SDI strategies drive local ones. As most detailed database maintenance and updating tasks are carried out at the local level, the input from local government has considerable impact on SDI implementation. The level of commitment to SDI implementation will vary considerably between nations as well as among regions and municipalities. As a result, a sub national, national or multinational SDI must take account of a large number of similar but often quite distinctive components that reflect the aspirations of the different subnational governmental agencies. While the top-down vision emphasises the need for standardisation and uniformity, the bottom-up vision stresses the importance of diversity and heterogeneity. Balancing the two visions will be a challenge, particularly for multinational initiatives such as INSPIRE, which also must address the cultural aspects of SDIs that are already in place in different European countries.

These findings come as no surprise to me as they also support the view expressed nearly twenty years ago by one of the pioneers in the original development of National Spatial Data Infrastructures, Nancy Tosta (1999), who pointed out that 'successful SDIs will be local in nature. This is as much a function of practical matters such as the challenges of coordinating large numbers of people over large areas, as it is recognising that all geography is local and issues, physical characteristics, and institutions vary significantly across nations and the world.'

Acknowledgement

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