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**Geological Survey**  
Suirbhéireacht Gheolaíochta  
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## Dublin city geo-environmental challenges

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*City Futures, University College Dublin, 22<sup>nd</sup> June 2019*

# Geological Survey Ireland



Geological Survey Ireland is Ireland's public earth science knowledge centre and is a division of the Department of Communications, Climate Action and Environment.

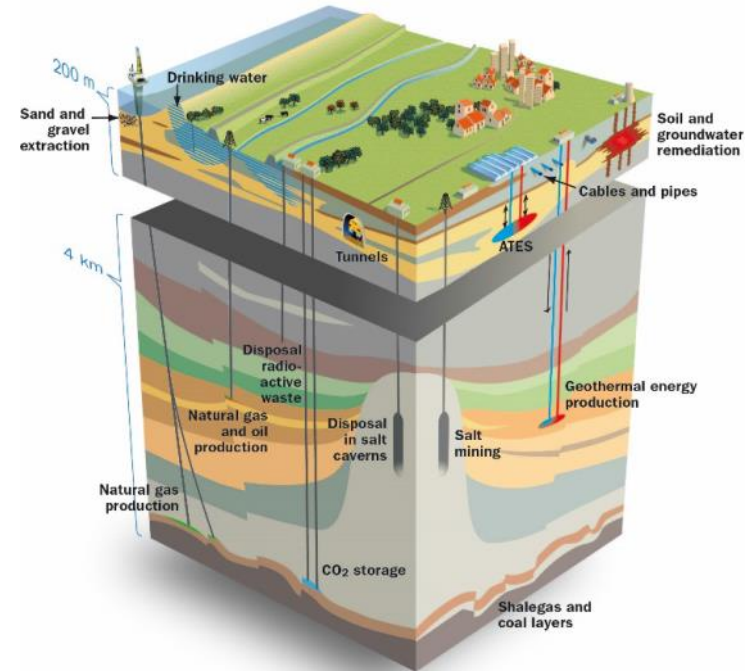
- Provider of information on all aspects of the subsurface: rock, soil, groundwater, minerals, aggregates, geohazards, geological heritage and seabed survey
- Statutory consultee for certain developments concerning the geological environment
- Open data policy; freely available at [www.gsi.ie](http://www.gsi.ie)

# What is Urban Geology?



Cities have a third dimension which we need to know about – the subsurface

“The study of the interaction of human and natural processes with the geological environment in urbanised areas, and the resulting impacts; **and** the provision of the necessary geo-information to enable sustainable development, regeneration and conservation”<sup>1</sup>.



<sup>1</sup> Culshaw and Price (2010)

# Why do we need Urban Geology?



- The use and reuse of urban underground space is becoming more attractive and necessary, the subsurface in Dublin is currently under-utilised
- The urban subsurface has an important role to play in helping us meet increasing energy needs (geothermal energy)
- Dublin is growing pop. grew by 5.6% from 2011 to 2016, to 1.73 million<sup>2</sup>. Low rise city with underutilised subsurface



# Policy drivers



| National policy (Ireland)                                                                                                  | Relevant goal                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Our Sustainable Future<br>(Govt. of Ireland, 2012)                                                                         | Goal 1: Improving the planning system so that <b>growth will have to predominantly take place in sustainable compact urban areas or rural areas</b>                                                  |
| Sustainable Development Goals National Implementation Plan 2018-2020<br>(Dept. Comms, Climate Action & Environment, 2018). | Goal 11: Make cities and human settlements inclusive, safe, <b>resilient and sustainable</b> .<br><br>Indicator 11.6: By 2030, <b>reduce the adverse per capita environmental impact of cities</b> . |
| Project Ireland 2040 National Development Plan 2018-2027<br>(Govt. of Ireland, 2018)                                       | The €2bn Urban Regeneration and Development Fund for the five cities and larger urban centres will <b>incentivise brownfield redevelopment and urban regeneration</b> .                              |
| Transport Strategy for the Greater Dublin Area 2016-2035 (NTA, 2016)                                                       | Proposes <b>major infrastructure projects including underground metro</b> (MetroLink)                                                                                                                |

# Subsurface challenges



The subsurface is generally ‘out of sight, out of mind’, considered only if there are exceptional problems or opportunities

Insufficient understanding of subsurface ground conditions places significant constraints on development of urban areas

- A key factor in overspend on construction projects (‘unforeseen conditions’)
- Results in inefficient planning, design and development
- Can affect management of geological risks – safety and sustainability



## Burlington Road, Dublin 4

- 3 basement levels in rock (Calp)
- 5 storey development

Photo: Mike Long

# Subsurface challenges



## 1. Data availability

- Difficult for national Geological Surveys to collect harmonised, high quality data on the urban subsurface
- Data exists in the private sector, captured for open use to a limited degree e.g. National Geotechnical Borehole Database

## 2. Data integration

- Raw data is of limited use to planners, policy makers, developers and the public
- Combine with relevant information and tailor outputs for stakeholders e.g. 3D models, guidelines, collaborations

# Dublin's geological environment



The idealised city setting: On flat, solid, low-radiation rock; beyond main seismicity zones; far from volcanoes and at least 20m above sea level<sup>3</sup>

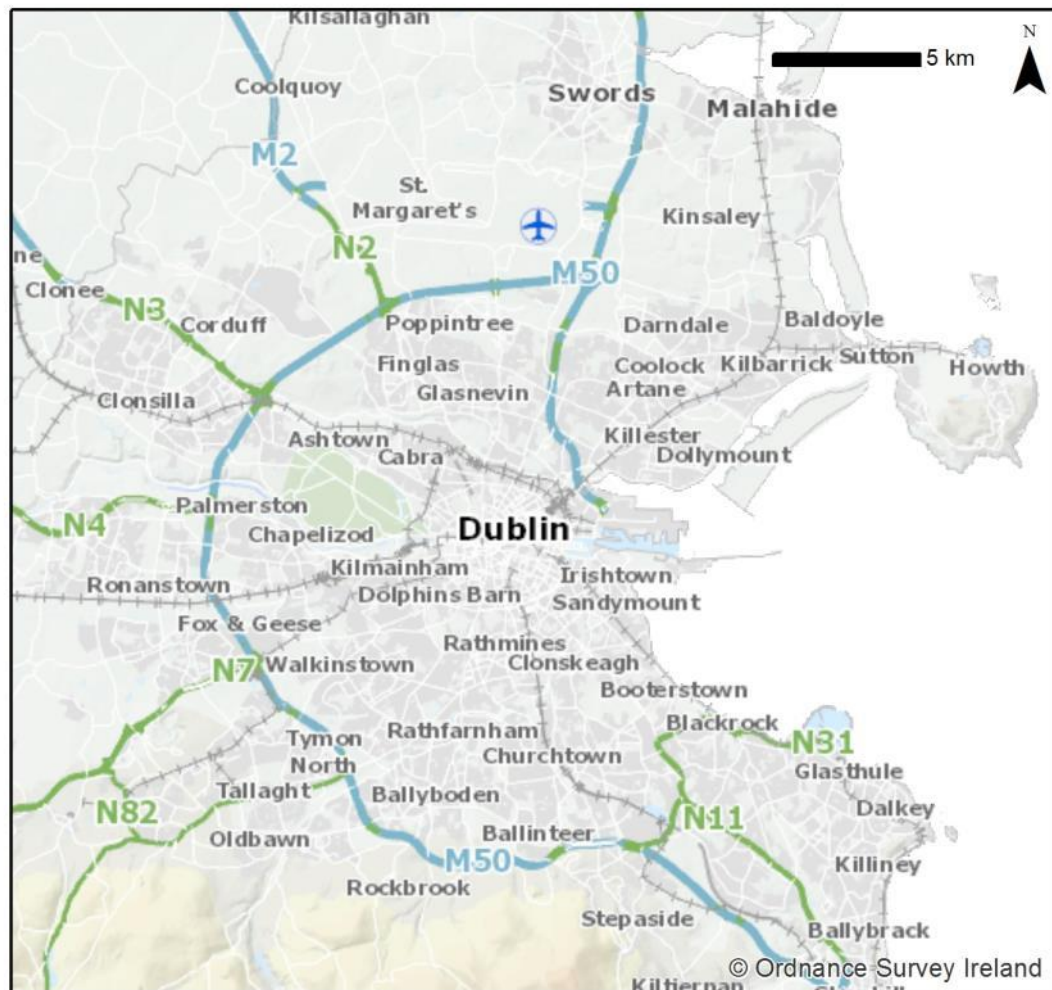
- Ireland's urban areas are not exposed to earthquakes and volcanoes

However, we have risk from

- Natural radioactivity: Radon exposure from rocks
- Riverine locations: Flooding
- Coastal locations: Sea level rise and coastal erosion

...and challenging rock and soil conditions

<sup>3</sup> de Mulder and Pereira, 2009



# Flooding, erosion & climate emergency

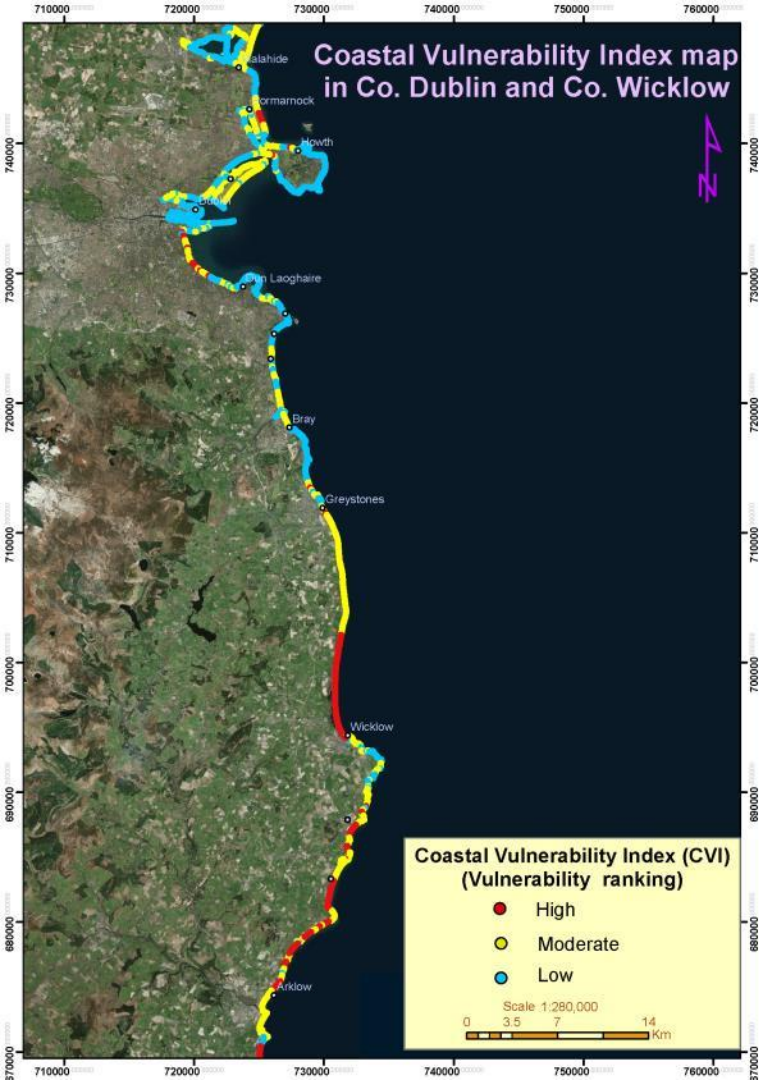


Urbanised river catchments are vulnerable to fluvial (river) and pluvial (rainfall) flooding due to sealed, impermeable surfaces

- Dublin is located on the River Liffey estuary, and its 11 tributaries
- Estimated 20,000 buildings at risk from flooding, and another 10,000 likely to become at risk due to climate change<sup>5</sup>
- Geological Survey Ireland is part of the Interdepartmental Flood Policy Coordination Group



<sup>5</sup> Kilraine, 2019



- Ireland's five main urban areas (Dublin, Cork, Limerick, Galway, Waterford) are sited on the coast
- Geological Survey Ireland is undertaking a new initiative to map coastal vulnerability to climate-related sea-level rise<sup>6</sup>
- Aim to identify the coastal regions most likely to be affected by impacts of sea-level rise by using a coastal vulnerability index

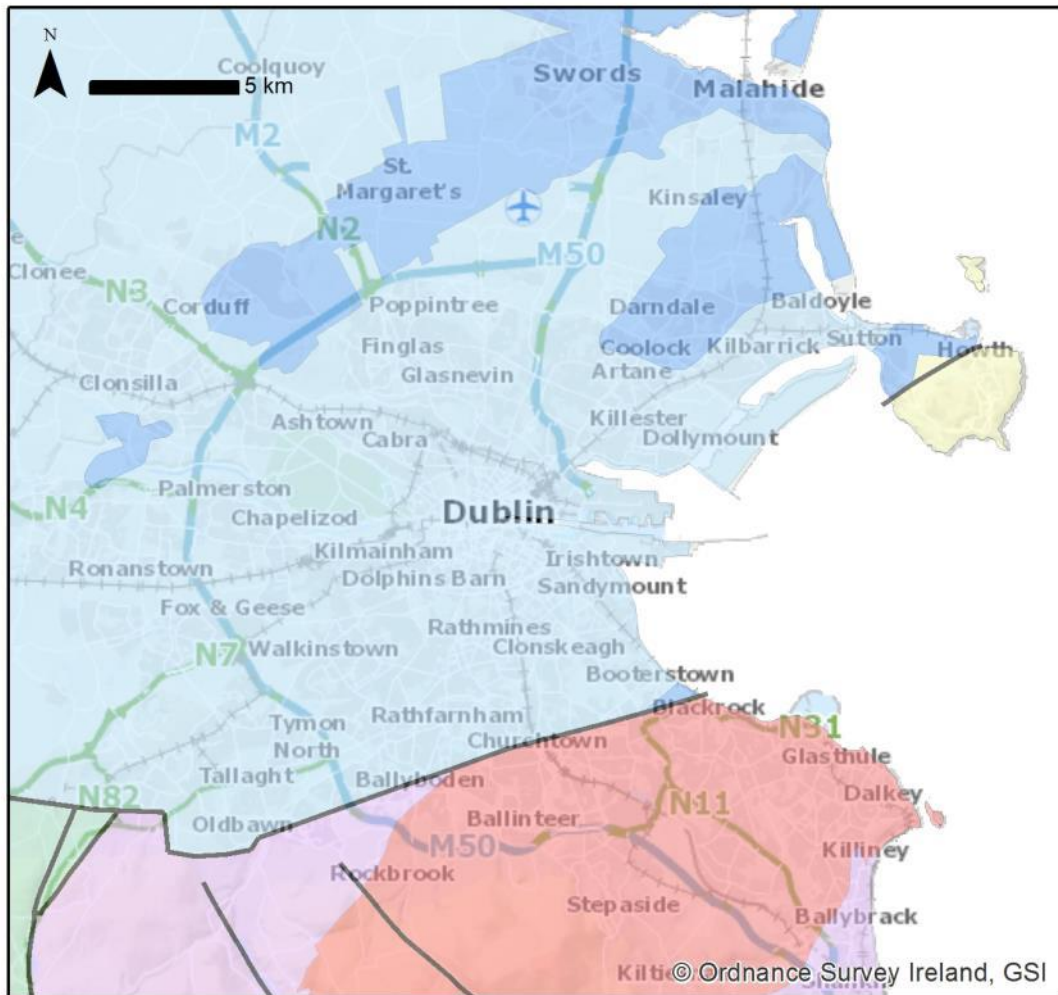
<sup>6</sup> Caloca-Casado, 2018

# Dublin's bedrock



Dominated by limestone of Lower Carboniferous age (c.330 MA) – the Dublin Basin

- Mapped in less detail than rural areas – poorly understood in composition and structure
  - Variable in its physical properties – can be strong or weak depending on how weathered it is, and clay content (shale)
  - Rock surface under soil is not a smooth surface – broken, weathered and decomposed
- > Challenges for foundation strength, tunnel boring
- Almost completely covered in a thick layer of glacial deposits



## Dublin Bedrock Geology (1:1,000,000 scale)

- Visean limestone & calcareous shale
- Tournaisian limestone
- Siluro-Devonian granitic rocks & appinite
- Silurian deep marine mudstone, greywacke & conglomerate
- Lower-Middle Ordovician slate, sandstone, greywacke, conglomerate
- Cambrian greywacke, slate, quartzite
- Bedrock Faults



Photo: Mike Long



# Dublin's soil



Subsoil (<1m depth) is the main medium for construction, excavation and tunnel boring in Dublin

- Significant thicknesses of glacial till, alluvium, sand & gravel, >10 in places
  - The till has variable physical properties (strength, compressibility) and frequent boulders making tunnelling challenging
  - The till has naturally elevated levels of certain elements (selenium, cadmium, arsenic) making classification for disposal/reuse difficult
- > Geological Survey Ireland working with EPA on soil classification
- 2% of Dublin (NB docklands, port) 'urban' or 'made ground'



## Dublin Port Tunnel

### Boulder clay

- Very stiff clay, usually stands up well
- Frequent cobbles, boulders
- Can have lenses of sand and gravel

Photo: Mike Long



# Made ground

- Most commonly reclamation of land from estuary and port, raising of low-lying ground and filling of historical quarry voids
- Industrial wastes such as ash, clinker and slag historically used as fill
- Often associated with contamination and archaeological artefacts
- Often contains brick, plastic, metal, concrete....etc
- Reuse/disposal challenges



# Groundwater



Groundwater is a consideration for:

**Water supply** | Dublin's mains supply is from surface water reservoirs; aquifer potential is modest but there are small local abstractions

**Dewatering excavations** | Pumping of water table, tidal considerations

**Basement impact assessment** | Distortion of water table from subsurface structures – planning consideration

**Geothermal energy** | Heating and cooling from subsurface water and rock

Dublin lacks a groundwater monitoring network – this will be important for future climate change and geothermal energy development

# Conclusions



- Subsurface resources of space, water and energy will become increasingly important considerations for future urban planning and development
- Dublin has limited subsurface development, although several major and mega-scale projects are set to bring the subsurface, and the importance of understanding and mapping it, into focus.
- Geological Survey Ireland provides a range of data and products relevant to subsurface investigations and research, but there exist opportunities to:
  - Acquire new urban data,
  - Increase data availability and integration, and
  - Collaborate with other urban stakeholders to optimize use of subsurface environment information.

# Thank you



Full paper available in proceedings

Co-author acknowledgements: Beatriz Mozo Lopez, Michael Sheehy, Sophie O'Connor, Sarah Blake, Eoin McGrath, Silvia Caloca-Casado, Ray Scanlon

Imagery acknowledgements: Mike Long (UCD), Cecil Shine & Jen Caleno (Minerex Environmental Ltd)

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