The ASK Network: developing a virtuous cycle of subsurface data and knowledge exchange

Le Réseau ASK: l'élaboration d'un cycle vertueux de données de subsurface et l'échange de connaissances

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ABSTRACT Knowledge of the subsurface is essential in delivering successful construction and regeneration projects. Inadequate understanding of subsurface ground conditions can constrain effective development of urban areas and is a key factor in project delay and overspending. Improving this situation demands much better use, and re-use, of subsurface data and knowledge. The establishment of ASK subsurface data and knowledge exchange network has led to substantial improvements in how urban subsurface data is reported and exchanged between the public and private sectors. Implementation of the GSPEC standardised digital data reporting format has improved the integrity and accessibility of data. ASK and GSPEC are enabling the expansion and exchange of high quality systematic subsurface datasets, improving development of robust 3D ground models which can be used to promote more cost effective and better informed ground engineering investigations, and monitoring and regulation of resources in the urban environment. The work underway in Glasgow is acting as a standard for change, both within the UK and Europe.

RÉSUMÉ La connaissance du sous-sol est essentielle dans l'exécution réussie des projets de régénération et de construction. La compréhension insuffisante des conditions du sous-sol peut contraindre le développement efficace des zones urbaines et elle est un facteur-clé dans le retard des projets et les dépenses excessives. L'amélioration de cette situation exige bien une meilleure utilisation et réutilisation des connaissances et des données du sous-sol. L'établissement des données de sous-sol ASK, et le réseau d'échange des connaissances ont abouti à des améliorations considérables de la procédure d'échange et de la déclaration des données du sous-sol du milieu urbain entre les secteurs publiques et privés. La mise en œuvre des données numériques normalisées GSPEC a amélioré l'intégrité et l'accessibilité de ces données. ASK et GSPEC permettent l'expansion et l'échange des groupes de données du sous-sol systématiques et de haute qualité, améliorent le développement des modèles 3D pédologiques robustes qui peuvent servir à promouvoir des études d'ingénierie du sol plus rentables et mieux informées, et la surveillance et la régulation des ressources dans l'environnement urbain. Les travaux qui sont en cours à Glasgow agissent en tant qu'une norme pour l'échange au Royaume-Uni et ainsi en Europe.

1 INTRODUCTION

Insufficient understanding of subsurface ground conditions is generally recognised by the construction industry across the UK and Europe as a key factor in overspending, project delays, and overly conservative design (e.g. Clayton 2001; Parry 2009; Baynes 2010). Cumulative loss to the economy is substantial. Improving this situation demands much better use, and re-use, of data and knowledge than is currently the case.

Recent collaboration between the British Geological Survey (BGS), Glasgow City Council (GCC), Scottish Water and the private sector (Grontmij) in the Glasgow area has established the potential for creating the necessary conditions for a substantial

improvement in how subsurface data in urban areas is reported and exchanged between the public and private sectors.

This accords with the principles of the EU INSPIRE Directive which include: the 'collect once, use many times' approach; storing data where it can be maintained most effectively, and is easy to find for more effective re-use.

1.1 Issues of data access and re-use, over data availability

Uncertainty in ground conditions in environmental remediation and construction projects often stems from poor accessibility and low re-use of ground investigation data both within projects (for example between specialist sub-contractors), and by subsequent projects (NCE 2011). The difficulty of extracting the data from ground investigation reports means re-use of the data within desk studies is limited, with data often never re-used (Threadgold & Hutchison 1992; Griffiths & Stokes 2008; Lelliot et al. 2009). Improving the accessibility of ground investigation data ought to increase the use of data in desk studies, and should lead to improved ground investigation design and in turn reduce uncertainty in ground conditions.

Work between BGS and GCC has highlighted in Glasgow key areas in the data generation and usage cycle where the links are weak – depicted by orange segments in Figure 1. Key issues are: subsurface data being reported largely in PDF format between consultancies, contractors and authorities from which data difficult to extract; key meta-data (e.g. borehole location, depth, construction information) reported separately to down-hole measurements (e.g. groundwater monitoring); the lack of use of a standardised data reporting formats; and, the absence of a centralised digital database. Required data is often split between several volumes of ground investigation reports and in different formats, making it time intensive to assimilate.

The collective extent to which these issues limit the re-use of ground investigation data in future desk studies or by other clients and third parties is significant – recent work found only 18% of in-situ groundwater data from recent, major infrastructure projects in Glasgow, can be used with a high degree of confidence due to the difficulty in accessing all the required data from the different volumes of the ground investigation reports and the disconnects between the data, uncertainty in measurement datum and units (Table 1).

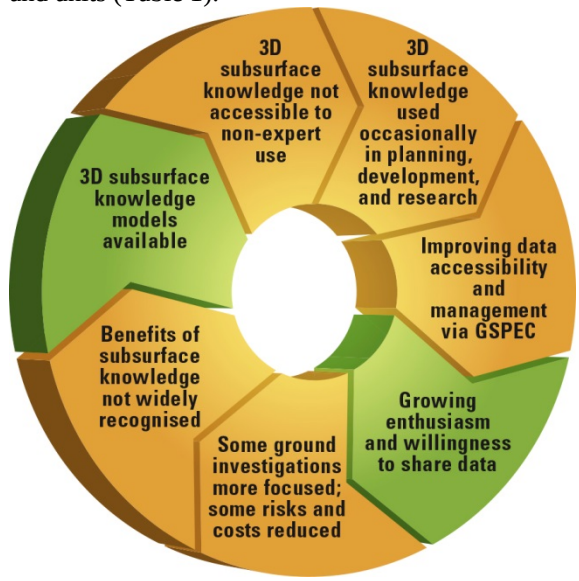

Figure 1. Current data delivery and exchange within GCC and public and private sector organisations in Glasgow. Green shading indicates areas functioning well; orange shading indicates areas which are weaker, but improving.

Table 1. Summary statistics indicating the degree of disconnects in subsurface data reporting, from a sample of 153 boreholes across three recent, major, regeneration sites in Glasgow.

Borehole information	% boreholes, for which this information is reported with groundwater monitoring data	% boreholes for which this information could be retrieved from reports
Grid reference	99	100
Depth	45	80
Screened interval	0	71
Datum of downhole measurements	42	58

2 3D GEOLOGICAL MODELLING

The development of urban 3D subsurface geological models is enabling more effective use of ground investigation data and helping improve understanding

of subsurface conditions (Chowdhury & Flentje 2007; Royse et al. 2008; Lelliott et al. 2009; Campbell et al. 2010; Aldiss et al. 2012). In Europe, geological surveys have been leading the development of 3D geological models on regional to local scales to underpin urban planning and sustainable development (e.g. Bridge et al. 2004; Bourgine et al. 2009), engineering hazard assessments (eg Culshaw 2005; Neumann et al. 2009), and groundwater management (eg Lelliot et al. 2006; Carneiro & Carvalho 2010; Campbell et al. 2010).

Development of these 3D geological models has helped environmental regulators and local authorities meet the requirements of recent environmental legislation, such as the EU Water Framework Directive that demand a 3D understanding of the geometry and properties of the main aquifers, as well as providing a tool for site investigation desk studies (Campbell et al. 2010).

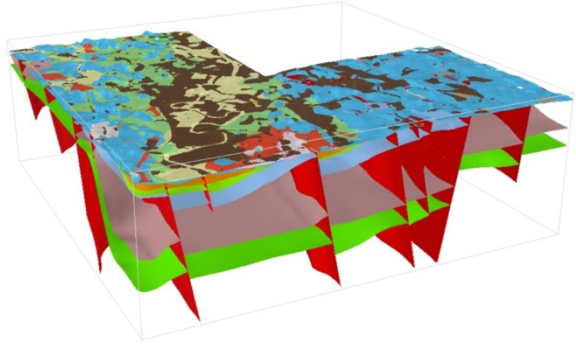

Figure 2. Bedrock and superficial deposits 3D model of south-east Glasgow looking north-west down the River Clyde. Model dimensions 10 x 10 km x 1 km deep, x3 vertical exaggeration.

The 3D geological models of Glasgow (Figure 2) developed by BGS have also helped greatly to enhance the geometry, and characterise the properties, of the very complex superficial deposits and bedrock beneath Glasgow.

Along with assisting site investigation, the Glasgow 3D models were designed to address specific scientific problems, including: assessing the thermogeological potential of minewaters and thick superficial deposit sequences for local heat extraction and storage; the history of glacial oscillations and the evolution of buried valleys in and adjacent to the Clyde valley; and the structural evolution of the bedrock.

However, 3D subsurface models are only part of the solution – the modelling geologists can only collate, and interpret the data which are accessible. Within the UK regional subsurface models are typically based on a small proportion of the data available, largely due to the time and cost required to extract the data in non-standardised formats from PDF ground investigation reports (Lelliot et al. 2009). For example, the BGS Glasgow Conurbation model was constructed from less than a third of the borehole data potentially available.

Development of 3D attributed geological models in the UK has highlighted the large amount of high quality data generated in ground investigations, but also the difficulties in accessing and re-using it.

The accessibility and re-use of ground investigation data would be greatly improved if it were reported between consultancies, contractors and end-users primarily as digital data, using the existing industry standard AGS digital reporting format (AGS 2004), as opposed to information embedded with PDF reports. Ground investigation data in AGS digital data format is significantly faster to assimilate and more accurate (there is a much lower risk of transcription errors) and is of a standardised format. If readily accessible from a centralised database in a standardised format, ground investigation data could be used to much better effect – both within future 3D attributed geological models, and to support planning, development and management of the subsurface. It would also allow an unbroken (virtuous) cycle of data acquisition; data storage and data re-use. This is the aim of the Accessing Subsurface Knowledge (ASK) network (www.bgs.ac.uk/asknetwork) and Glasgow SPEcification for data Capture (GSPEC) in Glasgow.

3 ASK NETWORK

ASK (Accessing Subsurface Knowledge) is a data and knowledge exchange network developed by BGS and Glasgow City Council following discussion with the private sector. The network aims to improve the exchange of information between public and private sector organisations involved in the use of ground investigation data, and in particular their acquisition, interpretation, reporting and re-use. Through an Innovation Agreement, network members can access

the BGS 3D geological models of Glasgow and provide feedback on their suitability for various purposes. ASK was launched in 2012 and now has thirteen private, including the leading civil engineering consultancies, seven public and three academic sector members.

3.1 ASK Network aims

The ASK Network aims to:

- develop and exchange high quality systematic subsurface data sets and methods
- facilitate effective re-use of subsurface data to better inform decision making and management of urban resources
- establish a data transfer mechanism to a centralised repository for raw subsurface data in standardised formats, to maximise accessibility and re-use of data (GSPEC)
- provide access to BGS's attributed 3D model coverage and related GIS data sets
- enable users to influence outputs from models to improve usability
- assess ASK Network expansion, and/or use as an exemplar for in other cities/areas of the UK
- explore integration of geotechnical data and 3D models within building information modelling (BIM)

3.2 GSPEC

The Glasgow SPEcification for data Capture (GSPEC), in tandem with the development of the ASK network aims to improve the accessibility and re-use of ground investigation data across the public and private sectors in the city of Glasgow. Under GSPEC, consultancies and contractors are contractually required by local authorities to report subsurface data in the AGS digital reporting format for subsurface data. The data are uploaded and transferred to a centralised repository within BGS for effective long-term access. An in-built validation process within this web portal service ensures all data received and stored by the BGS are compliant to the AGS standard. GSPEC is, therefore, not a new specification for data reporting; but instead a means of enforcing compliance to existing standards, and initiating the use of digital data reporting formats in addition to ground investigation PDF reports. This step change in data and knowledge exchange will hugely increase the accessibility, integrity, and re-use of subsurface data within Glasgow, and significantly increase the amount of data available for ground engineering, monitoring and regulation of resources in the urban environment.

In the UK, the BGS already acts as custodian of any ground investigation data donated by industry, and many other subsurface data as part of the National Geoscience Data Centre (NGDC); GSPEC is, therefore, also a continuation of BGS's remit as a custodian of national data.

The trial in Glasgow is now gathering significant momentum: it is now a requirement of Glasgow City Council for all subsurface data to be submitted using GSPEC, and the data are being validated and transferred to BGS using the GSPEC web service portal; Grontmij have also adopted the use of GSPEC making it a requirement of their contractors; Scottish Water is in the process of looking to adopt GSPEC and the possibility of it being a contractual requirement of their geological survey subcontractors; and, discussions are taking place with senior management within the surrounding 8 local authorities in the Clyde area for the adoption GSPEC in response to their need for increased re-use of existing data and a wider knowledge base for policy and planning decisions.

The potential for a wider roll-out on a national-scale is significant if the trial in Glasgow continues to be successful. Major consultancies, and national organisations, such as Grontmij and Scottish Water, have reported some widespread benefits in adopting GSPEC and reporting subsurface data in standardized digital format, and having a virtuous cycle of data and knowledge exchange through the ASK Network and access to BGS 3D subsurface models. More rapid manipulation of data; less transcription errors in data; more rapid and effective development of 3D models of site investigations; cost saving, are some of the main benefits reported by these organisations. The Scottish Government is strongly supportive of the aims of GSPEC, and work is ongoing to include GSPEC within the national e-Planning and future e-Building Warrant systems.

4 THE EUROPEAN DIMENSION

Enforcing the adoption of a standardized digital data format for reporting subsurface data, is consistent with best practice in subsurface data management across Europe; as is generating a strong partnership and knowledge exchange framework between public and private sector stakeholders. In cities, such as Hamburg, where subsurface data are reported to a centralised database in the Geological Survey (BSU) using standardized digital templates and reporting codes (following Eurocode7), the impact of subsurface data in underpinning urban planning and management, is vastly greater than otherwise possible. Data received by the Geological Survey can be much more rapidly added to the survey datasets and incorporated in subsurface models. In turn, the increased data accessibility and availability means uncertainty within 3D models and ground conditions is reduced. A virtuous cycle of data and knowledge exchange in the city has been developed between the public and private sector – both sectors working from the centralized subsurface datasets hosted by the geological survey, and coherent city-scale subsurface models (e.g. geological, groundwater or geothermal) can developed by different organisations.

In cities with less established data management practices, where there is an absence of legislative drivers for reporting subsurface data, or to a specific format, GSPEC and ASK are increasingly seen as a transferrable mechanism for establishing and increasing data accessibility and re-use. A potential trial of GSPEC/ASK, or a close analogue, is being discussed within cities such as Oslo within the European COST SUB-URBAN network to improve data accessibility and re-use.

Discussions between geological surveys, city municipalities and city partners across different cities in the European COST SUB-URBAN network, have highlighted several key foundations to achieving a good data and knowledge exchange, and for the full potential of subsurface data to be realized through re-use:

- Centralised repository and standardised data reporting formats are key for data management and data accessibility
- Shared web portal services to centralised databases held by geological surveys, provide both access and a high awareness of the data available to city municipalities and wider city partners
- Incorporation of public and private sector data to national databases is highly valuable and cost effective, despite significant validation costs
- Strong inter-organisational relationships are essential to achieving data and knowledge exchange, and are largely due to collaboration and interest of key individuals within organisations.

These four pillars of data management found the basis of the GSPEC/ASK network, and the work in Glasgow is following some of the best practice examples of subsurface data management and knowledge exchange in Europe. The key difference is that GSPEC/ASK provide a means of achieving this data and knowledge exchange in the absence of legislative drivers.

CONCLUSIONS

Knowledge of the subsurface is essential in delivering successful construction and regeneration projects. Inadequate understanding of subsurface ground conditions can place significant constraints on the effective development of urban areas and is a key factor in project delay and overspending. The recent economic downturn has made vital to maximise past investment in subsurface data and improve data availability for cost effectiveness and the wider good, and is encouraging better collaboration and integration between public and private sector organisations involved in urban regeneration.

In the Glasgow area these changes are enabled by:

- pioneering development of the ASK subsurface data and knowledge exchange network between public and private sectors
- implementation of the GSPEC standardised digital data reporting format to improve the integrity and accessibility of data;
- development of a centralized and publicly accessible data repository.

Combined, these are enabling the expansion and exchange of high quality systematic subsurface datasets, and allowing more readily the development of robust 3D ground models which can be used to pro-

mote more cost effective and better informed ground engineering investigations, and monitoring and regulation of resources in the urban environment.

The work underway in Glasgow is acting as a standard for change, both within the UK and Europe.

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