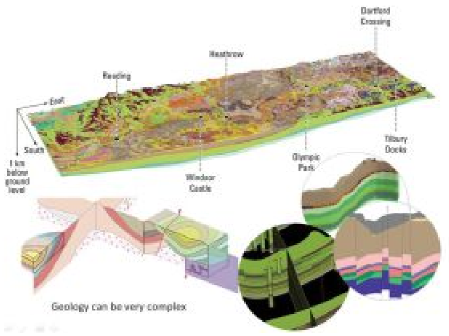
The Role of Geological Data in the Smart City Agenda



Advances in the use of GIS and 3D modelling software have meant that there is now a greater opportunity to develop geo-environmental information systems for urban development, argues Dr Katherine Royse of BGS.

By 2050, 70% of the world's population will be living in cities. Cities have a major impact on the social and economic development of nations. They consume 75% of the world's resources. This evolution raises a very important change with regard to the deployment and management of all types of infrastructures within cities. The sustainable development of our cities is of paramount importance if cities are to cope with the impacts of climate change, population growth, congestion and resource demands.

One solution to these issues is to make cities smart, which means being connected and integrated with confidence and precision – that means knowing where you, your people, assets, sensors and systems are. Smart isn't always about technology. It's about having efficient and effective systems that improve the quality of life for everyone. A city can be defined as 'smart' when investments in human and social capital, traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with wise management of natural resources, through participatory action and engagement.

What has Geology got to do with this Agenda?

The ideal urban form is for compact cites with efficient integrated infrastructure which maximises the potential of the subsurface. The subsurface is a valuable yet very complex expanse which is becoming increasingly congested. For example, the subsurface provides many resources such as space, heat, water, and building materials all of which need to be developed efficiently and sustainably. Difficult ground conditions are much better managed if anticipated. With 33% of all project overruns caused by unexpected ground conditions, not understanding the subsurface is often very costly.

The development of the urban underground as a response to the increasing need for space in the urban environment has resulted in new demands for high-quality geo-environmental data. New guidance and legislative changes have also driven demand; for example in the UK, the Planning Policy Statements and the water framework directive and part IIA of the Environment Protection Act 1990 have forced developers, planning authorities and regulators to consider the implications and impact of large-scale development initiatives on the environment. To comply with the principles of sustainable development, developers increasingly are required to demonstrate that proposals are based on the best possible scientific information and analysis of risk. Nowhere are these issues more relevant than in the context of the urban environment.

The case for using geo-environmental information to underpin preliminary site appraisal and for developing regional strategies has been made elsewhere and has been discussed in depth by Culshaw & Ellison (2002). In the UK, studies commissioned by the Department of the Environment in the 1980s and 1990s (Smith & Ellison 1999) promoted the use of applied geological maps to identify the principal geological factors that should be taken into account for development planning. Since this work was completed, advances in the use of GIS and 3D modelling software have meant that there is now a greater opportunity to develop geo-environmental information systems for urban development, which can take greater account of the third dimension. As a result, new and innovative ways of communicating and visualizing geoscientific information have been developed.

Presenting geoscientific information is one of the key issues around the lack of geodata being utilised in decision making. Urban geologists have two problems to overcome: firstly, the traditional method of visualizing geoscientific information is via a geological map and secondly, changes in planning policy means that different types of data are required. The geological map is an excellent way of recording several sets of 2D information on a flat surface but it requires a significant amount of expert knowledge to interpret its meaning. For the non-geoscientist, the geological map presents itself as a confusing array of colours and lines, which have little relevance to users' everyday working lives.

The second issue of changing needs of planning policy, such as new innovative uses of the urban subsurface for geo-energy storage for example, will require data that describes the conductive heat properties of the subsurface geology, putting more functions underground will increase the competition for space and the potential for complex interactions between different uses to impact each other will be increased (Hack 2009). Detailed information on how subsurface rock properties will change over time is very limited and even where this does exist often the quality of the data and interpretations isn't verified.

There has been a significant change in the type of data-users requiring geoscience information. Data-users can be divided into two camps, ‘thick’ and ‘thin’ (Turner 2003). Traditionally, geoscientific information has been provided to ‘thick’ clients – those who are happy to interpret and manipulate raw data; typically, they are keen to have large quantities of un-interpreted data (e.g. academics). Thin clients, in contrast, desire simple, concise data that answer precise questions (Turner 2003). Thin clients make up the majority of planners and developers. This view was supported by Culshaw (2003), who suggested that academic users were no longer the most important users of geoscientific information. Therefore, if geoscience data is going to be used widely within the urban environment, geoscientists need to radically rethink the way geoscientific data is presented and visualized. Before urban geologists can produce new outputs three questions need to be considered (Royse et al 2008): what geo-environmental questions do users need answering, what geodata do I need to answer these questions and if the data is available, why is it not being fully used?

Geological Projects

The British Geological Survey has developed a suite of spatial data aimed at UK infrastructure sector (BGSCivils) to address these issues for the engineering community. Essentially a geology map for people who have to put things in the ground, its aims are twofold: to provide information for engineers in their terminology to get wider use of BGS Geodata in civil engineering projects/BIM and to encourage a dialogue with engineers to enable further data/knowledge sharing. The Civils project itself started ten years ago from different beginnings with wholly different purposes; initially it was a one-off project to look at ways of installing electrical earthing cables in a way that prevented their (almost immediate) theft, and aspects of that work went on to be used for geo-forensic purposes, such as looking for covert burials.

Whilst very different projects, they demonstrated a basic set of principles (that the construction industry has worked with for over half a century) rocks and soils (of the engineering kind) occur in certain places (which is geology) and behave in certain ways (which is rock/soil mechanics). BGS Civils is essentially a suite of nine national engineering property maps providing the key engineering characteristics of the geology of Great Britain including: Excavatability, Strength, Bulking volume, Foundation conditions, Engineered fill, Discontinuities, Corrosivity, Sulphate-sulphide, Resistivity.

The urban environment usually contains a wealth of legacy of geological information from past site investigations, water extraction or mining activities (Culshaw and Price 2011). The problem is in finding and accessing this information. It isn’t sufficient to just record details of the location and source of borehole logs to enable their use in 3D modelling – the data contained in the log must not only be digitised but also quality assured (Royse et al 2009). Although the collection and conversion of data into interoperable formats is still a challenge, it is the long-term data storage that may be a bigger issue (Culshaw and Price 2011).

Consequently, only 18% of data from recent major infrastructure projects can be used with a high degree of confidence. Work on removing the disconnects between available data, and stakeholders has been undertaken by British Geological Survey and Glasgow City Council where data is now procured in standardised accessible format and cross-sectoral awareness of what data exists and when best used. The project was funded by a local authority and research council’s initiative (LARCI) and resulted in the development of the GSPEC (Glasgow specification for data capture) as a mechanism for improved data delivery and onward transfer. Data is deposited as raw digital data in standardised AGS forms. Key metadata (e.g. grid reference, borehole ID, borehole construction) reported with all associated data.

In conclusion, there are many ways in which geoscience information can be and should be used to support planning and sustainable development of our urban centres. Its use in the smart city agenda has been limited because of issues around the reuse of data and its interpretation by non-specialists. However, current developments focused on engaging the user community and making use of current geospatial modelling methods and virtual reality technology is starting to increase the use of geoscience data and information in smart cities not just in the UK but all over the world.

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