Karst & Tunnelling

Karst is widespread in Ireland, is a major source of ground water, and is intimately intertwined with seasonal surface flooding. Karst can be unstable and represent a time-varying environment with the appearance of seasonal lakes. Due to its extreme heterogeneity there is still no accepted 'best method' for imaging conduits or other structures in karst. It poses a critical problem in infrastructure development (e.g. motorway building) and offers a 'laboratory' for further scientific research.
This research will determine the most reliable geophysical methods for imaging through karst and determining karst geo-mechanical properties. This will be done by applying 'integrative' and 'derivative' imaging methods and combine different methodologies using formal joint inversion techniques. Forward numerical simulations in heterogeneous models will support the interpretation.
Buried valleys have a significant influence on surface and ground water drainage patterns and have implications for (i) geotechnical works, (ii) the factors controlling flooding and (iii) contaminant transport pathways. They have been encountered as part of Arup's work on the Galway City transport project.
This research will determine the distribution of buried limestone valleys in the Galway City area by analysing existing date and preparing a 3D ground mode in collaboration with Arup.
Project titles:

- Geological investigation of buried limestone valleys between Lough Corrib and Galway City
- Developing a toolkit for imaging shallow karst

Coastal and Material Stability

Although under steady state conditions shelf systems are usually in equilibrium, unprecedented sediment inputs, tsunami surges, storm surges and climate change-driven seabed impacts mean that new equilibria will be reached, the pathways to these new states need to be understood (both from a hazard and a geotechnical perspective).
The main objectives of iCRAG's research in de-risking offshore wind are:

- To identify and investigate the primary geological and geotechnical constraints to developing offshore wind in the Irish Sea through site evaluation;
- To identify potential areas for future development and de-risk existing challenges at these sites;
- To identify data gaps in our current understanding of site development.

Risk assessment methodologies used for peat stability assessment are often inconsistent. This research theme is determining what rheological deformation model that best describes the behaviour of peat. Furthermore it is not yet clear if best 'risk assessment' should be Qualitative, Probabilistic or Deterministic within data limitations. Undertaking research

using an existing large databank of observations, as well as undertaking empirical testing at study sites will improve scientific understanding of peat slope stability assessment, as well as inform engineering methodologies and standards for future practice.
Construction activity on peatlands has increased significantly since 2000 due to the development of on-shore wind renewables. This construction activity has produced a large databank of geotechnical data and observations that has not yet been robustly scientifically evaluated. This research theme will utilise, research and evaluate this data to answer three key questions: (1) Are the risk assessment methodologies employed on peatland environments consistent? (2) Are these methodologies appropriate to a peat substrate, in terms of its deformation behaviour? (3) Have these methodologies been successful in mitigating risk and long term peatland management?
Project titles:

- Peat slope stability and the effectiveness of mitigation measures on peatland sites in Ireland
- Geotechnical de-risking of the Irish offshore environment through geological assessment and mapping

Time varying effects

Sub-marine landslides are a significant risk for coastal communities (tsunami generation) and offshore engineering infrastructure. Storm triggered submarine landslides is a new area of scientific research and is of broad scientific and practical significance. Continental margins earthquakes are usually thought to be responsible for slope failure triggering. Recent work demonstrates that specific storm-induced sea states can impose significant cyclical pressure fluctuations on the sea floor. In this research theme we ask – should storms be considered as a viable slope failure trigger near offshore shelf breaks?
This research theme ismeasuring cyclical pressures on the sea floor using data from the iMARL offshore network, and is using 20 piston cores collected in 2010 to test the effects of measured pressure by subjecting samples to cyclical loading in a physical laboratory (examine material weakening as a function of frequency and amplitude of load cycles). This work is supported by laboratory work with numerical modelling in granular materials.
Karst environments change with time due mainly to water ingression and non-elastic changes in moduli under long term loads. Here we develop new methods for determining the temporal variation of moduli (on the 100s m spatial scale) on a 15 minute time scale, 24/7 for several months. Data will be streamed in real time so changes can be monitored remotely.
This research theme usesrepeat seismic shots using an airgun in a buried water tank (at 15 minute temporal resolution), and recorded on a nearby seismometer. Seismic Coda Wave Interferometry is applied to determine velocity changes as small as 0.1%. If the forcing is known (e.g. atmospheric pressure) we can determine large scale (e.g. 400m x 400m) average moduli changes for the rock volume.
Project titles:

- Storm induced cyclical seafloor pressure fluctuations effect on sea floor and offshore slope stability
- Time lapse geophysical monitoring in karst systems