



NERC Briefing note

Integrating NERC(BGS) subsurface research and data to city development processes and policy

Key learning outcomes





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NERC Policy and Practice Briefing Note – Output from the NERC Innovation Funding Programme, and KE Fellowship NE/N005368/1 - *Integrating subsurface environmental data and knowledge into city planning.*





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Executive summary

This report summarises the midpoint findings of a three year NERC Knowledge Exchange (KE) Fellowship examining how NERC(BGS) subsurface environmental data could have higher impact to city development processes, planning and policy.

The NERC Fellowship is the first to see a NERC(BGS) researcher to be embedded within local government (Glasgow City Council) over a significant time period (three years) working with multiple service teams and levels of local government (LG), from senior management, to development policy teams, to geotechnical, engineering and project design groups within Development and Regeneration and Land and Environmental services.

At present, there is a key gap in the use of NERC(BGS) research within early strategic decisions in LG development planning and policy – Figure (i). This is despite the relevance of the research and data to these decisions, the significant historical investment by NERC(BGS) in LG data acquisition, and the availability of regional datasets of subsurface ground conditions. Strategic knowledge of likely ground conditions and resource opportunities is essential for LG to inform Local Development Plan (LDP) policies, to be able to ‘screen’ and utilise land assets to greatest effect, to stimulate most appropriate city development and investment, and to deliver required housing and infrastructure. Key upfront LDP decisions are made largely in the absence of any strategic subsurface knowledge or screening data of subsurface ground conditions, (e.g. likely construction and remediation costs) with the exception of mining, or subsurface opportunities (e.g. building space, geothermal energy). This is in stark contrast to the high level of utilisation of NERC(BGS) data by the insurance industry to inform decisions of risk and land value/costs, and by both LG and engineering and geotechnical consultancies in the later-stages of the development process to inform project-scale decisions of design and construction – Figure (i).

There are, therefore, key disconnects in the current use and impact of NERC(BGS) data within early stages of city development planning and policy. There is now a significant opportunity to bridge the knowledge gaps within both NERC(BGS) and LG, and to understand: what are the most relevant knowledge of subsurface conditions and opportunities for LG development planning and policy; and, what is the most accessible and relevant mechanism for delivery of the optimal knowledge.

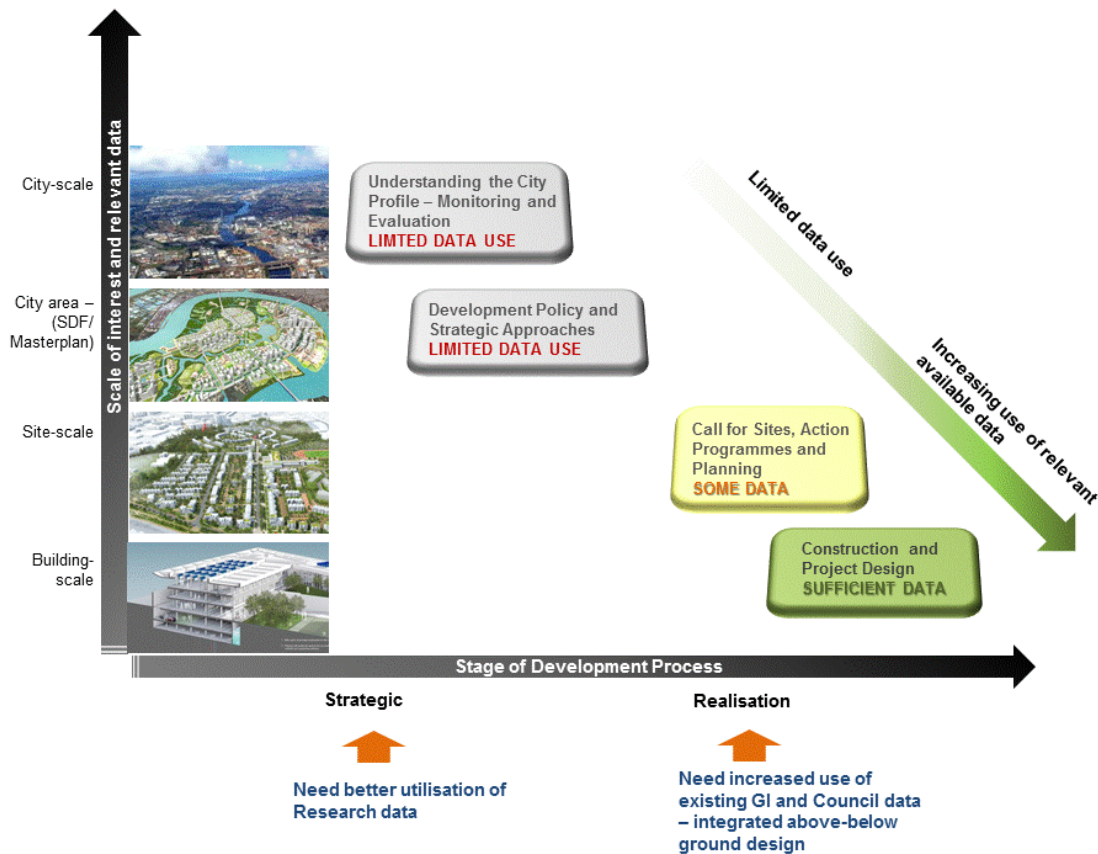


Figure (i) – Awareness, understanding and utilisation of NERC data and research is relatively good at project-scale decisions and workflow processes, but almost completely absent at strategic levels.

The aim of this Fellowship is to develop in-depth learning and understanding with Glasgow City Council (GCC), and other LG's, to establish how NERC(BGS) data could be most appropriately and effectively utilised within early-stage strategic decisions of city development processes and LDP policy, and what are the most appropriate roles and processes within both organisations to connect to develop more resilient and sustainable pathways to impact in the future. The pilots and case studies being developed by the Fellowship, both with GCC and other local authorities and key national stakeholders in Scotland (e.g. Improvement Service), will develop robust test-bed for how wider replication and uptake of the learning outcomes can be achieved. Existing data and knowledge exchange mechanisms (e.g. the national e-planning and e-building portals), and LG platforms (e.g. national Improvement Service, Scotland) will be incorporated wherever possible by the work.

Glasgow City Council is the first LG in the UK to formally recognise the subsurface within its City Development Plan, and as such, forms a key pilot to examine how relevant NERC(BGS) data could be most appropriately and effectively used to inform LG city development planning policy, to aid earlier identification and mitigation of ground conditions, as well as increased utilisation and management of subsurface resources.



The importance of greater utilisation of relevant, high quality strategic data to inform LG Development Plan (LDP) policy and planning processes, through increased collaborative working between professions to cascade downstream benefits and enable LG to deliver transformational city development and investment solutions, is recognised and being called for by the current ongoing national Planning Review in Scotland (Scottish Government 2016, 2017). Utilising greater knowledge earlier, the review is calling for LG planning and LDP policy to take a more strategic view of land required for housing, potentially new zoning of land to assist housing delivery, and a proactive approach to infrastructure planning to deliver integrated, low carbon city development and improved communities (Scottish Government 2017). Evidence suggests that earlier use of appropriate environmental data brings substantial added value and cost benefit – one unit of planning is estimated to reduce response actions by 4-7 units of downstream expenditure and to reduce risk and uncertainty for developers (Department for Communities and Local Government 2006; Aecom 2015).

The work activities and pilots of the Fellowship with GCC are providing tangible case studies of how these recommendations of the current national planning review can be realised.

The mid-point findings from the Fellowship are:

1. New cross-organisational understanding is required between LG and NERC(BGS), which is not tied to individual projects or research programmes

Mutual organisational understanding, is an essential prerequisite for increased collaborative working between the professions and for LG and NERC(BGS) to identify: what subsurface data and knowledge are required for different scales of decisions, at different stages in the city development process; and, how relevant knowledge and data can be most effectively be mapped through organisational workflows, and evidence-based policy.

Developing this cross-organisational understanding, identifying which roles and processes in both organisations should be connected, and what are the most effective platforms for the roles to engage, will take significant time and investment in the first instance. In the future, this rich cross-organisational understanding must be part of both organisations 'DNA', and not tied to individual projects or research programmes.

It is essential that there is greater cross-organisational understanding at executive levels in the future, in order for increased evidence-based policy to be realised, and wider linkages to be identified and cascading down through organisational roles, in line with the recommendations of the current planning review in Scotland.

2. Increased engagement with national training programmes to LG, and LG networks, forms a key vehicle to increase awareness of NERC(BGS) data, and the capacity of LDP to utilise relevant evidence to inform policy.

Developing stronger links between NERC(BGS) and national LG training programmes or platforms will be instrumental to develop more resilient organisational contacts between NERC(BGS) and LG – and in increase cross-organisational understanding of how each organisation, and individual roles and processes within, could most effectively interact and contribute to the overall LDP and city development process.



More resilient organisational linkages within national training programmes/workshops, would negate the reliance on contact on individual projects or individuals for LG utilisation of NERC(BGS) data and research. Awareness of relevant NERC(BGS) datasets, and LG capacity to utilise these data, could be significantly increased with LG for relatively little time and cost to NERC(BGS). Importantly, it would mean the training, awareness and understanding being developed was between different roles and levels in LG and NERC organisations.

The Fellowship is organising the first such workshop in Scotland, between all 32 LG LDP teams, 3 May 2017, in conjunction with the Scottish Improvement Service and COSLA.

3. The potential role of national Improvement Service for Local Governments in Scotland and the APSE (UK)

Within Scotland, the national Improvement Service (IS) for LG's forms a key vehicle for enabling resilient, organisational engagement and knowledge exchange between NERC(BGS) and LG. There are clear synergies between the aims of the IS and NERC(BGS) to ensure increased impact of available research and data to LG and policy. Some of the key IS activities of relevance to NERC(BGS) are: *IS Workshops* – these are open to all local governments in Scotland and are used to provide training, or discussion forums, for different personnel and roles within local governments; and the *Spatial Data Innovation Hub* which is aimed at centralising key spatial data for LG nationally. The Association for Public Service Excellence (APSE) forms a similar vehicle for engaging with LG, and potentially disseminating NERC(BGS) data, at a UK scale.

4. The role of 3D information for early strategic decisions in LG development planning and policy needs to be better understood.

Greater understanding is still required across a range of actors (LG's, NERC(BGS), universities, software vendors, consultancies, public services) as to what is the most appropriate and relevant integration of above and below ground datasets to inform new spatial planning approaches – existing research and derived spatial information may be relevant, but refined presentation and delivery are required for these to provide optimal and accessible knowledge to the key questions being asked in LDP. Increased understanding of what is the most relevant knowledge of ground conditions to support strategic city development policy decisions is essential.

3D presentation of information can be a powerful visualisation tool, but this does not increase capacity of non-specialists to understand and translate the information to inform relevant LDP. Finally, there remains a lack of clarity and understanding of what is the most effective and accessible software platform to do examine a range of information products at city-scale. There also remains lack of understanding to; and,

5. Targeted information that synthesise and summarise comprehensive geoscience data is essential for NERC(BGS) data to be accessible to LDP policy and city planning

Traditional 2D and 3D geological information, which is used extensively within latter stages of the development process in design and construction, has limited relevance or accessibility to early strategic decisions in city planning.



Traditional comprehensive NERC(BGS) information (e.g. geological sequences, geological cross-sections) needs to be translated to key subsurface horizons (e.g. depth to bedrock, depth to groundwater, or depth to geotechnical risk horizons), to support evidence based approaches on land asset utilisation and strategic development frameworks. Similar thematic screening data of subsurface conditions and resource opportunities from NERC(BGS) have been successfully used by the insurance industry and regulators to inform policies. Lessons learnt from these approaches to knowledge delivery, could be applied to city development planning.

Where existing NERC(BGS) datasets have already been refined to show key subsurface properties (e.g. depth to groundwater), learning from the Fellowship indicates further small changes to the presentation of these would also significantly increase the accessibility of datasets to informing city development policy.

Detailed work between geologists and city development policy teams in the cities Oslo and Glasgow, indicates the same key strategic knowledge of subsurface conditions, is required by LG development policy teams, irrespective of different drivers for knowledge and urban context (Municipality of Oslo 2017). This suggests a replicable package of relevant and accessible data and research can be created by NERC(BGS) for cities, not only in the UK, but of equal relevance internationally (Campbell 2016; van der Meulen et al. 2016; Seoul Metropolitan Government 2016).

6. There are limited systematic flow paths of data or knowledge between NERC and Local Governments

Developing new systematic and automated data ingestion processes from local government framework contracts and data procurement processes is essential for: a) NERC(BGS) to have sufficient data to develop higher quality strategic research and information for cities in the future; and b) for LG to have increased open data, better internal data management and data re-use reducing duplication, and improving data analytics capacity, in line for example with the aspirations and drivers of the Future Cities programme.

Shallow subsurface data (typically <50 m depth) represent a key data gap within NERC National Geoscience Data Centre (NGDC), in the absence of legislative requirements to report this data to NERC(BGS) as the UK National Geoscience Data Centre (NGDC). LG's procure a large amount of the new, high quality, ground investigation data to the shallow subsurface generated each year in the UK.

7. The ASK (Accessing Subsurface Knowledge) Network – a successful knowledge exchange network between NERC, LG's and stakeholders.

The ASK (Accessing Subsurface Knowledge) Network is a UK knowledge exchange Network being led by the Fellowship, linking a broad range of stakeholders (local and national), who either use and/or generate subsurface data within different stages of the city development process.

The network is providing an effective forum for piloting and rolling out new automated data ingestion processes to NERC(NGDC-BGS) using standardised, validated digital data format (AGS). There has been strong success and increasing uptake of the pilot through national stakeholders. Of equal importance, the network provides an effective forum for NERC(BGS)



to have on-going conversations and iterative knowledge development with a very wide range of stakeholders. Network discussions have addressed questions of what new knowledge could be relevant to unlocking future city development; what data services will be required / desired in the future; and new data procurement processes between LG's, stakeholders, and NERC (NGDC-BGS) to develop increased centralised knowledge.

The network is being extended to include other NERC research centres (e.g. EDIC-CEH), and other research councils (e.g. the EPSRC Urban Big Data Centre) and a broader range of outside stakeholders (e.g. LDP officers, developers, urban designers, community services).



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1. The importance of increasing the impact of NERC(BGS) data and research to cities

Largely unregulated and unplanned in the UK, as in many other parts of the world, the ground beneath cities is increasingly recognised by local governments as a key asset to unlocking key city development challenges. New integrated above and below ground spatial planning approaches are essential for LG to be able to utilise land assets to greatest effect to stimulate most appropriate city development and investment, to deliver required housing and infrastructure, and develop cities to be more resilient and sustainable places with connected communities of greater well-being.

Development of these new place-based solutions requires greater, high quality, strategic knowledge of the subsurface to be front-loaded to local development processes and policy.

The need for greater, higher quality, strategic knowledge to be front-loaded to local development planning in order to deliver new place-based solutions for required city development is identified by current national planning reform for housing and infrastructure, and the UK government Homes and Communities Agency (UK Government 2015; Scottish Government 2016). NERC(BGS) subsurface data is recognised as a key component part of this strategic knowledge (Scottish Government 2016) required by LG within early strategic decisions of city development approaches and planning policy. Earlier understanding of likely ground conditions and subsurface resource opportunities (underground building space, renewable energy, sustainable drainage) through increased use of relevant NERC(BGS) information to inform LDP policy could enable LG's to designate and utilise land assets more effectively from the outset, which would cascade significant downstream benefit right through the development process, and help increase the efficiency of planning, and mitigate and de-risk later construction costs for both LG's and private developers. Unlocking and de-risking key tracts of vacant and derelict land in cities, for example, represents a key barrier and challenge for many local governments to delivering wider transformational development as well as immediate housing and infrastructure.

Indeed, LG's aspire to make much greater utilisation of NERC(BGS) and other UK research council (RCUK) organisations research to inform new development approaches and increased evidence-based policy, to enable earlier and more effective intervention of development risks for better outcomes, and appropriate investment (GCC 2011). These aspirations follow the broader national visions for increased data accessibility and wider exploitation of spatial data to inform public services and policy, and increased business intelligence, as set out by the digital public services strategy by the Scottish Government Information Sharing and Spatial Information boards (Scottish Government 2012; Morgan 2014) as well as research and innovate UK investment in initiatives of the Future Cities Catapult and SMART cities.



In Scotland, the Scottish Government pays for several key environmental datasets, developed and licenced by NERC(BGS) to be freely available to LG's for decision making processes, under the Scottish Government Agreement (2015). However, awareness of these data, is incomplete across relevant service teams in LG, and there is limited and non-systematic use of the data.

This is symptomatic of the limited awareness or utilisation of existing relevant NERC(BGS) within early-stage of city development planning and LDP policy. There are key knowledge gaps within both NERC(BGS) and LG planning teams as to how to most appropriately and effectively bridge this knowledge gap – which roles and processes are most relevant to connect in organisations – and what delivery of relevant NERC(BGS) data is most accessible to LG development planning and policy. New relationships and conversations between NERC and LG organisations and data centres are required to achieve this.

Current utilisation of NERC(BGS) data within LG across the development process

Work with GCC and other local authorities highlights a strong disparity in the awareness and utilisation of NERC(BGS) data within LG at different stages of the development process – Fig. 1. Awareness and utilisation of NERC(BGS) data and research is relatively high within geotechnical and environmental service teams in LG and it is used substantially to inform design and construction programmes towards the end of the development process. In stark contrast, awareness and utilisation of relevant NERC(BGS) data is almost completely absent within early strategic decisions of the development process, by LG development planning and policy. The city of Glasgow has, for example, the most comprehensive NERC(BGS) urban geoscience model in the UK, as well as applied 2D datasets developed to support urban planning approaches, yet none are used to inform strategic development approaches or policy.

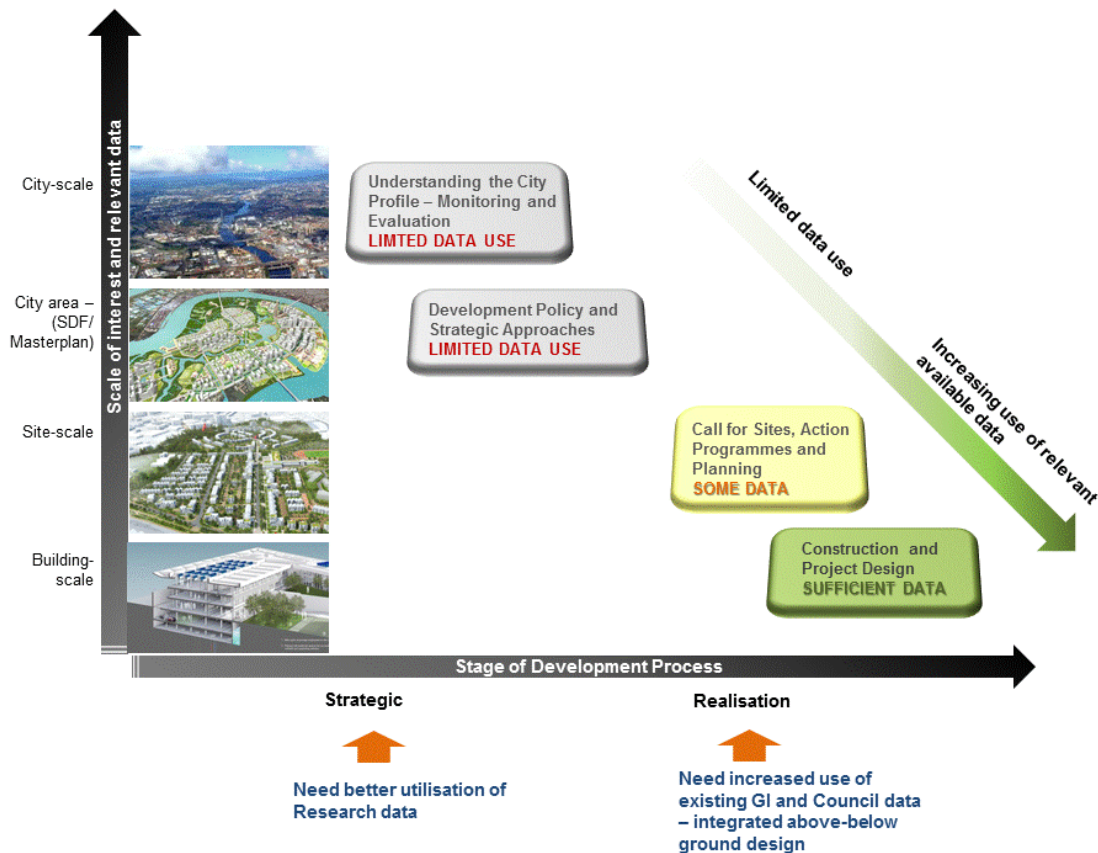


Fig. 1 – Awareness , understanding and utilisation of NERC data and research is relatively good at project-scale decisions and workflow processes, but almost completely absent at strategic levels.

Several factors underpin this key disconnect within strategic levels of the LG development process and development planning and policy. Fundamentally, the disconnect is a manifestation of the historical relationship between BGS and LG’s, where the organisations have traditionally interacted in the design and delivery of specific projects (the end-stage of the city development process) and communication has largely been between geologists and geotechnical specialists. This has contributed to the different awareness in LG between early-stage policy teams and later-stage design teams of the existing, relevant NERC(BGS) data and information, as well as the relatively limited understanding within NERC(BGS) of what early-stage strategic decisions local governments are required to make to deliver investment and infrastructure and therein what is the most appropriate and relevant delivery of strategic subsurface knowledge to inform policy. These points are discussed in more detail below.

Historically there have been long-standing relationships between BGS and geotechnical and environmental service teams in LG (e.g. contaminated land officers, geotechnical engineers, and environmental health officers). Significant investment has been expended by NERC(BGS) in data acquisition and to develop relevant regional datasets of subsurface environment and ground conditions for these service teams within LG. Formerly, this relationship was maintained by Regional BGS geologists who formed an ongoing point of contact with LG’s. In more recent years the relationship between the NERC(BGS) and LG organisations has been increasingly developed/tied to individual projects and between individual BGS geoscientists and relevant subsurface specialists



within the geotechnical and environmental service teams (e.g. contaminated land officers, geotechnical engineers, environmental health officers). As a result of the past and present relationships between the organisations, there is a relatively high awareness and utilisation of existing NERC(BGS) data geotechnical and environmental LG service teams – comparable to that by the insurance industry, or by private sector geotechnical consultancies leading site investigation, remediation and construction works.

In contrast, there has been much more limited, if any, engagement by NERC(BGS) with city development planning and policy teams in LG. And as a result, there is limited awareness within LG development policy and planning teams of what NERC(BGS) data exists, or its relevance. There is also much weaker understanding within NERC(BGS) of: what is the most accessible delivery of NERC(BGS) data to these more strategic levels in LG; what capacity exists within planning teams to utilise different forms of strategic subsurface information; and exactly what range of decisions development planning teams are having to make, and what other datasets and research are required.

Local governments and NERC both need to develop higher impact from past investment in data.

There is a strong need and aspiration within LG's to develop higher impact from both their own data and RCUK data (including NERC(BGS)) to develop higher quality strategic knowledge which can inform early strategic decisions and development policy – Fig.1. Equally, it is essential for NERC(BGS) to develop stronger relationships with LG to be able to provide accessible relevant data, which can inform evidence-based policy.

Local governments recognise the significant cumulative downstream benefit which could be realised by greater utilisation of data earlier in city development processes and policy. Indeed, this is seen as fundamental, rather than being aspirational, to LG being able to deliver required city development and infrastructure, with better outcomes and reduced costs, and attracting investment (GCC 2011, 2017). It is at these early strategic stages of the city development processes where decisions are made about: how land assets are zoned for development; how to deliver integrated infrastructure and a low carbon, connected city; deciding what mitigation is required by LG's to unlock brownfield land for development; and how appropriate investment opportunities should be prioritised, and generated.

Development of appropriate strategic knowledge and datasets from project-scale and point data procured by LG is not straight forward – it requires detailed understanding of the questions being asked, the limitations and scale of the data, and thereby the most appropriate interpolated output, and upscaling methods.

NERC(BGS) has a key role to play here for local governments and cities – Fig 2. Successful development of this role will depend not only on greater data inflow to NERC(BGS) from LG's, but also a greater understanding in NERC of what research is relevant and accessible to strategic levels of LG development processes – Fig.2. The Fellowship with GCC is aimed at developing better understanding of how each of these can be achieved, and to identify the most appropriate, sustainable mechanisms for replicating with other LG's.

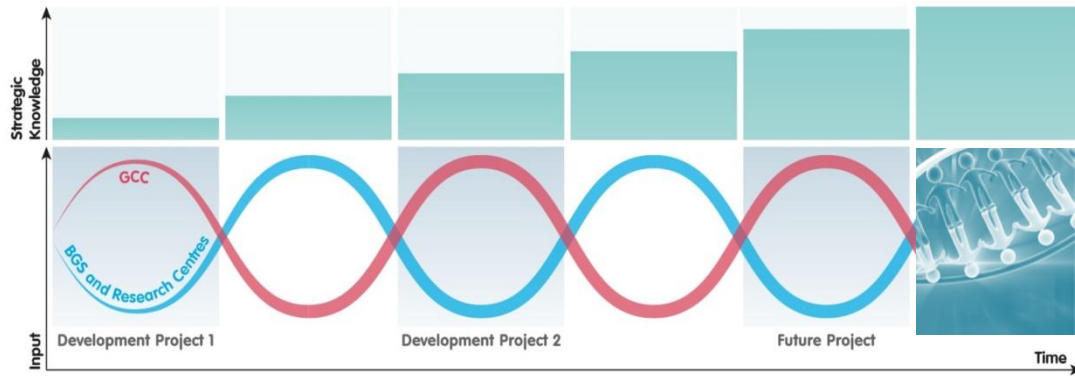


Fig. 2 – Higher quality strategic knowledge can be developed over time with increased data accessibility to NERC, LG and other stakeholders.

2. Key gaps in understanding within NERC(BGS) and local government

There is currently a disconnection between NERC(BGS) and LG development planning and policy specialists. This is reflected not only in the present disparity in awareness and utilisation of NERC(BGS) data in LG's, but also in the key knowledge gaps within both organisations. These include:

In NERC(BGS):

- ❖ There is limited understanding of the full range of decisions LG's are needing to make in city development processes, and at what levels and roles these decisions are made
- ❖ There is incomplete understanding of the differing capacity within these levels to utilise different forms of relevant subsurface information data.
- ❖ What training and guidance is required to be delivered with NERC research and data, to ensure data can be utilised by local governments.

In local governments:

- ❖ A lack of awareness of what NERC data and research knowledge exists and its relevance – particularly within strategic levels. Specialist services teams, such as environmental and geotechnical service teams overseeing design and construction of development, have a much better awareness, but it is still incomplete.
- ❖ Weak understanding, as to the importance of scale of data and how different NERC(BGS) of the subsurface data are relevant and appropriate to different scales of decisions;

Bridging the critical knowledge gaps requires increased awareness, understanding and capacity within both organisations – Fig. 3.

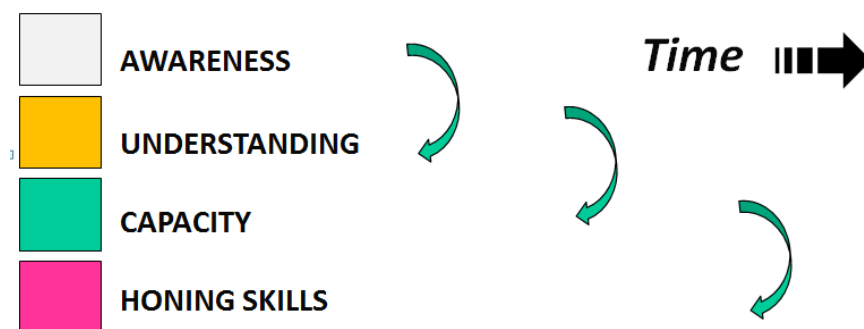


Fig. 3 –Increasing awareness, understanding, and capacity are the cornerstones to LG being able to harness the value of existing data and research, and for NERC to deliver future accessible and relevant data.

The amount of time and investment required to identify which roles and processes in both organisations should be connected, and what are the most effective platforms for the roles to engage, is significant. The learning being developed from the Fellowship by NERC(BGS) and GCC, will

be used to identify more sustainable and replicable methods for NERC(BGS) to engage with LG development planning teams. Key learning points from the work between NERC(BGS) and GCC so far are discussed in the sections below.

New cross-organisational understanding, which is not tied to individual projects or research programmes is required

Utilisation and impact of NERC(BGS) research within city development processes requires mutual awareness and understanding – both within NERC and LG’s – of what subsurface data and knowledge are required for different scales of decisions in city development processes, from city-scale to project-scale, and how relevant NERC data and research could be most effectively be mapped through organisational workflows, to support decision making processes and policy.

This requires rich cross-organisational understanding, which must be part of both organisations ‘DNA’, and not tied to individual projects or research programmes

The evidence-base required by LG to develop transformational city development policy, for new place-based solutions, must be derived from not only LG strategic data and knowledge but that of other relevant stakeholders, such as NERC(BGS) – Fig.4.

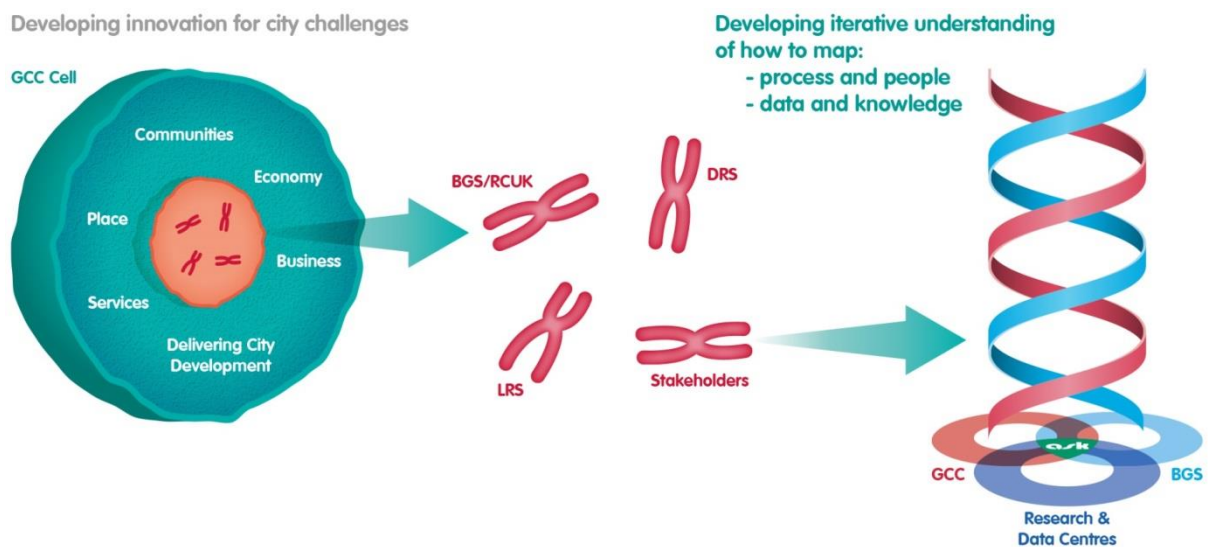


Fig. 4 – To deliver new city development approaches, the city ‘cell’ must not only be comprised of Local Government service teams, but also the data and knowledge of RCUK and other key stakeholders. This requires rich cross-organisational understanding, which must be part of our DNA, rather than linked to specific projects or individuals.

There are limited systematic flow paths of data or knowledge between NERC and Local Governments

The existing knowledge gaps are also manifested in the very limited systematic data flowpaths between NERC(BGS) and local governments. Data exchange, or utilisation, at any stage of the development process is heavily reliant of contact between individuals, rather than organisational roles or workflows.

LG's procure a large amount of the new, high quality, ground investigation data generated each year in the UK. In the absence of legislative requirements to report shallow borehole data to NERC(BGS) as the UK National Geoscience Data Centre (NGDC), only a small proportion of all site investigation borehole data are held by BGS(NGDC). These data are, however, an important component of urban subsurface environmental knowledge, and are required by NERC(BGS) to be able to develop higher quality relevant strategic urban geoscience information in the future. LG's also largely unaware of the NGDC, and the services it provides to access existing data.

Developing new systematic and automated data ingestion processes from local government (and national stakeholder) framework contracts and data procurement processes is essential for: a) NERC to have sufficient data to develop higher quality strategic research and data for cities in the future; and b) for LG to have increased open data, better internal data management and data re-use reducing duplication, and improving data analytics capacity, in line for example with the aspirations and drivers of the Future Cities programme – Fig. 5.

The Fellowship is piloting new data ingestion mechanisms, via revised contractual requirements of LG's and key national stakeholders, which will mean ground investigation data from major redevelopment contracts are deposited to the centralised National Geoscience Data Centre (NGDC) in a standardised, validated digital data format (AGS), using an automated web service. Project-scale data will be available for long-term re-use by all stakeholders under Open Government Licence (OGL), and the increased accessibility of these data to NERC(BGS) will enable NERC(BGS) to develop higher quality strategic information of the subsurface and ground conditions. The pilot is now being extended to a national-scale across Scotland through key stakeholders, and it forms a robust test for a replicable template for elsewhere in UK and internationally.

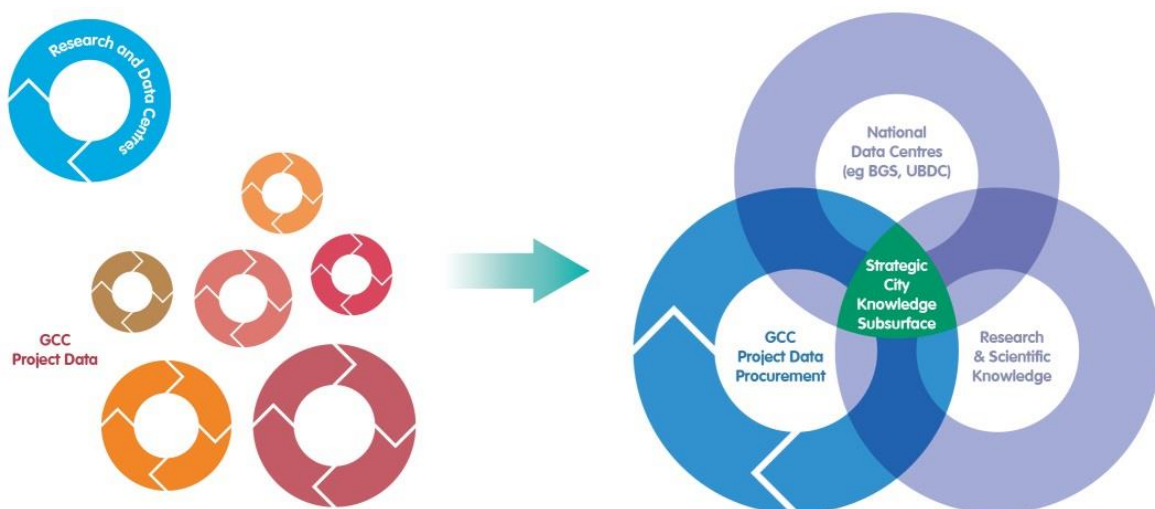


Fig. 5 – Transformation of present data project-level data utilisation and re-use needs to happen to



enable LG and NERC to develop relevant higher quality subsurface knowledge and policy for city development processes.



The role of 3D information for LG development planning and policy needs to be better understood

3D information and models can be highly effective communication tools, and there is a strong, aspiration within LG's for greater utilisation of 3D data and information, to support new integrated above and below ground spatial planning approaches in line with FutureCities and SMART cities initiatives. Private sector city stakeholders who undertake design and construction work share a similar drive to be working increasingly with 3D, above and below ground, Business Information Models (BIM), in line with the UK Government construction and industrial strategies (UK Government 2015). NERC(BGS) has also, independently, invested significant resources in recent years to produce 3D geological information and models for key regions in the UK and internationally – Glasgow forming a key UK pilot (Merritt et al. 2007; Kessler et al. 2009; Campbell 2010, 2016; Kearsley et al. 2015).

There, is however, relatively poor understanding by any of the actors (software vendors, LG, NERC(BGS), innovation programmes) as to what is the most appropriate and relevant integration of above and below ground datasets for new spatial planning approaches; what is the most relevant strategic information of ground conditions for 3D models targeted at supporting early strategic city development policy decisions; or, what is the most accessible software platform to do this at a city-scale.

To begin to address some of these gaps, the Fellowship has identified several pilots, or 'demonstrator projects' between NERC(BGS) and GCC. The first of these is assisting GCC to undertake a strategic housing land audit based both above and below-ground screening datasets, to assess what land assets could provide required housing infrastructure, and what investment is required to unlock and deliver the development on these land assets.

Lessons could also be learnt from where NERC(BGS) thematic screening data of subsurface conditions and resource opportunities have been successfully used by the insurance industry and regulators to inform policies –for example, the use of NERC(BGS) groundwater vulnerability and resource potential maps used by environmental regulators. The lessons learnt from these approaches of knowledge delivery, could be applied to city development planning. Small changes to the presentation of these thematic data may significantly increase the accessibility of datasets to informing city development policy (see following section).

There is also a varied capacity within LGs to utilise 3D subsurface information, particularly at strategic levels within development planning and policy teams. Training to these LG areas is required to ensure relevant strategic subsurface information can be utilised effectively and appropriately in 3D according to scale, certainty and relevance. 3D information and models by themselves do not provide this knowledge or training. Moreover, models, crucially as yet, do not establish systematic knowledge pathways between different roles and organisations to ensure the full potential of data is harnessed.

3D models and information do, undoubtedly, offer a powerful visualisation tool which could significantly aid LG development planning teams to develop a conceptual understanding of how integrated above-and-below ground place-based solutions to city development could be developed, and utilised to deliver required infrastructure. 3D models should however be seen as one part of a work process, rather than a panacea, to improve communication and utilisation of NERC subsurface data within LGs and city development processes.



It should be noted in contrast that Project and Design Management, Geotechnical, engineering and environmental service teams) already utilise 3D information, and they represent high capacity independent users of data. Within GCC and other LG's, these teams already use 3D subsurface information from NERC(BGS) and are working to develop their own 3D information and BIMs.

Translating comprehensive NERC(BGS) geological information on key subsurface horizons and properties is essential for providing relevant strategic knowledge to LG development planning processes

NERC research organisations have traditionally fulfilled a 'Survey' function of supplying comprehensive above and below ground environmental datasets or research. These are highly utilised, and very relevant and accessible to specialist teams within LG's involved in project-scale design and construction stages of the development process. The information within these comprehensive datasets are equally relevant to earlier strategic roles and decisions within LG's, but different delivery of the information is required for it be accessible to these strategic LG decisions.

Translating comprehensive geological information for key surfaces (e.g. key geological horizons) is required to develop optimal 'screening' knowledge which is accessible to LG development planning policy. For example, **refining NERC(BGS) information** to show depth to bedrock, depth to groundwater, or depth to geotechnical risk horizons, instead of the entire geological model and individual geological horizons, would greatly increase the accessibility and impact of the information on likely ground conditions, and associated risks and costs of above-and-below ground development opportunities. Equally, Action Learning (see p26) of the Fellowship has found small changes to the presentation of information can vastly increase the accessibility of the information. Changing a depth to groundwater map to display only two categories of depth to groundwater, which are of critical relevance to development decisions, leaving other areas non-shaded, vastly increases the accessibility of the relevant data and knowledge. Applying appropriate thresholds to information in such a way could help refine some NERC(BGS) datasets.

Thematic screening data of subsurface conditions and resource opportunities is essential for LG development planning and policy teams to be able to develop integrated above and below ground conceptual model of cities land assets and how new integrated place-based solutions could be realised.

Detailed discussions between geologists from NERC(BGS) and Norwegian Geological Survey (NGU) and LG development planning teams in Glasgow (GCC) and Oslo (Oslo Municipality), respectively, have identified the following 'key surfaces' of geological understanding to be important and also accessible information (Municipality of Oslo 2017), to LG development planning processes:

- depth to bedrock;
- depth to clay;
- depth to horizons of geotechnical risk (inc. mining);
- depth to groundwater;

Interestingly, the drivers for these data in Glasgow and Oslo are very different – within Glasgow these data are required by LG's to be able to mitigate and unlock brownfield development, which is often seen as too costly to develop by stakeholders, whilst in Oslo the data are required by the LG to



constrain brownfield development and elaborate engineering and architectural urban building design, which can incur subsidence and adjacent infrastructure damage in some geological contexts (Municipality of Oslo 2017). Despite the opposing drivers, the same strategic knowledge of the subsurface information, and translation of geological information, are required by the cities strategic development planning.

The work within these two cities suggests that a replicable package of relevant and accessible data and research can be created by NERC(BGS) for cities which would have relevance internationally as well as the UK.

A refinement of NERC research delivery, but not a replacement, is therefore required to support evidence based development policy in LG; and not a complete new tranche of research products.

Better delivery of NERC(BGS) data and knowledge, would enable LG to undertake more effective spatial planning analysis. NERC(BGS) research products have in the past been assumed to be accessible to this planning process, but in reality, the spatial planning analysis used to inform LG development policy and investment strategies are based almost entirely on above-ground city data, with little if any consideration of subsurface ground conditions, resources or opportunities, aside from mining risks. To improve the effectiveness of this analysis process LG and NERC organisations need to work together more closely.

Greater understanding is still required to elucidate what format and presentation of appropriate NERC(BGS) data is most accessible and relevant to LG development planning and policy. For example, there is need for stronger understanding within NERC(BGS) of:

- When 2D or 3D presentation of subsurface information (e.g. of ground conditions) is more appropriate and accessible to inform development policy. For example, is depth to rockhead – a key NERC(BGS) dataset to the development planning and policy – most accessible and relevant as a 2D grid, or as a 3D surface?
- Displaying key horizons of the subsurface and its properties (e.g. depth to groundwater) as 3D surfaces can be highly effective aid to increasing capacity on non-subsurface specialists in visualising and understanding how above, and below-ground development could be integrated, and associated risks or costs. However, it remains to be proven if 3D surfaces are as relevant or as intuitive as 2D maps of the same information to informing LG development planning and policy.

Increased engagement with national training programmes to LG, and LG networks, forms a key vehicle to increase awareness of NERC(BGS) data, and to pilot new approaches

Increasing NERC(BGS) engagement with formal training programmes to LG, and existing LG networks, forms a key vehicle to increase awareness and utilisation of NERC research within a wide network of local governments. Engagement with such platforms could significantly increase utilisation and impact of appropriate NERC(BGS) data within city development planning and policy, for relatively limited time and cost investment for any organisation.



Greater engagement with existing LG training and network platforms, would also negate the reliance on utilisation of NERC(BGS) data and research being done through contact on individual projects or individuals, and help develop more resilient organisational connections. Importantly, it would also mean the training, awareness and understanding is developed between different roles and levels in LG and NERC(BGS), replacing the much weaker knowledge development model which currently exists and relies on individual contacts, and on individuals being in the 'right place, right time'.

There are potentially significant benefits to engaging with centralised LG platforms:

- It would enable NERC(BGS) to tap into existing well-established and recognised communication and knowledge dissemination pathways to LG's nationally, and significantly increase awareness of NERC(BGS) as a relevant organisation of knowledge for LG.
- Providing training services to LG in relevant appropriate NERC(BGS) data to LG development planning and policy could significantly increase the capacity of LG's to map NERC data and research appropriately through organisational workflows, and into policy and guidance. This could significantly increase the impact and utilisation of NERC data and research by other city stakeholders (e.g. developers, consultancies, contractors).
- It negates the reliance on contact between individuals in organisations, developing much more resilient organisation connections across levels and roles It enables NERC(BGS) to engage with multiple, and potentially all, LG at once, rather than disconnected and bespoke interaction for separate LG's.
-
- It could open opportunities to pilot new centralised data flows, and licence agreements for data between LG and NERC(BGS).

The national Improvement Service for Local Governments in Scotland

Within Scotland, the national Improvement Service (IS) for LG's in Scotland forms a key vehicle for NERC(BGS) to engage with.



The Scottish IS purpose is to:

"help councils and their partners to improve the health, quality of life and opportunities of all people in Scotland through community leadership, strong local governance and the delivery of high quality, efficient local services. [The IS does this] by providing a range of products and providing advisory services including consultation and facilitation, learning and skills, performance management and improvement, and research" (Improvement Service 2015).

The main aims of the IS are to:

- Help facilitate a step-change in productivity and efficiency of LG services
- Support the delivery of improved outcomes
- Supporting development of work processes which are of increased resilience and sustainability



- Supporting increased collaborative working
- Support improved research and analytical support

There are clear synergies between the aims of the IS and NERC(BGS) to ensure increased impact of available research and data to LG. Some of the key IS activities of relevance to NERC(BGS) are:

- IS Workshop series – these are open to all local governments in Scotland and are used to provide training, or discussion forums, for different personnel and roles within local governments - for example, increasing awareness and capacity of LG services of relevant external, or national centralised data, and services, or to aid LG's endorse new national legislation.
- Spatial Data Innovation Hub – the IS has also recently launched a Spatial Data Innovation Hub, aimed at centralising key spatial data for use by LG nationally.

Increasing NERC(BGS) connections with the IS could open significant opportunities, and should form a key vehicle for NERC(BGS) engagement with LG's in the future.

The Fellowship is piloting the first NERC(BGS)-IS workshop in Scotland in May 2017 to begin this process, and raise awareness of existing relevant NERC(BGS) within LG. Representatives from LG Development planning teams and geotechnical groups will be invited from all 32 LG's in Scotland, as well as the Regional planning groups and national parks – more information is provided on this in Section 3.

The input required from NERC organisations to engage with this, or similar IS Workshops, would be on the order of 1 to 2 days annually, and therefore minimal to the significant potential increase in awareness of relevant NERC(BGS) data to LG services, and opportunities to pilot new mechanisms of data delivery, and increased data acquisition to NERC(BGS).

Workshops are an incredibly valuable and effective means for sharing and cascading awareness and understanding within organisations, between different teams and roles.

The Association for Public Service Excellence (APSE) – UK

The Association for Public Service Excellence (APSE) forms a potential vehicle for NERC(BGS) to engage with LG on a UK-basis, alongside the Improvement Service in Scotland. The APSE is a non-profit organisation aimed at promoting excellence in the delivery of frontline services to local communities around the UK (APSE 2016). It connects more than 250 local authorities (LG) and other organisations and provides a centralised voice and point to: facilitate increased data and knowledge exchange on LG services; provide a platform for advice and innovative solutions; and, to develop new, viable ways forward in an effort to help one another.

The APSE is owned by its members and, working on their behalf, maintains and develops a network of local government officers, managers and councillors from local authorities across England, Northern Ireland, Scotland and Wales.

Following the NERC(BGS)-IS workshop pilot in Scotland, and the learning gained from this, the Fellowship and NERC(BGS) could look to replicate a similar pilot with the APSE.



Need to develop a means of tracking benefit – what metrics?

There is a need to develop a means of tracking the benefit of utilising relevant strategic data and knowledge of the subsurface within city development planning – this demonstrates the costs and benefits of the approach to other LG and the value to NERC.

Tracking needs to encompass a range of metrics of ‘benefit’ – benefits could be measured in: reduced costs of construction and design phases at the end of city development processes; increased utilisation of NERC data and research; realisation of integrated above and below ground planning of infrastructure and place; increased use of subsurface resources (underground building space, energy, water); and formal planning of the subsurface.

Assigning economic value and benefit to utilisation of data within city development processes is complex (Compernelle 2015), and as yet there is no clear understanding of what is the most appropriate metric, when considering cost-benefits across the whole process. Estimating cost-benefits with an one stage (e.g. design and construction) is easier. It is likely there will be increased costs early on in development processes, from increased data procurement, data licencing or software investment costs, but that there will be significant downstream savings in construction phases. A further aspiration is that increased evidence-based development policy will enable LG to run more efficient planning process with associated cost savings, and inform decisions which ultimately lead to increased investment in the city. Hidden economic savings within health and environmental sectors are also possible, from city development fostering a higher quality environment, and more connected communities of increased well-being and health. Developing means of tracking some of these benefits is essential to demonstrate the economic value of NERC(BGS) data to LG and other city stakeholders.



3. Testing new more replicable sustainable data and knowledge pathways between NERC(BGS) and local government - Pilots

Glasgow City Council is the first LG in the UK to formally recognise the subsurface within its City Development Plan, and it therefore presents a key opportunity to examine how NERC(BGS) data and research can be most appropriately and effectively integrated to LG city development policy and planning.

A range of pilots are being undertaken by the Fellowship with Glasgow City Council (GCC) and several key national stakeholders, to:

- Identify stronger, more resilient (and in some cases automated) data and knowledge pathways between NERC(BGS) which could be replicable in other cities
- to develop understanding of which NERC(BGS) data are most relevant to LG city development planning and policy, and what is the most relevant and accessible packaging of these data to provide relevant strategic knowledge of subsurface conditions and opportunities, which can inform investment decisions and strategic development policy
- and, to identify how, NERC(BGS) can be most appropriately and effectively integrated to LG city development policy and planning – what are the most relevant and effective LG platforms (e.g. the IS spatial data hub) and workflow processes, or legislative planning processes (e.g. Supplementary Guidance) and systems (e.g. Scottish Government e-planning and e-building portals).

The pilots developed in Glasgow through the Fellowship, as well as with other stakeholders (e.g. the IS) in Scotland will provide a robust test bed for uptake by other LG's in Scotland, as well as elsewhere in UK and overseas. The sections below provide an overview of some of the key pilots being undertaken by the Fellowship, and the key lessons from these so far.

Key value of 'Action Learning' - demonstrating and piloting NERC data within LG workflows

Developing the required level of meaningful understanding between NERC(BGS) scientists and LG development planning teams of: how NERC(BGS) data are relevant to early strategic decisions in development planning policy; and how it could be better integrated existing and future LG work flow processes, is a not simple task due to the large knowledge gaps and disconnects between the organisations. Establishing which are the most relevant roles and processes to connect between the organisations takes significant investment in time and personnel. Other key elements requiring deeper understanding are: the capacity of different levels and roles within LG to utilise relevant NERC(BGS) data; how NERC(BGS) data currently enters LG's across multiple service teams; and what the key decisions within LG development planning policy to which it is most relevant.

‘Action learning’ – that is the discussion, review, demonstration and application (piloting) of NERC(BGS) data to LG work flows and tasks – has been found to be by far the most effective means of developing this required level of understanding – Fig. 6. Only in applying and using NERC(BGS) data within LG work cases can LG roles come to fully appreciate its relevance, and how it could be best utilised and integrated within existing workflows and LG / planning platforms or portals. Equally it is the only real means by which NERC(BGS) can fully understand what presentation and delivery of strategic knowledge is most accessible to inform key strategic decisions in LG developing planning policy, to inform investment decisions or utilisation of land assets and infrastructure delivery.

‘Action Learning’ is time intensive, and reliant on individuals from NERC(BGS), such as KE fellows, to broker this learning development. Many different test cases are required across multiple teams and roles in LG’s. The approach is, therefore, not a sustainable, or an appropriate, means of developing the required understanding across NERC and with every individual LG, or indeed with other stakeholders. However, the understanding developed from this Action Learning process with GCC is a very valuable mechanism to develop sufficient understanding from which more sustainable, long-term knowledge flow paths can be established between NERC and Local Governments.

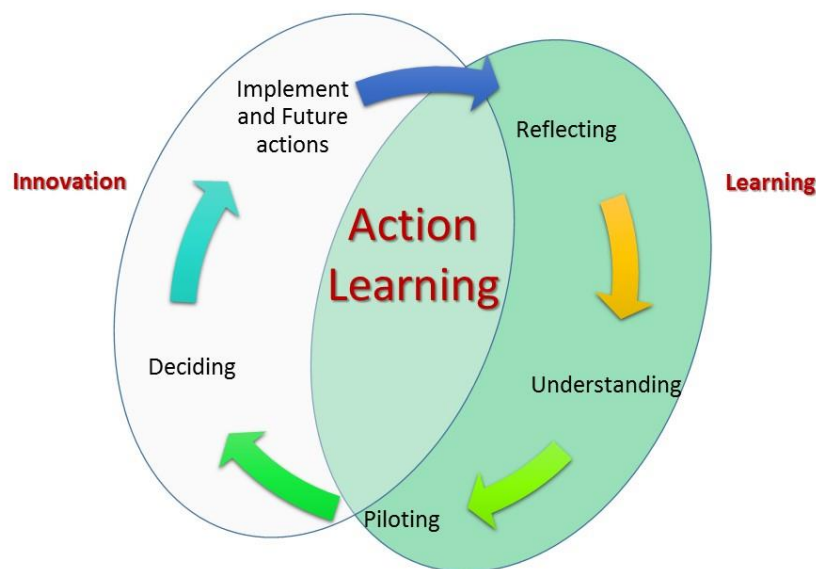


Fig. 6 – Critical reflection, reframing, and refining skills are key processes of Action Learning. Innovation and new understanding to real problems is developed from iterative reflection, piloting and review between teams, and organisations (Revans 1983; Argyris et al. 1985).

NERC(BGS) – Improvement Service workshop

The Fellowship is piloting the first national NERC(BGS)-IS workshop in Scotland in May 2017, to raise awareness of existing relevant NERC(BGS) knowledge within LG and to begin the process of developing more resilient and sustainable relationship and engagement between NERC(BGS) and multiple areas of LG. .The workshop will provide a key forum for NERC(BGS) to engage systematically with all LG’s and with different levels and roles in LG’s – including, critically, LG policy



teams. It is envisaged the workshop will be one of many in the long-term, and future events could also include other key research organisations to LG (e.g. regulators, other NERC centres (e.g. CEH) and research providers (e.g. JHI)).

The IS and workshop events, have to the potential to provide a key future platform for all these roles and actors to discuss how NERC(BGS) (and other research bodies) data might be most appropriately connected to LG through the IS spatial data hub, and how the IS hub could be used to increase the flow of relevant project-scale LG data to NERC(BGS) (and other research bodies) for development of higher quality strategic knowledge. Other NERC(BGS) science areas are now also looking to engage with the Scottish IS to this end.

Embedding NERC data into city development work processes and policy for transformative impact and business intelligence

Embedding NERC data and research within city development policy and planning guidance would instigate a step change in the impact and utilisation of NERC data to a range of city stakeholders (e.g. developers, urban designers, architects, geotechnical consultancies), and as well as to LG business intelligence.

Glasgow City Council is the first LG in UK to formally recognise the subsurface within its City Development Plan (GCC 2011, 2017), and it is working to:

- ❖ identify existing relevant NERC(BGS) data within its existing planning Supplementary Guidance documents;
- ❖ produce a supporting Developers Guidance document which highlight existing NERC(BGS) data and their potential relevance to developers and development proposals.

Supplementary Guidance (SG) planning documents outline the key development priorities of LG's, and stipulate or recommend the key data developers should consider as part of a development design concept. Mapping NERC(BGS) resources/services to these Supplementary Guidance documents, or a Developer Guidance document could significantly increase awareness and utilisation of NERC(BGS) data within the formal planning process. If NERC(BGS) were formally included within these documents, there would be much greater expectation, or requirement, for developers to consult and utilise NERC(BGS) data within development proposals – either in pre-planning application phase, or within applications. Greater utilisation of these data at planning stage, would enable LG to make more informed and effective decisions about what mitigation and investment will be needed to unlock development priorities and land tracts.

Part of the work of the Fellowship with GCC has been to identify how existing relevant NERC(BGS) data could be most appropriately mapped into these SG planning documents, and to future alternate planning mechanisms (Scottish Government 2017). The Action Learning within the fellowship has been instrumental to developing the understanding as to how this could be most appropriately done.

New data procurement and data capture mechanisms to NERC from LG and key stakeholders



New data procurement and data capture mechanisms to NERC from LG and key stakeholders is essential to: increase accessibility and re-use of data to cities, and to NERC; and for NERC(BGS) to be able to deliver higher quality strategic subsurface knowledge for city challenges in the future.

To improve data accessibility and re-use it is essential that there is a change to data procurement in LG's (and within key regional or national stakeholders) so that data are procured in standardised digital data formats, rather than disparately stored PDF documents. Use of standardised digital data formats opens the door to:

- ❖ developing automated data ingestion and validation processes – within both LG and NERC(BGS);
- ❖ development of relational databases within LG's linked to GIS or other spatial data platforms and tools – giving increased internal data re-use, better data analytic capacity, and increased business intelligence;
- ❖ enabling integration of data with National Data Centres, such as the NGDC (NERC BGS), or the Urban Big Data Centre (ESRC)
- ❖ linkages with other digital data ingestion processes and spatial data innovation hubs (e.g. Future Cities open data; Scottish Government Spatial Innovation Hub; national government e-building and e-planning portal systems, which in the future are likely to be requesting 3D above and below ground planning applications and data.
- ❖ and for research organisations like NERC(BGS) to develop higher quality subsurface datasets, products and services from a larger volume of high quality data – Figs. 4 and 5.

These aspirations are directly in line with the broader national vision for increased data accessibility and wider exploitation of spatial data to inform public services and policy, as being driven by Scottish Government Boards of Information Sharing and Spatial Information (Scottish Government 2012; Morgan 2014).

The Fellowship is continuing previous work championed by NERC(BGS) and Glasgow City Council to pilot – and expand to other key national stakeholders – new data procurement requirements in which framework contracts for development work and ground investigations request all subsurface environmental data from ground investigations to be submitted to NERC(BGS) NGDC in a standardised digital data format (AGS format), for long-term access and re-use by all parties (LG's, NERC(BGS), public and private sector stakeholders).

The AGS format is a raw data format, constructed to British Standard, which enables NERC(BGS) to both validate and ingest the data uploaded automatically. Ground investigation data are originally generated by drillers and contractors in this AGS format. In the past the AGS data have been converted and reported in PDF reports on request of LG or consultancies. Altering LG contracts and data procurement so that the AGS file is also requested has, therefore, not been met with any significant resistance from consultancies or contractors, as the AGS files are already generated. Nearly all parties also see the wide benefit of having access to greater body of data to inform future work; and that rather than leading to a reduced volume of ground investigation work, it will enable more effective and targeted work, but likely no less in volume. Part of the success and uptake of the approach within Glasgow, and now other parts of the UK, is also due to the fact that no one party undertakes the majority of ground investigation work in the UK and therefore no one company has a vested interest in sharing a large data holding. Attempts to replicate the approach in Denmark by a city municipality were met with much greater resistance, as one consultancy undertook over half of all ground investigation work in the country (Bonsor 2014). Adoption of the data deposition process, and compliance to the existing AGS standardised digital reporting format also does not cause any



significant extra work or cost to any actor – the AGS standard already existed, and ground investigation data in the UK were already originally generated in this AGS format by drillers and contractors. These AGS data were, however, traditionally converted to PDF information for the purposes of site investigation reports, and in the absence of no other subsequent re-use of the data there were no drivers to use the AGS data. The ASK network pilot simply requested deposition of this original AGS format data to NERC(NGDC-BGS), and enforced compliance to the AGS reporting standard using an on-line validation tool.

The initial pilot by GCC to contractually request ags data from ground investigation work are deposited to the NERC(BGS) National Geoscience Data Centre (NGDC) for long-term access and re-use, received strong interest and uptake by local and national stakeholders in Scotland. Scottish Water and Sweco reported significant downstream benefits in being able to handle large data sets, reduced financial risk from greater certainty in ground conditions, and rapid 3D visualisation of data, for minimal upstream costs in training and communication (Scottish Water, 2014; Sweco 2014). Both Scottish Water and Transport Scotland are now piloting the data procurement approach within the national framework contracts, and on major infrastructure projects – both to realise increased data re-use internally within these projects; but to aid the development of higher quality strategic knowledge of the subsurface – either by themselves, or by NERC(BGS) in the longer term.

Contractual requirements, rather than legislative drivers, have been found to be the key vehicles to ensure compliance of data deposition to NERC(BGS) and use of the standardised digital data reporting format. The same experience has been gained in Netherlands, where despite new national legislative requirements to submit all subsurface ground investigation data to the national Geological Survey (TNO), it was only by changing contractual requirements of key stakeholders that data were deposited to the geological survey in accordance with the legislation.

There is increasing interest in replicating the approach by other LG's and national stakeholders, due to the realised benefits in increased internal data re-use, better data analytic capacity, and increased business intelligence – and the Fellowship is working to facilitate this.

The NGDC has since launched a UK digital data portal, to develop increased automated ingestion to NERC(BGS) of ground investigation data and any associated shallow subsurface environmental data. Data submitted to the portal can be queried and re-accessed from the NERC(BGS) accessions web service, using key word or map-based searches. The ASK network is working to increase awareness, nationally, of the service.

The ASK (Accessing Subsurface Knowledge) Network – a forum for UK KE between NERC, LG's and stakeholders

The ASK (Accessing Subsurface Knowledge) Network is a UK KE Network linking a broad range of stakeholders, who either use and/or generate subsurface data within stages of the city development process, from: local governments, business, consultancies, contractors, NERC(BGS), to universities, national improvement services and National Data Centres (e.g. NERC, ESRC centres). The network also links to other UK initiatives

and innovation hubs within this work area (e.g. Future Cities catapult, ThinkDeep UK, Urban Innovation, UK government city Foresight programme) and RCUK investment (e.g. EPSRC Urban Big





Data centre and research); and internationally (e.g. EU COST Sub-Urban Action; LUCI; Rockefeller RC 100 cities) provides an effective forum for discussion.

The network was originated from work in Glasgow in 2013, to pilot increased data deposition to NERC(NGDC-BGS) using the standardised AGS digital format for shallow (<50 m) subsurface data from the large number of site investigation work occurring in the Glasgow region. Under an innovation agreement members of the ASK network were able to gain enhanced access to the NERC(BGS) 3D geological model of the Glasgow conurbation, to highlight the data products NERC(BGS) could deliver in the future with increased data deposition. Data deposited to NERC(NGDC-BGS) using the ingestion mechanism is also then held for long-term re-use and widespread benefit through open-access web-services.

The pilot and the ASK network saw marked success and there was strong engagement by key national stakeholders (e.g. Transport Scotland, Scottish Water) to make the data deposition process a contractual requirement of their framework contracts for all ground investigation work. GCC has also made it requirement of framework contracts, and other LG's, both in Scotland and England and Wales, are looking to replicate. Key factors to the success of the initiative and data reporting mechanism have been:

- It has been easy for stakeholders (e.g. other LG's) to replicate the contractual clauses and requirements established by the initial pioneers.
- The UK Government construction and BIM strategies are increasing the need for private sector consultancies in design and construction, and land remediation to have increased capacity to handle ground investigation data in 3D models.
- There is widespread appreciation amongst a range of stakeholders (from drilling contractors to geotechnical-engineering consultancies) of the widespread benefits which could be realised from developing a centralised database of accessible, standardised and validated data, held by NERC(NGDC-BGS) for long-term re-access. There is equal appreciation by stakeholders that the development of required future data services by NERC(BGS) takes time, and that it is only possible with increased data availability.
- Stakeholders perceive the benefits from having access to increased data services and higher quality strategic data products in the future outweigh the costs in training/communication to implement changes to contractual requirements of site investigation data.

Growing development of ASK Network

Since the initial launch in 2013, the ASK network has been replicated in other regions (e.g. Wales, 2015), and there have been several ASK events in Scotland. The ASK network is providing a very effective forum for NERC(BGS) to have on-going conversations and iterative knowledge development with a broad range of stakeholders. Key opportunities provided by the network include:

- ❖ Ability to pilot new data exchange mechanisms and development of new NERC(BGS) centralised databases and web-services with a wide range of stakeholders, rapidly and effectively;
- ❖ Opportunities to discuss what data services will be required / desired in the future;
- ❖ Assess potential improvements in data procurement processes and aspirations for future data re-access and data and information services would be aspired to by LG's, stakeholders, and NERC (NGDC-BGS).



- ❖ Increases the flexibility and agility of NERC(BGS) to engage with different stakeholders and communities of stakeholders, with broader uptake, engagement and promotion of the network

At its inception the ASK Network was focused on facilitating knowledge exchange between geoscientists and geotechnical specialists involved in design and construction phases, at the end of the development process. In light of the key knowledge gaps, and limited utilisation of derived strategic knowledge of subsurface conditions within early strategic phases of city development process, the network is now being extended to include a broader range of city stakeholders – LG development planning teams and officers, national and regional planning organisations, urban designers, developers and community organisations. This is enabling discussions of what new knowledge could be relevant to unlocking future city development amongst a broad group of actors and NERC(BGS) and the NGDC to capture stakeholder evidence base. Other NERC data centres (e.g. EDIC-CEH), as well as the ESRC Urban Big Data Centre (UBDC) are also engaged or formal members of the Network.

The DNA of our required knowledge development

LG's and NERC(BGS) both require higher impact and accessibility of NERC(BGS) data. Developing the required awareness and understanding across NERC and LG organisations to realise this, will require iterative and in depth conversations between the organisations across multiple levels and roles – the present knowledge gaps are significant in both organisations.

Developing these new knowledge pathways is integral to delivery of required future city development. Our future conversations and perceptions need to over-arch research programmes and to occur at strategic levels, not just within individual projects – it needs to become part of our knowledge DNA – Fig. 7.

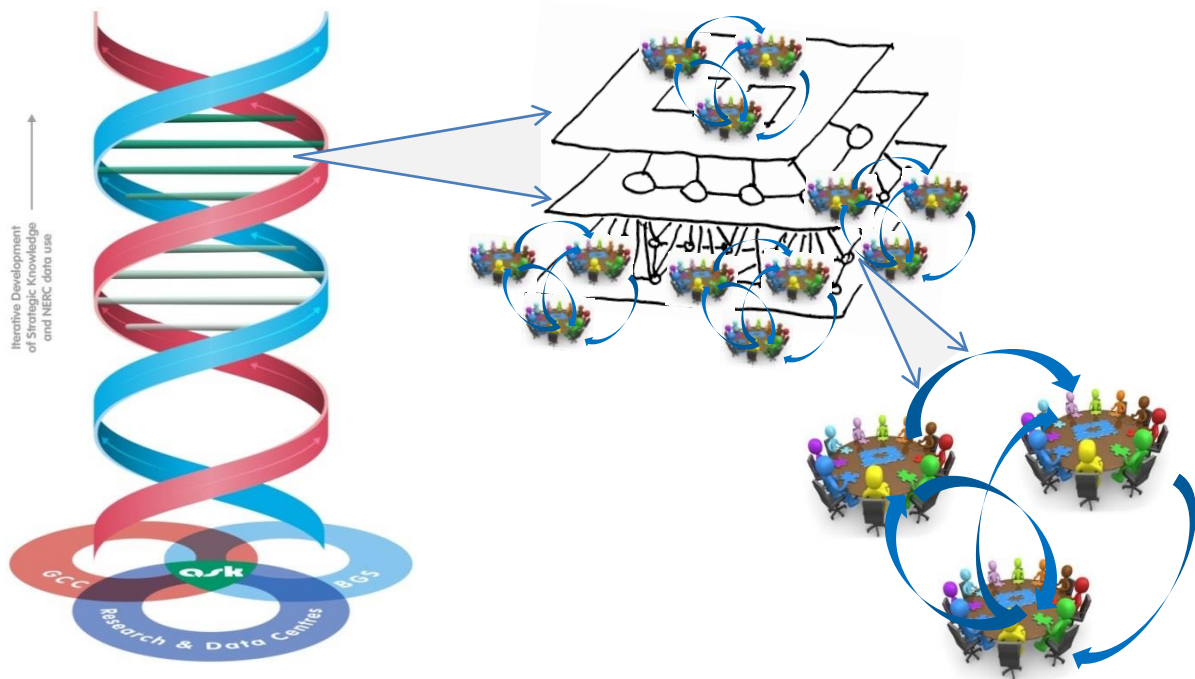


Fig. 7 – The DNA of the required knowledge development between NERC organisations and local governments, extends across multiple levels and roles.





References

Aecom (2015) Designing City Resilience 2015: City X The emerging city, An AECOM publication in association with Designing City Resilience and RIBA, pp122.

Argyis C, Putman R, D Smith. 1985. *Action Science*. Jossey-Bass Social and behavioural science series, 480pp, ISBN 0875896650, 9780875896656.

ASPE. 2016. Association for Public Service Excellence (APSE) Services Directory: a guide to APSE's activities and services, ASPE report, pp20.

Bonsor HC. 2014. Delivery and Impact of subsurface data in the absence of a comprehensive legislative framework – shared issues and difficulties in Denmark and Scotland, European Cooperation in Science and Technology (COST) Report, of Action TU1206, pp25.

Bonsor HC. 2015. Establishment of a national register and database for subsurface data in the Netherlands – lessons learnt. European Cooperation in Science and Technology (COST) Report, of Action TU1206, pp23.

Campbell SDG, Merrit JE, O Dochartaigh BE, Mansour M, Hughes AG, Fordyce FM, Entwistle DC, Monoaghan AA, Loughlin SC. 2010. 3D geological models and their hydrogeological applications: supporting urban development: a case study in Glasgow-Clyde, UK. *Zeitschrift der Deutschen Gesellschaft für Geowissenschaften*, 161 (2), 251-262.

Campbell SDG. 2016. The subsurface in planning and decision making – shared issues in Hong Kong and Glasgow, European Cooperation in Science and Technology (COST) Report, of Action TU1206, pp36.

Compernelle T. 2016. Identifying ways to realize cost savings for subsurface projects by improving the use of geological and subsurface information. European Cooperation in Science and Technology (COST) report, TU1206-32038, pp18.

Department for Communities and Local Government. 2006. Planning Policy Statement 9: Biodiversity and geological conservation. Final Regulatory Impact Assessment. Communities and Local Government Publications. 10pp.

Glasgow City Council. 2017. City Development Plan, GCC Development Planning, ppX.

Glasgow City Council. 2011. The Local Development Plan for Glasgow - Main Issues Report, Glasgow city Council, pp129.

Homes and Communities Agency. 2015. Guidance on dereliction, demolition and remediation costs. Department for Homes & Communities, UK Government Guidance document, March 2015, pp56.

Kearsey T, Williams J, Finlayson A, Williamson P, Dobbs M, Marchant B. 2015. Testing the application of stochastic simulations to predict the lithology of glacial and fluvial deposits in Central Glasgow, UK. *Engineering Geology*, 187; 98-112.



Kessler H, Mathers SJ, Sobisch H-G. 2009. The capture and dissemination of integrated 3D geospatial knowledge at the British Geological Survey using GSI3D software and methodology, *Computers & Geosciences*, 35; 1311-1321.

Improvement Service. 2015. Improvement Service strategic framework, Improvement Service report, September 2015, pp16.

Merrit JE, Monaghan AA, Entwisle DC, Hughes AG, Campbell SDG, Browne MAE. 2007. 3D attributed models for addressing environmental and engineering problems in areas of urban regeneration, *First Break*, 25; 79-84.

Morgan, J. 2014. Scotlands digital future: a data vision for Scotland, Presentation at ASK Network Event, 2014.

Municipality of Oslo. 2017. Final report – Oslo sub-surface project 2013-2016, Agency for planning and building services, Municipality of Oslo, pp75.

Revans R. 1983. *ABC of Action Learning*, Routledge, 160pp, ISBN-10: 140942703X

Scottish Government. 2012. Scotland's Digital Future: Delivery of Public Services strategy, Scottish Government pp31.

Scottish Government. 2016. Draft Planning Delivery Advice: Housing and Infrastructure, Planning and Architect Division, Consultation, Scottish Government, pp32.

Scottish Government. 2017. Places, People and Planning: A consultation on the future of the Scottish planning system, Planning and Architecture Division, Scottish Government, pp51. ISBN: 978-1-78652-736-3.

Scottish Water. 2014. Use of ASK Network 3D models in inform infrastructure construction and delivery, Presentation at ASK Network Event, 2014.

Seoul Metropolitan Government. 2016. Urban Planning of Seoul – the 100 Year Masterplan, Seoul Metropolitan Government, Urban Planning Bureau, Planning document, pp40.

Sweco. 2014. Case study: application of ASK and GSPEC to Sighthill, Presentation at ASK Network Event, 2014.

UK Government. 2015. Industrial Strategy: government and industry in partnership: Business Information Modelling (BIM), pp22.

Van der Muelen M, Campbell SDG, Lawrence DJ, Gonzalez RCL, van Campenhout IPAM. 2016. Out of Sight – Out of Mind? Considering the subsurface in urban planning – state of the art. European Cooperation in Science and Technology (COST) Report, of Action TU1206, pp69.