CUSP2014: The Geoscience Context for Europe’s Urban Sustainability - Lessons from Glasgow and beyond

29–30 May 2014 at:
Glasgow Science Centre

Early-stage Researchers’ Workshop 29 May
Full-day Conference 30 May

Glasgow, Scotland’s largest city, is built along the upper Clyde estuary and lower River Clyde. In the heart of the city are the Clyde Gateway and Clyde Waterfront areas—a national urban regeneration priority for Scotland. This regeneration is intended to stimulate economic growth, drive smaller community projects, and tackle concentrated deprivation resulting from industrial decline. To underpin this regeneration, the British Geological Survey has been developing integrated and attributed dynamic shallow-earth 3D models and other geoscience datasets and knowledge, in partnership with Glasgow City Council and other organisations.

This transdisciplinary project—the Clyde-Urban Super-Project (CUSP)—aims to make geoscience information more accessible, relevant and understandable to the wide range of users involved in the sustainable regeneration and development of Glasgow. These events will showcase CUSP, its knowledge exchange (ASK and GSPEC), and its relevance to sustainable use of the urban subsurface, which is being promoted by the related European COST Action-Sub-Urban, whose partners from across Europe with illustrate their work.

Joint events organised by the Royal Society of Edinburgh (RSE), British Geological Survey (BGS), the European Cooperation on Science and Technology (COST) (Sub-Urban) and Glasgow City Council.

Free events - registration required in advance
Register online at: http://www.rse.org.uk/events/    T: 0131 240 2780

The Royal Society of Edinburgh, Scotland’s National Academy, is Scottish Charity No SC000470
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| 13.30 | Welcome and Introduction by Chair                                                                 | Dr Diarmad Campbell  
**Chief Geologist, Scotland, BGS**                                                                 |
| 13.35 | Glasgow Through the Ice Age                                                                      | Andrew Finlayson  
**Quaternary Geologist, BGS**                                                                       |
| 13.55 | Strengths and Weaknesses of Deterministic 3D modelling of Superficial Deposits – Lessons from Glasgow | Dr Katie Whitbread  
**Sedimentary Geologist/Geomorphologist, BGS**                                                        |
| 14.15 | Using Stochastic Modelling to Understand Variation in Lithology of Glacial and Fluvial deposits in Central Glasgow, UK | Dr Tim Kearsey  
**Survey Geologist, BGS**                                                                     |
| 14.35 | Management and Access to Subsurface data in Urban Areas: Lessons learnt from Glasgow and Europe   | Helen Bonsor  
**Hydrogeologist, BGS**                                                                     |
| 14.55 | Glasgow Energy from Mine Workings Project: Progress to Date                                      | Emma Church  
**PhD Research Student, Glasgow Caledonian University**                                                     |
| 15.15 | Heat from Minewaters: Energy in the Right Place                                                  | Dr Hugh Barron  
**Responsive Surveys Scotland Manager, BGS**                                                                |
| 15.35 | Tea/Coffee and Opportunity to view Posters                                                       |                                                                                                                                 |
| 15.55 | The Restoration of Saltmarshes and Their Value as a Coastal Flood Defence                        | Kate Wade  
**Sediment Ecology Research Group, St Andrews University**                                                   |
| 16.15 | Human Impact on Sediment Quality in the Clyde Post-Industrial Catchment                           | Dr Solveigh Lass-Evans  
**Daphne Jackson Fellow, British Geological Survey**                                                             |
| 16.35 | The Influence of Sediment Characteristics on the Transport of Pathogens from Freshwater to Coast  | Adam Wyness  
**PhD Researcher & Post Graduate Representative, The James Hutton Institute**                        |
| 16.55 | Closing Remarks                                                                                  | Professor Paul Bishop FRSE  
**Professor of Geography, University of Glasgow**                                                                 |
| 17.00 | Close                                                                                             |                                                                                                                                 |
Evening Reception
hosted by Glasgow City Council

Venue: Glasgow Science Centre
Timings: Thursday, 29 May 2014
        17.30–18.30

Bailie Philip Braat will open the civic reception on behalf of Glasgow City Council.

Please email events@royalsoced.org.uk in advance if you wish to attend.
Conference Programme

Friday, 30 May 2014

08.30  Registration

The Urban Agenda and its Wider Context

08.55  Introduction and Overview
Dr Diarmad Campbell
Chief Geologist, Scotland, BGS
(Dr Martin Smith, Simon Price, BGS)

09.05  Welcome and Conference Opening
Sir Kenneth Calman KCB FRSE FMedSci
Chancellor, The University of Glasgow

Session 1: Subsurface Knowledge Exchange in Europe and Beyond

09.15  Introduction by Chair
Dr Michiel van der Meulen
Chief Geologist, Research Manager Geomodelling, TNO/Geological Survey of the Netherlands

09.20  Urban Planners and the Subsurface: Out of Sight, Out of Mind
Ignace Van Campenhout
Municipality of Rotterdam

09.40  ASK Knowledge Exchange Network for Glasgow and Beyond
Helen Bonsor
Hydrogeologist, BGS
(Hugh Barron¹, Jonathan Lowndes¹, Garry Baker¹, David Hay², Simon Watson³, Donald Linn², Iain Hall⁴, Ken Lawrie¹
¹BGS; ²Glasgow City Council; ³Hunterian Museum; ⁴Grontmij)

09.55  BRO: A Revolution in Dutch Subsurface Data and Information Management
Dr Michiel van der Meulen
Chief Geologist, Research Manager Geomodelling, TNO/Geological Survey of the Netherlands

10.10  COST Action TU1206 Sub-Urban: A European Network to Improve Understanding and Use of the Ground Beneath our Cities
Hans deBeer
Vice-chair, COST TU1206; Team Leader, Groundwater and Urban Geology, Geological Survey of Norway
(Dr Diarmad Campbell, BGS)

10.30  Tea/Coffee and Opportunity to view Posters

Session 2: Urban Subsurface 3D Property Modelling

11.00  Introduction by Chair
Dr Diarmad Campbell, BGS

11.10  National to Urban Scales of Subsurface Modelling in the Netherlands
Dr Jeroen Schokker
Geologist/Geomodeller, TNO/Geological Survey of the Netherlands
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| 11.30 | **How to Present a Can of Worms: Capturing the Complexity of Glasgow’s Superficial Deposits**<br>Dr Katie Whitbread<br>*Sedimentary Geologist/Geomorphologist, BGS*
|       | (Sarah Arkley, Dr Andrew Finlayson, BGS)                                                                                                             |
| 11.45 | **Big Faults, Little Faults: Multi-scalar Bedrock Modelling in the Clyde Catchment**
|       | Dr Alison Monaghan<br>*Geologist, BGS*
|       | (Mike McCormac, Dr Dave Millward, Dr Tim Kearsey, Bill McLean, Tony Irving, BGS)                                                                 |
| 12.00 | **Stochastic Modelling of Glasgow’s Superficial Geology**
|       | Andrew Kingdon<br>*Petrophysicist and Team Leader Parameterisation and Statistics, BGS*
|       | (John Williams, Paul Williamson, Dr Murray Lark, Dr Tim Kearsey, Andrew Finlayson, Marcus Dobbs, BGS)                                               |
| 12.15 | **Geotechnical GIS of Glasgow**
|       | David Entwisle<br>*Senior Engineering Geologist, BGS*
|       | (Suzanne Self, BGS)                                                                                                                                    |
| 12.30 | Lunch                                                                                                                                                 |
|       | **Session 3: Urban Geochemistry and its Wider Context (soil, sediment and surface water quality)**                                                  |
| 13.30 | **Introduction by Chair**
|       | Fiona Fordyce<br>*Senior Environmental Geochemist, BGS*                                                                                              |
| 13.35 | **Geochemical Baseline Surveys of Glasgow and the Clyde Basin: Overview and Soils**
|       | Fiona Fordyce, BGS<br>(Paul Everett¹, Dr Jenny Bearcock², Bob Lister²
|       | BGS Edinburgh¹, BGS Keyworth²)                                                                                                                       |
| 13.50 | **Mapping the Water Chemistry of the Clyde Basin Drainage Network: Regional Context and the Urban Imprint**
|       | Dr Jenny Bearcock<br>*Hydrogeochemist, BGS*
|       | (Pauline Smedley¹, Paul Everett², Louise Ander¹, Fiona Fordyce²
|       | BGS Edinburgh¹, BGS Keyworth²)                                                                                                                       |
| 14.05 | **Soil Quality and Health/Deprivation Indicators in Glasgow**
|       | Professor Marian Scott OBE FRSE<br>*Professor of Environmental Statistics, School of Mathematics and Statistics, University of Glasgow*
|       | (Stephen Morrison¹ Fiona Fordyce²
|       | National Australia Bank¹, BGS²)                                                                                                                       |
Programme

14.20 Chemical Speciation and Bioaccessibility of Chromium in Contaminated Glasgow Soils  
Professor John Farmer  
*Professor Emeritus and Senior Honorary Professorial Fellow, University of Edinburgh*  
(Andrew Broadway¹, Fiona Fordyce²)  
Environmental Resources Management (ERM)¹, BGS²

14.35 Anthropogenic and Natural Geochemical Factors on Urban Soil Quality  
Professor Andrew Hursthouse FRSC  
*Professor of Environmental Geochemistry, University of the West of Scotland*

14.50 Q&A

15.00 Tea/coffee and Opportunity to view Posters

Session 4: Urban Groundwater, Estuary and Marine

15.30 Introduction by Chair  
Brighid Ó Dochartaigh  
*Senior Hydrogeologist, BGS*

15.35 Groundwater Modelling and Monitoring in Hamburg  
Paul Meyer  
*Hydrogeologist, Groundwater Modeller, CONSULAQUA Hamburg*  
and Lothar Moosmann  
*Hydrogeologist, Ministry of Urban Development and Environment of Hamburg (BSU) – Geological Survey*

15.55 Urban Groundwater: A Pilot Monitoring Network for Glasgow  
Stephanie Bricker  
*Hydrogeologist, BGS*  
(Brighid Ó Dochartaigh, Helen Bonsor, BGS)

16.10 Groundwater Modelling to Improve Conceptual Understanding of Flow under Glasgow  
Dr Majdi Mansour  
*Senior Groundwater Modeller, BGS*  
(Brighid Ó Dochartaigh, Dr Rachel Dearden, Ryan Turner, Dr Andrew Hughes, BGS)

16.25 Urban Dependence on Coastal Seas – Glasgow and the Firth of Clyde  
Professor Michael Heath  
*Professor of Fisheries Science, University of Strathclyde*

16.40 Estuary and Marine Contamination in the Clyde Catchment  
Dr David Jones  
*Project leader/Geochemist, BGS*

17.00 CUSP: The Global Dimension  
Dr Martin Smith  
*Science Director, BGS Global*  
(Dr Diarmad Campbell, BGS)

17.15 Closing Remarks  
Professor John Coggins OBE FRSE  
*Former Vice-Principal for Life Sciences and Medicine, University of Glasgow*
Introduction and Overview
Dr Diarmad Campbell
Chief Geologist, Scotland, BGS
The Clyde-Urban Super-Project (CUSP) has been a cornerstone of the British Geological Survey’s strategy since 2009, fostering multidisciplinary integration between teams of geoscientists within BGS, and cultivating collaboration with external partners from a wide range of backgrounds. The project has adopted a whole systems approach, focussed on improving and sharing knowledge to support decision-making in relation to the shallow sub-surface of the Glasgow conurbation. Glasgow City Council has been a key strategic partner throughout, helping to implement new approaches to data acquisition (GSPEC), and to establish, with BGS and others, a pioneering sub-surface knowledge exchange network (ASK) to bring together BGS, the public and private sectors, and the research community, CUSP has also addressed wider geoscience issues of the catchment and estuary of the Clyde, and most notably its groundwater, and the geochemistry of its soils and waters. Particular emphasis has been placed on multi-scalar and multi-attributed, 3D modelling (both deterministic and stochastic) to characterise the complex superficial deposits, and faulted bedrock which underlie Glasgow. These models are exemplars, and the most ambitious of their type yet completed in the UK. They also provide the basis, in combination with the various other CUSP datasets, for a geoscience strategy for the urban subsurface in general. As a consequence, CUSP is also a key element of an ongoing Action ‘Sub-Urban’ (TU1206) under the European Cooperation on Science and Technology programme (COST). This Action, promotes sustainable use of the urban subsurface and involves representatives from major cities, geological survey organisations, and researchers from across Europe, and further afield. The ultimate aim of the Action is to encourage greater recognition by planners, developers, and policy makers of the importance of the urban sub-surface, to improve decision-making in relation to it, and to accrue economic, social and environmental benefits as a result.

Urban Planners and the Subsurface: Out of Sight, Out of Mind
Ignace Van Campenhout
Municipality of Rotterdam
The subsurface appears to be unknown territory to urban developers, which is why it is often overlooked during the initial phases of urban development. This can lead to financial complications and delays and prevents optimal exploitation of sustainable space and energy opportunities. It is our responsibility to seduce urban developers to incorporate the subsurface in their plans. In Rotterdam, we prepare subsurface information tailored to their needs and handover this information in a process where subsurface specialists and urban planners get an understanding of each others fields of expertise. This way we make sure that the subsurface “lands” with urban planners.

ASK Knowledge Exchange Network for Glasgow and Beyond
Helen Bonsor
Hydrogeologist, BGS
Insufficient understanding of subsurface ground conditions places significant constraints on the effective and sustainable development of urban areas. Recent collaboration between the British Geological Survey (BGS), Glasgow City Council (GCC) and the private sector (Grontmij Ltd) has demonstrated the potential for creating the conditions necessary for a major step-change in how subsurface data in urban areas are reported and re-used by public and private sectors, to improve data availability for the wider good. Requisite conditions to this change in Glasgow have been: 1) the development of a data and knowledge exchange network between public and private sectors in Glasgow – ASK (Accessing Subsurface Knowledge); 2) implementation of a standardised digital data reporting format, to improve the integrity and accessibility of data and 3) development of a centralised data repository. Combined, these will enable the development and exchange of high-quality systematic subsurface datasets, between public and private sectors in the urban area, which can be used and updated to support decision making. GCC have taken the lead in this change, making it a contractual requirement for subsurface data to be submitted to the Council in a standardised digital format. These data are transferred and validated via a web portal to the BGS for long-term storage and re-use by all interested parties. There has been strong support of the work by government, national agencies and the public and private sectors and the ASK initiative could act as a standard for change for managing and reporting subsurface data across public and private sector users, both within the UK and, potentially, further afield.
BRO: A Revolution in Dutch Subsurface Data and Information Management
Dr Michiel van der Meulen
Chief Geologist, Research Manager Geomodelling, TNO/Geological Survey of the Netherlands
Pursuant to a new law that will become effective in 2015, the national Dutch subsurface database operated by the Geological Survey of the Netherlands will become an official government register (a ‘key register’ for the subsurface; further referred to by its Dutch acronym BRO). Dutch government bodies will be obliged to submit all subsurface data that are gathered under their responsibility to the BRO, and consult it when making policies or decisions that pertain to, or can be affected by the subsurface. The BRO firmly establishes the survey database as a national asset, and presents a major step ahead in understanding and managing the Dutch subsurface, the resources it holds and the challenges it presents. The presentation will discuss the rationale behind the BRO, its design principles, the implementation process, the implications and the opportunities it presents.

COST Action TU1206 Sub-Urban: A European Network to Improve Understanding and Use of the Ground Beneath our Cities
Hans deBeer
Vice-chair COST TU1206; Team Leader, Groundwater and Urban Geology, Geological Survey of Norway
Urbanisation and its sustainability are the focus of the European Cooperation in Science and Technology (COST) Action TU1206, Sub-Urban - A European network to improve understanding and use of the ground beneath our cities. This aims to transform relationships between experts who develop urban subsurface geoscience knowledge - principally national Geological Survey Organisations (GSOs) and those who can most benefit from it - urban decision makers, practitioners and the wider research community. Under COST’s Transport and Urban Development Domain, Sub-Urban has established a network of GSOs and other researchers in over 24 countries, to draw together and evaluate collective urban geoscience research in 3D/4D characterisation, prediction and visualisation.

National to Urban Scales of Subsurface Modelling in the Netherlands
Dr Jeroen Schokker
Geologist/Geomodeller, TNO/Geological Survey of the Netherlands
The Geological Survey of the Netherlands (GSN) produces a diverse suite of nation-wide subsurface models. GeoTOP, our latest generation of 3D models, schematises the subsurface up to a depth of 50 m in millions of voxels of 100x100x0.5m, thus providing estimates of geological unit and lithological class, including uncertainties. To improve the applicability of GeoTOP in urbanised regions, we focus particularly on: (1) improved model resolution by increasing the amount and diversity of input data; (2) improved characterisation of man-made deposits; (3) integrated 3D visualisation of geology, subsurface infrastructure and above-ground information.

How to Present a Can of Worms: Capturing the Complexity of Glasgow’s Superficial Deposits
Dr Katie Whitbread
Sedimentary Geologist/Geomorphologist, BGS
The interaction of glaciers, rivers and the sea in Glasgow’s ‘recent’ geological past has left a legacy of complex superficial deposits underlying the city. The variability of these deposits provides a challenge to any who venture to engage with the subsurface, whether it be to build on it, tunnel through it, tap it, or interpret the history of environmental change recorded in the sediments. CUSP 3D models of Glasgow’s superficial deposits, developed using a deterministic (or interpretive) methodology to utilise all available geological data, are allowing us to examine the complex nature of the underground at city to site scales. These models reveal regional patterns in the sequences of superficial deposits, and therefore ground conditions, that characterise different geo-environmental domains. At local scales, the models are helping us to unpick the spatial relationships between different geological units to enable better predictions of ground conditions in areas of potential development or significance for groundwater assessments.
Big Faults, Little Faults: Multi-scalar Bedrock Modelling in the Clyde Catchment
Dr Alison Monaghan
Geologist, BGS
CUSP bedrock models will be used to examine the challenge of faulted model consistency at multi-scales in the context of a Geological Survey model product. A positive side-effect of mining and industrialisation of Clyde Catchment coalfield areas is the subsurface borehole and mine plan dataset, used by BGS to produce 11 GOCAD faulted stratigraphic surface models. These encompass local-scale models for hazard assessment, infrastructure planning etc, to regional-scale models for energy resource potential and tectonic evolution. In addition, five interpretative GSI3D models define the data-poor volcanic and older Carboniferous bedrock. Fault geometries are complex, with throws from one to hundreds of metres.

Stochastic Modelling of Glasgow’s Superficial Geology
Andrew Kingdon
Petrophysicist and Team Leader Parameterisation and Statistics, BGS
Models of the geological structure beneath Glasgow have been created within a fixed lithostratigraphy. However, because units can be highly heterogeneous, this is not the most effective way of describing the variability of subsurface properties. To investigate this, the lithology of the superficial deposits in Glasgow has been stochastically modelled on a 3-D grid, with physical properties extrapolated throughout this grid. Properties include density (measured from geotechnical boreholes) and hydraulic conductivity (derived from particle size distribution). Each provides different statistical challenges, but offers new insights into the variability of ground conditions, thus aiding redevelopment.

Geotechnical GIS of Glasgow
David Entwisle CGeol FGS
Senior Engineering Geologist, BGS
The 3D geological model of Glasgow City and environs is an important tool for many organisations and professions who deal with the ground. The variation of lithology, geotechnical and hydrogeological characteristics are described as part of a classification of the modelled geological units. The Geotechnical GIS provides a simple method of accessing geological and geotechnical cross-sections, and summary graphs show the variation for a range of geotechnical parameters, as well as the modelled geology and other relevant information such as undermining. Geotechnical data, from the associated database, are shown using software specifically designed for the GIS.

Geochemical Baseline Surveys of Glasgow and the Clyde Basin:
Overview and Soils
Fiona Fordyce
Senior Environmental Geochemist, BGS
The distribution of potentially harmful substances in the environment is of growing concern under current environmental protection legislation. Recently, the British Geological Survey (BGS) has carried out extensive surveys of rural and urban soil and stream quality in the Clyde Basin to aid land and water management/protection. The results reveal that metal concentrations in urban soils are typically up to 2.5 times (median values) that of rural soils as a result of pollution. These newly-available datasets demonstrate the impacts of urbanisation and the post-industrial legacy of the Glasgow conurbation, as well as of historical mining activities, on environmental quality.

Mapping the Water Chemistry of the Clyde Basin Drainage Network: Regional Context and the Urban Imprint
Dr Jenny Bearcock
Hydrogeochemist, BGS
Mapping the chemistry of stream and river water across the Clyde Basin serves both to characterise the water quality and assess the dominant controls. Surveys of the Clyde drainage network, undertaken between 2003 and 2010, have generated data encompassing rural and urban streams, rivers, and estuarine water. Mapping displays the large spatial variability in chemical composition across the Basin and the varying influences of controls such as rainfall, land cover and geology. They also display the chemistry of the urban area within the context of the wider drainage network. This presentation highlights the upcoming production of an online atlas and database of surface-water chemistry which characterises the Clyde drainage network and provides a new resource for stakeholder organisations.
Soil Quality and Health/Deprivation Indicators in Glasgow
Professor Marian Scott OBE FRSE

Professor of Environmental Statistics, School of Mathematics and Statistics, University of Glasgow

The environment plays an important role in moderating health and wellbeing, but the relationships between environmental factors and health and wellbeing are complex, with many interactions. Exposure to environmental risk factors is not equally distributed, and links between poor health and environmental inequalities (e.g. inferior housing, crime and industrial emissions) form part of the Environmental Justice Agenda. In this paper, we report on an investigation of the spatial associations between soil metal content, air pollution (NO2/PM10), deprivation and health (respiratory cases and lung cancer incidence) across Glasgow.

Chemical Speciation and Bioaccessibility of Chromium in Contaminated Glasgow Soils
Professor John Farmer

Professor Emeritus and Senior Honorary Professorial Fellow, University of Edinburgh

There is an historical legacy of potentially harmful trace element (e.g. Cr, Pb) contamination in Glasgow soils. The Unified Bioaccessibility Method, which mimics the chemical environment of the human gastrointestinal system, was applied to 27 BGS G-BASE soils, including several with Cr(VI) in secondary minerals arising from disposal of chromite ore processing residue (COPR). Oral bioaccessible Cr was higher in the COPR-affected soils, but Cr(VI) was reduced to Cr(III) during ingestion. Bioaccessible Pb, on average about 50% of soil total Pb, was more closely related to soil total Pb than to original source, as revealed by isotopic measurements (e.g. 206Pb/207Pb).

Anthropogenic and Natural Geochemical Factors on Urban Soil Quality
Professor Andrew Hursthouse FRSC

Professor of Environmental Geochemistry, University of the West of Scotland

The inventory of polluting substances in urban soils derives from diverse sources including direct disposal, diffuse deposition and in the case of elemental components, the natural geochemical signature. The inventory can reflect the net accumulation through the life of the city–many soils, in public open spaces, have maintained their land use for centuries, others represent imported materials often supplemented by chemical inputs through short-term land management activities. Potentially polluting activities, traditionally encountered in risk-based assessments, may be absent, but significant quantities of substances of concern may be identified. This presentation will provide an overview of studies addressing the contributions of “city life” to soil quality and implications for future function. Examples will come from many locations, none the least from this “dear green place”.

Groundwater Modelling and Monitoring in Hamburg
Paul Meyer

Hydrogeologist, Groundwater Modeller, CONSULAQUA Hamburg
Lothar Moosmann

Hydrogeologist, Ministry of Urban Development and Environment of Hamburg (BSU) – Geological Survey

Article 1 of the Water Framework Directive (WFD) lists as one of its purposes a contribution to “the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use “, as well as “a significant reduction in pollution of groundwater …”. To ensure the protection of groundwater resources, a unified groundwater model for the metropolitan region of Hamburg has been created. A great number of geological and hydrological data have been the basis of the model. It can be applied for a variety of issues concerning the water supply of the City including, for instance, concepts for groundwater abstractions or optimisation of groundwater monitoring programmes. The model will be mainly used by the Ministry of Urban Development and Environment, especially the Geological Survey and the Department of Water Management and the state-owned public water supply company Hamburg Water. The already-established workflow will be further developed.
Urban Groundwater: A Pilot Monitoring Network for Glasgow
Stephanie Bricker
*Hydrogeologist, BGS*

Better understanding of urban groundwater systems in the UK is needed to enhance sustainable urban regeneration and development, particularly related to increased use of sustainable drainage systems (SuDS); groundwater vulnerability; and understanding the role of groundwater in flooding. In the absence of systematic groundwater monitoring data for many urban aquifers, infrastructure and data from third-party site investigations have been used to design a pilot monitoring network for Glasgow. The pilot study demonstrates the value of existing ground investigation data and infrastructure in improving understanding of urban groundwater systems, and highlights the importance of standardised data collection and management. In partnership with Glasgow City Council and SEPA, results from the pilot network have been used to develop a longer-term strategy for groundwater monitoring within the city.

Groundwater Modelling to Improve Conceptual Understanding of Flow under Glasgow
Dr Majdi Mansour
*Senior Groundwater Modeller, BGS*

The recent construction of a highly detailed three-dimensional geological framework model has provided improved representation of the complex Quaternary deposits beneath Glasgow. This has allowed a detailed conceptualisation of the groundwater flow regime for these superficial deposits. The conceptual model assumes that these deposits do not form a continuous aquifer and there is uncertainty whether the underlying bedrock transmits groundwater to surface discharging points. A simple numerical groundwater flow model has been used to test these hypotheses. To improve the robustness of the model, there is a need to collect more groundwater-level data, particularly outside central Glasgow.

Urban Dependence on Coastal Seas – Glasgow and the Firth of Clyde
Professor Michael Heath
*Professor of Fisheries Science, University of Strathclyde*

Coastal and estuarine cities have always had strong connection to the sea. However, these connections change over time as the needs and demands of urban communities evolve. The Firth of Clyde is a large semi-enclosed marine water body which for many centuries has supported the City of Glasgow by providing food, trading and transportation, a sink for urban waste, and recreational space. However, these goods and services have been provided at a cost to the biodiversity of the marine ecosystem and, consequently, the supply of fresh seafood to the city. This presentation will review the ecological changes that have occurred in the Firth of Clyde as a result of intensive harvesting, and the implications for future exploitation of the living resources in the Firth Estuary and marine contamination in the Clyde Catchment.

Estuary and Marine Contamination in the Clyde Catchment
Dr David Jones
*Project leader/Geochemist, BGS*

Estuaries are important habitats for fish, shellfish, birds and mammals, but they are also sinks for sediment and contaminants from urban, industrial and recreational activities upstream, along shore and in the adjacent coastal zone. There have been relatively few detailed studies of sediment contamination in UK estuaries, but one such study was carried out in the Clyde estuary in conjunction with Glasgow City Council and SEPA. This shows the areal extent of different potential contaminants in the sediments and their distribution with depth. From the latter, a contamination history can be deduced, especially using organic contaminants, lead isotopes and radionuclides.

CUSP: The Global Dimension
Dr Martin Smith
*Science Director, BGS Global*

Cities, described as the largest object of human creation are essentially ‘systems of systems’ involving ‘networks of people, flow of materials and decisions’. Research into these systems requires multi-factor and multi-scale modelling and analysis and, as the demands for space and resources increase, then a sound understanding the subsurface of our cities is a key component, arguably as important as economic data. Glasgow and the CUSP project is leading the way in raising awareness in the importance of the subsurface and in developing and testing approaches. In this talk we attempt to draw the varied strands of CUSP together and to look at the potential for Glasgow to be an influencer to other global cities and for the application of the CUSP project to future urban research.
Speaker biographies

Dr Jenny Bearcock
Hydrogeochemist, BGS

Jenny studied Environmental Earth Science at Aberystwyth University, before completing her PhD in 2008 on acidic and circum-neutral mine drainage in Wales and Ireland. Since then she has worked at the British Geological Survey as a hydrochemist, mainly undertaking research in the context of understanding the processes and controls affecting baseline groundwater chemistry and regional stream water chemistry. For five years she has also been responsible for leading field teams undertaking geochemical sampling, including two summer seasons within the Clyde Basin for the CUSP project.

Helen Bonsor
Hydrogeologist, BGS

Helen studied geology at the University of St Andrews, before going on to study hydrogeology at the University of Birmingham (2008). She has since worked at the British Geological Survey as a hydrogeologist. Her interests are focused on groundwater resource characterisation, including large-scale data reviews and groundwater resource characterisation within Africa and SE Asia, national groundwater quality sampling and urban groundwater monitoring in the UK. Helen is currently leading a review of urban groundwater monitoring practices within Europe as part of the Sub-Urban Action (TU1206) within the EU COST.

Stephanie Bricker
Hydrogeologist, BGS

Stephanie Bricker is a chartered hydrogeologist with ten years’ experience in physical hydrogeology and groundwater resource management. After studying hydrogeology at University College London (2008), Stephanie began her career at the Environment Agency, working as a hydrogeologist within Thames Region. In 2008 she joined the British Geological Survey, where she has specialised in the characterisation of Quaternary aquifers, urban groundwater environments and the development of quantitative conceptual models, in the context of environmental change. Stephanie has recently managed the BGS FutureThames cross-cutting project on integrated geoscience research in London and the Thames Basin.

Sir Kenneth Calman KCB FRSE FMedSci
Chancellor, The University of Glasgow

Sir Kenneth Calman is Chancellor of the University of Glasgow. He graduated in medicine in Glasgow and became Professor of Oncology in 1974. He remained in that post for ten years. In 1984, he became Dean of Postgraduate Medicine and Professor of Postgraduate Medical Education at the University of Glasgow and Consultant Physician with an interest in palliative care at Victoria Infirmary, Glasgow. In 1989, he was appointed Chief Medical Officer at the Scottish Home and Health Department, and in September 1991 he became Chief Medical Officer in the Department of Health in London. He was a member of the Executive Board of the World Health Organisation, and its Chairman (1998-99). He was Vice-Chancellor and Warden of the University of Durham from 1998 until 2007. He was a Member of the Statistics Commission from 1999 until 2007. He is President of the Institute of Medical Ethics and Deputy Chair of the Board of the British Library. He chaired the Commission on Scottish Devolution (2008-09), and was President of the British Medical Association (2008). He was awarded a KCB in 1996. He became Chairman of the National Trust for Scotland in September 2010. His most recent books are A study of storytelling, humour and learning in medicine and Medical Education: Past present and future. He is currently researching for an M.Litt on Scottish Literature and Medicine.
Hans de Beer (43) has a MSc in hydrogeology from the VU University Amsterdam (1994) and 20 years’ experience in urban water management, groundwater monitoring and modelling. After ten years as project manager and hydrogeology consultant in the Netherlands, Hans started early 2005 at the Geological Survey of Norway (NGU), where he has been working as senior researcher in hydrogeology. Since 2012, Hans has held the position of team leader for the Groundwater and Urban Geology group at NGU and pursues a PhD on hydrogeological characterisation for in-situ preservation of urban archaeological sites.

Hans de Beer
Vice-chair COST TU1206; Team Leader Groundwater and Urban Geology, Geological Survey of Norway

Ignace (1956) studied Geology at the University of Amsterdam. Thereafter, he joined Shell in 1983, working as exploration geophysicist in UK, Africa and Asia. In 1997, he started working for Halliburton Professional Services as workflow consultant, auditing the exploration companies in the UK, Russia and FSU. Since 2001, his work for the City of Rotterdam Engineers involves 3D modeling of the subsurface in order to facilitate integral subsurface evaluation in urban development projects. Initiated the “underground scan” and recently the “subsurface serious game”. Represents Rotterdam in COST-SUBURBAN. Since 2011, also active as geophysicist for the geothermal energy division of Brabant Water.

Ignace Van Campenhout
Municipality of Rotterdam

David Entwisle
Senior Engineering Geologist, BGS

A senior engineering geologist with over 30 years’ experience and extensive knowledge of soil and rock mechanics, engineering geology and geohazards. He has authored papers on geophysics, geochemistry, material behaviour and engineering geology. He has developed methods, with others, of presenting geotechnical data and engineering geological information in 3D geological models and GIS for planners and the construction industry. He was a committee member of the Engineering Group, Geological Society and Chairman (2010 to 2012). Currently a member of the Association of Geotechnical and Geoenvironmental Specialists (AGS) laboratory and digital data transfer format committees and British Standards Institution committee 526/3, Site Investigation and Ground Testing, and subcommittee 526/3/4 BS5930 revision group.
Professor John Farmer  
*Professor Emeritus and Senior Honorary Professorial Fellow, University of Edinburgh*

A double Chemistry graduate (1969, 1972) of Glasgow University, John Farmer first investigated potentially harmful elements in contaminated Glasgow soils in the mid-1970s. A move to Edinburgh University in 1987 saw expanding emphasis on the analytical speciation, environmental geochemistry and health implications of lead, chromium, arsenic, mercury, antimony, cadmium, uranium and manganese in terrestrial and freshwater environments. Chair of the 6th International Symposium on Environmental Geochemistry (2003), President of the Society for Environmental Geochemistry and Health (2002–05) and Executive Editor of *Science of the Total Environment* (2002–11), he has been Emeritus Professor of Environmental Geochemistry at Edinburgh University since 2009.

Fiona Fordyce  
*Senior Environmental Geochemist, BGS*

Fiona studied geology at St Andrews University and has worked for the British Geological Survey for 23 years. Her main areas of interest include investigating soil, stream sediment and water quality in the context of rural and urban environmental assessments, contamination and links to plant, animal and human health, both nationally and internationally. In the UK, much of the focus for the last ten years has been quantifying the chemical quality of urban environments, including Stoke-on-Trent, Manchester and Glasgow. Fiona has been a Special Adviser for the International Medical Geology Association since 2006.

Professor Michael Heath  
*Professor of Fisheries Science, University of Strathclyde*

Michael Heath studied oceanography and marine biology at Bangor University in North Wales before moving to the Marine Laboratory in Aberdeen. There, he worked on herring stocks, modelling of marine ecosystems and the effects of climate change. In 2010, he took up the Chair in Fisheries Science in the Department of Mathematics and Statistics at the University of Strathclyde, established as part of the Marine Science and Technology Scotland (MASTS) pooling scheme. He currently leads a research team focusing on mathematical and statistical modelling of the effects of fishing on marine populations and ecosystems.

Professor Andrew Hursthouse FRSC  
*Professor of Environmental Geochemistry, University of the West of Scotland*

Professor Andrew Hursthouse is Head of Physical Sciences and Professor of Environmental Geochemistry at the University of the West of Scotland. Andrew applies an ‘earth-systems’ approach to research, which covers the transport/behaviour of pollutants in the environment (air quality, land degradation and remediation, and aquatic biogeochemistry), evaluating the impact on ecosystems and for human health. Andrew has a keen interest in urban ecosystems and their soils and these studies have links to policy and knowledge transfer activities which have been focused on the role and evolution of environmental management tools. He is currently President of the Society for Environmental Geochemistry & Health (SEGH) and a founding Trustee of Environmental Protection – Scotland (EP-S).
Dr Majdi Mansour  
**Senior Groundwater Modeller, BGS**

Majdi Mansour (1972) studied Civil Engineering in Beirut, Lebanon, where he worked on water resources-related projects. He obtained an MSc and a PhD (2003) in Civil Engineering from the University of Birmingham, UK. He started working at the British Geological Survey in 2002, where he has developed and applied numerical tools to estimate recharge and simulate groundwater flows in a range of countries and climatic situations. Majdi has been involved in the simulation of groundwater flows in many alluvial aquifers in Scotland. Currently, he is looking at the application of tools to simulate multiphase flows in porous medium.

Andrew Kingdon  
**Petrophysicist and Team Leader Parameterisation and Statistics, BGS**

Andrew Kingdon is BGS Team Leader for Parameterisation and Statistics, a petrophysicist with over 20 years involvement in understanding distribution of the physical properties in the subsurface and its *in-situ* stress fields. He is responsible for developing tools that permit easy data extraction from complex geodata sources, populating geological volumes to understand heterogeneity, and developing models of complex interactions between the geological variability and of subsurface fluid flow.

Dr David Jones  
**Project leader/Geochemist, BGS**

Dave Jones graduated from Leeds University and obtained his doctorate from Oxford. He has worked for the British Geological Survey for over 30 years in a variety of areas including environmental radioactivity, estuarine contamination, mineral exploration and, more recently, geological CO₂ storage. He is project leader for BGS studies in the Clyde Estuary and led earlier work on contamination in the Irish Sea and was involved in studies in the Schelde Estuary in Belgium and off the Farallon Islands in the USA.

Dr Michiel van der Meulen  
**Chief Geologist, Research Manager Geomodelling, TNO/Geological Survey of the Netherlands**

Michiel J. van der Meulen studied geology at Utrecht University. After obtaining his PhD in 1999, he started working on mineral resources and supplies at Rijkswaterstaat (directorate-general of Public Works and Water Management). In 2003, Michiel joined the Geological Survey of the Netherlands, where he continued working on minerals and the relationship between land use and geology. Since 2006, he held various management positions, and his scope and responsibilities have broadened to supplying geological information in
Lothar Moosmann
*Hydrogeologist, Ministry of Urban Development and Environment of Hamburg (BSU) – Geological Survey*

Lothar Moosmann studied Geography and Hydrology at the University of Freiburg (1994). He then worked in various projects of applied hydrogeology and groundwater modelling. Since 2000, he has been working at the Geological Survey of Hamburg. His work focuses on hydrogeology, groundwater modelling, information and advice.

Brighid Ó Dochartaigh
*Hydrogeologist, BGS*

Brighid studied Geology and Physical Geography at Edinburgh University and hydrogeology at Birmingham University, and has worked for BGS since 1997 on many aspects of groundwater resources in the UK and internationally, particularly in ‘difficult’ (e.g., low permeability, urban, dryland or arctic) hydrogeological environments. In Scotland, Brighid has worked with SEPA and Scottish Water to develop and manage sustainable groundwater resources, including producing national aquifer and groundwater vulnerability maps. Brighid has led groundwater research within CUSP from its inception, integrating groundwater monitoring, modelling and interaction with other disciplines including soil quality and information management.

Dr Alison Monaghan
*Geologist, BGS*

With over 15 years’ experience of 3D geological modelling in Central Scotland, Alison has been involved the CUSP work since its inception. From core logging and hazard mapping in Bellahouston Park, to utilising the CUSP modelling work as an exemplar for corporate BGS modelling procedures and quality control, Alison is a geologist-modeller and deputy Team Leader for the BGS National Geological Model. She also undertakes technical and management roles in carbon capture and storage (CCS) and unconventional gas projects, as well as maintaining a scientific interest in Carboniferous stratigraphy and volcanic geochronology.

Paul Meyer
*Hydrogeologist, Groundwater Modeller, CONSULAQUA Hamburg*

Paul Meyer has a MSc in Geosciences (area of specialisation: Hydrogeology) from the Ruhr-University Bochum and more than five years of professional experience in hydrogeology, with a special focus on groundwater modelling and water management. He worked as a consultant in the Ruhr area for an expert engineering office for numerical modelling (delta h) from 2009 until 2012. Since early 2012, Paul started at CONSULAQUA Hamburg, a wholly-owned subsidiary of the water supply company Hamburg Water. Amongst other projects, he is groundwater modeler of the regional model Hamburg, which will be applied for a variety of issues concerning the water supply of the city of Hamburg.
Dr Jeroen Schokker  
**Geologist/Geomodeller, TNO/Geological Survey of the Netherlands**

Jeroen Schokker (1975) graduated from the Vrije Universiteit Amsterdam in Quaternary Geology and obtained his PhD from Utrecht University on the Middle to Late Quaternary infill of the Roer Valley Graben (SE Netherlands). In 2003, he entered the Geological Survey of the Netherlands and has since contributed to a wide range of applied mapping projects. From 2010, he has specialised in 3D subsurface modelling, particularly GeoTOP. In recent years, Jeroen has focused on 3D urban subsurface modelling through a co-operation with the Municipality of Rotterdam and his involvement in European COST Action Sub-Urban.

Marian Scott OBE FRSE  
**Professor of Environmental Statistics, School of Mathematics and Statistics, University of Glasgow**

Marian Scott is Professor of Environmental Statistics at the University of Glasgow. She is a chartered statistician, an elected fellow of the International Statistical Institute and a Fellow of the Royal Society of Edinburgh. She has been involved in the Royal Statistical Society, Environmental Statistics Section, is a member of the Environmetrics Society and a Trustee of Statistics in Public Resources, Utilities and Environment (SPRUCE). She has been active in promoting the cause of interdisciplinary research, particularly with regard to Statistics within the Environmental Sciences.

Dr Martin Smith  
**Science Director, BGS Global**

Dr Martin Smith was appointed in 2013 to lead the newly formed BGS Global Geoscience programme. A graduate of Aberdeen University and a Chartered Geologist he previously led the UK Geology and Landscape programme with responsibility for onshore surveys, provision of policy advice to government including EU Directives and response to national events. He is currently engaged in developing BGS expertise internationally and in providing expert technical advice on subsurface geology for major infrastructure projects. A founding member of the BGS Glasgow (CUSP) project he has research interests in developing sub-urban geology and monitoring and linking to surface processes.

Dr Katie Whitbread  
**Sedimentary Geologist/Geomorphologist, BGS**

Working as a geologist at the British Geological Survey since 2005, Katie has been involved in 3D modelling of superficial deposits in Glasgow since the early stages of CUSP, and in 2012 conducted a Geodiversity Audit of the City of Glasgow for Glasgow City Council. Her other work for BGS includes geological field surveying, 3D geological modelling for commercial clients, and research into surface processes (rivers and hillslopes). Katie has a degree in Natural Science from the University of Cambridge and a PhD in Earth Science (Postglacial river erosion) from the University of Glasgow.
Conference Organising Committee

Professor Paul Bishop FRSE
Professor of Geography, University of Glasgow

Dr Diarmad Campbell
Chief Geologist, Scotland, British Geological Survey

Oonagh Carroll
Events Officer, RSE

Professor John Coggins OBE FRSE
Former Vice-Principal for Life Sciences and Medicine,
University of Glasgow

Professor David Paterson
Executive Director
MASTS
(The Marine Alliance for Science and Technology for Scotland)