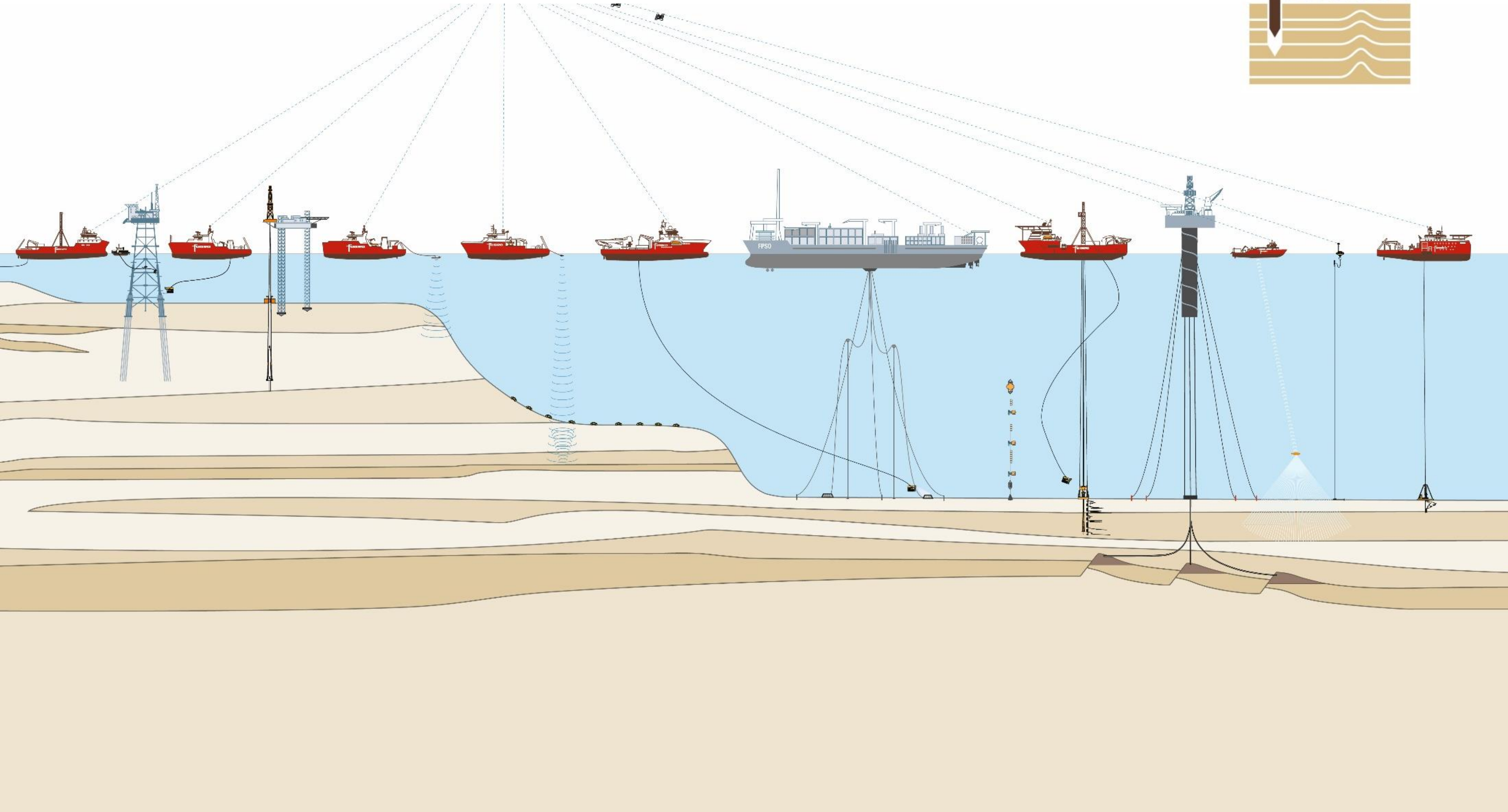

Geospatial data integration for geotechnical site characterisation

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Authors and abstract

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Abstract

Smart data management is essential to comprehend the numerous, intricate datasets associated with offshore developments that cover large extents of potentially variable soil conditions. Integration of foundation zone data using ArcGIS Spatial Analysis culminates in an integrated engineering ground model. This presentation describes our approach to offshore site characterisation via the application of bespoke ArcGIS add-ins developed to enhance data access, integration, analysis and visualisation.

Keywords

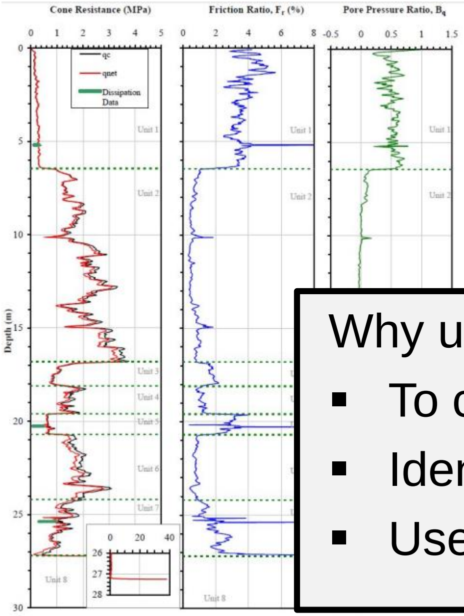
Data integration, Spatial analysis, Site characterisation, Ground model, GIS.

Outline

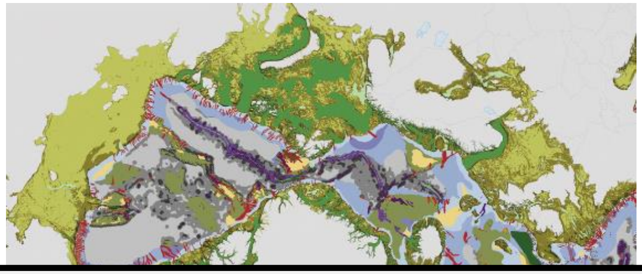
- Available datasets
- Site characterisation
- Case studies
- Geospatial analysis
- Conclusions

Available Datasets

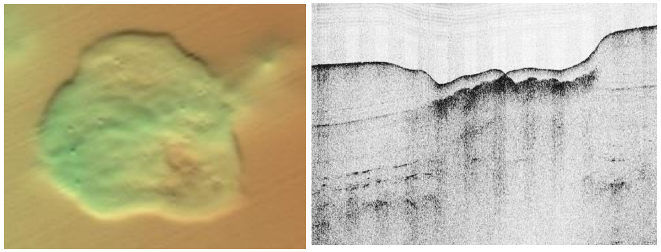
Geotechnical



Geological



Geophysical

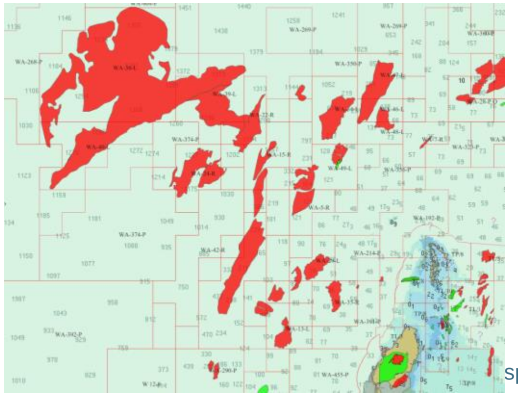


Why use GIS?

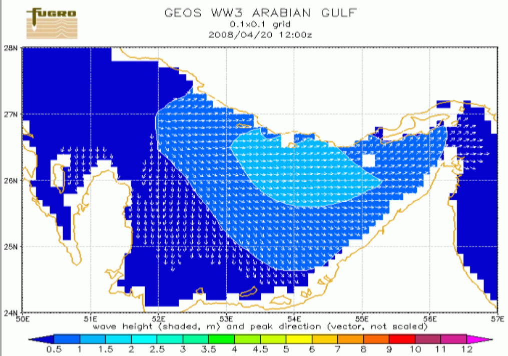
- To centralise all project data in single database
- Identify trends and anomalies to characterise the site
- Use GIS as correlation, analysis and manipulation tool

Environmental

Cultural / Legislative



Metocean



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Site Characterisation: Approach

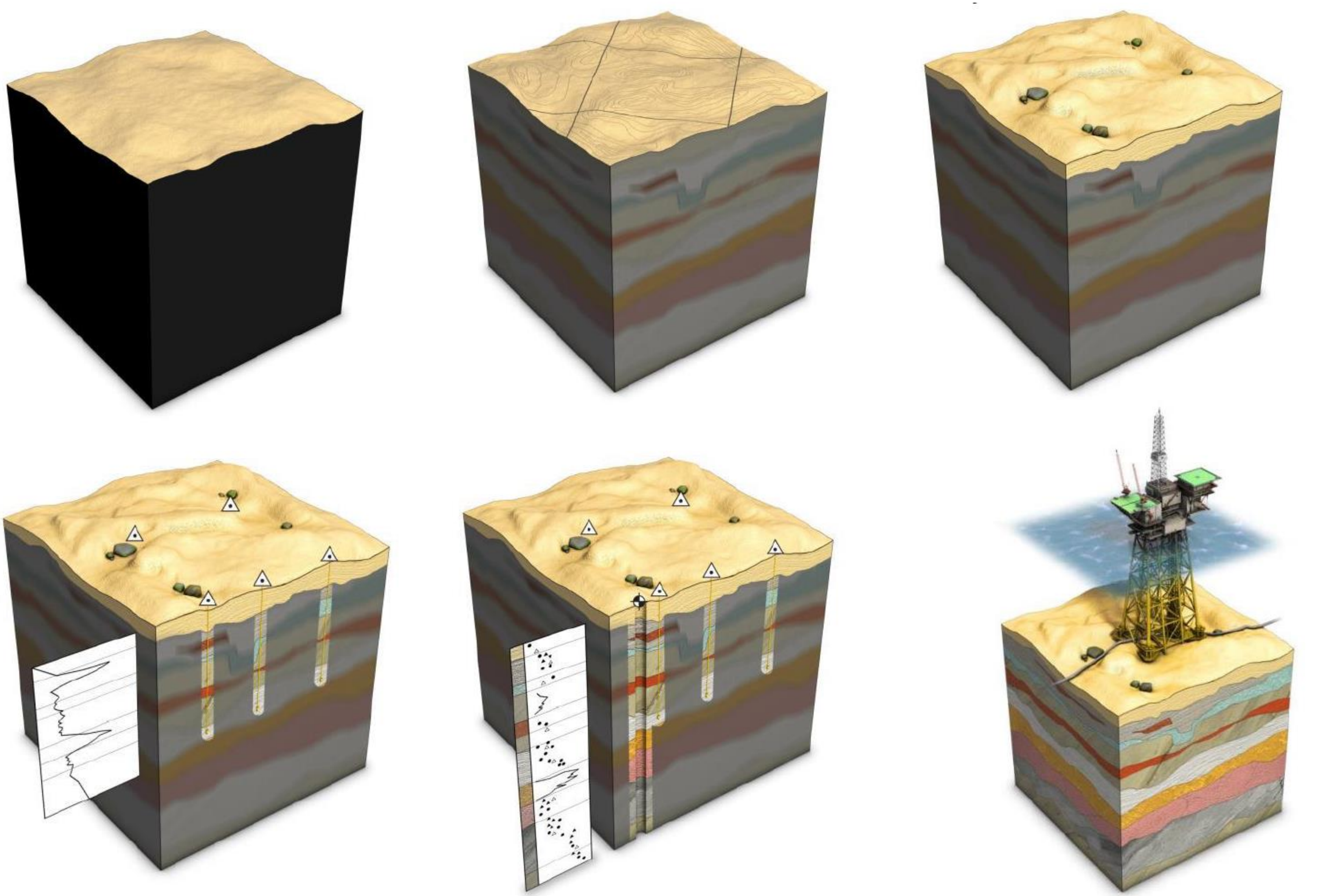
Traditional approach

- Datasets studied in isolation by each discipline
- Data handled in different software for very specific uses
- Can lead to incomplete and potentially conflicting conclusions

Modern (integrated) approach

- Integrate multiple large datasets to provide a predictive, flexible and accessible database of site conditions – Ground model
- Maximise use of site-specific geotechnical investigations, using geophysical surveys to optimise geotechnical acquisition, and making existing data more discoverable
- Identify data gaps, uncertainties and engineering constraints
- Assist with subsea infrastructure positioning and foundation concept selection

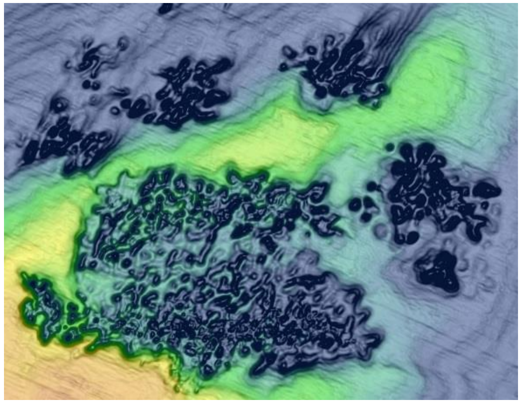
Site Characterisation: Objective

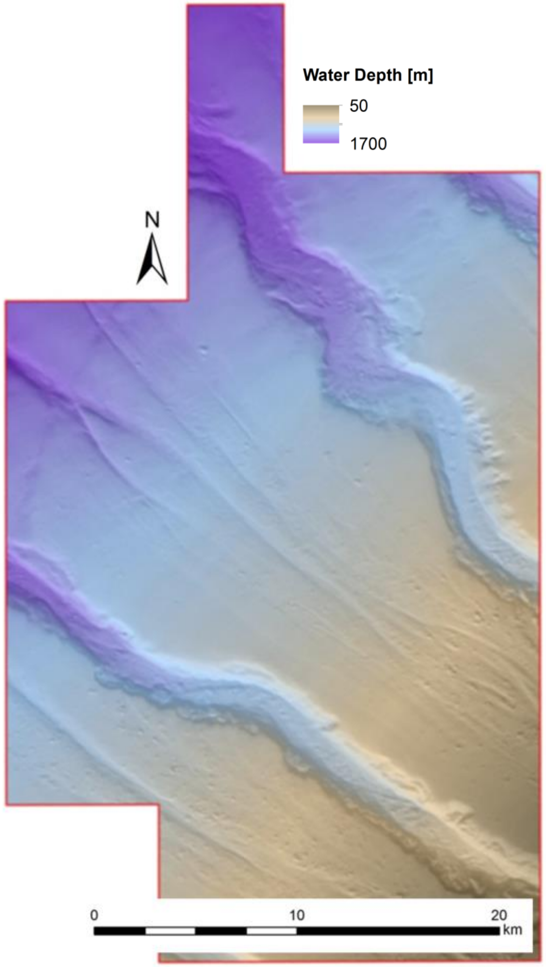


Site Characterisation: Challenges

Features of offshore developments that can present an engineering or data management challenge with respect to site characterisation include:

- Large spatial extent, particularly pipelines
- Greater potential for encountering variable soil conditions
- Numerous foundation locations
- Potential for requiring multiple foundation concepts
- Large and intricate geotechnical and geophysical datasets
- Unique engineering considerations





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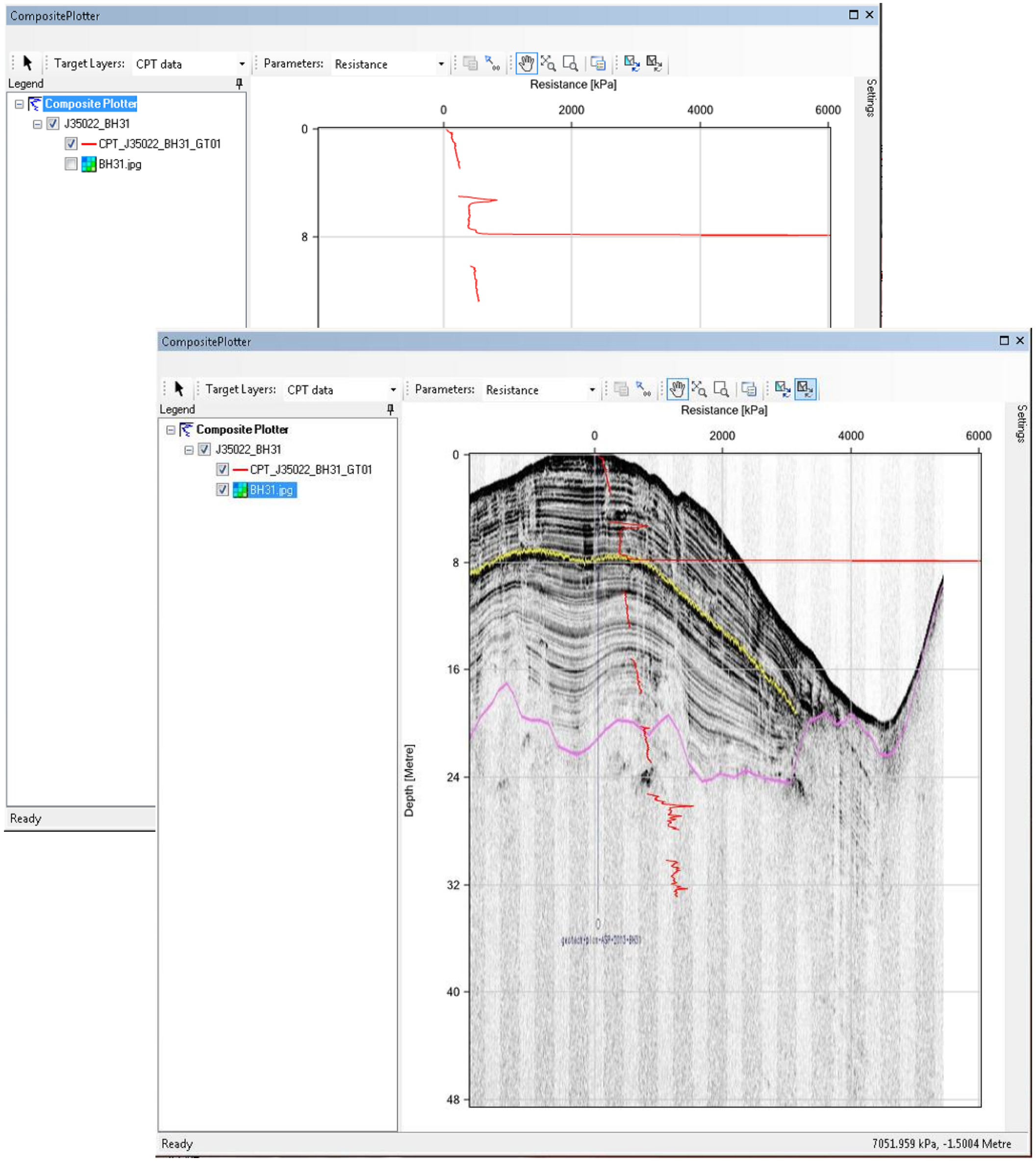
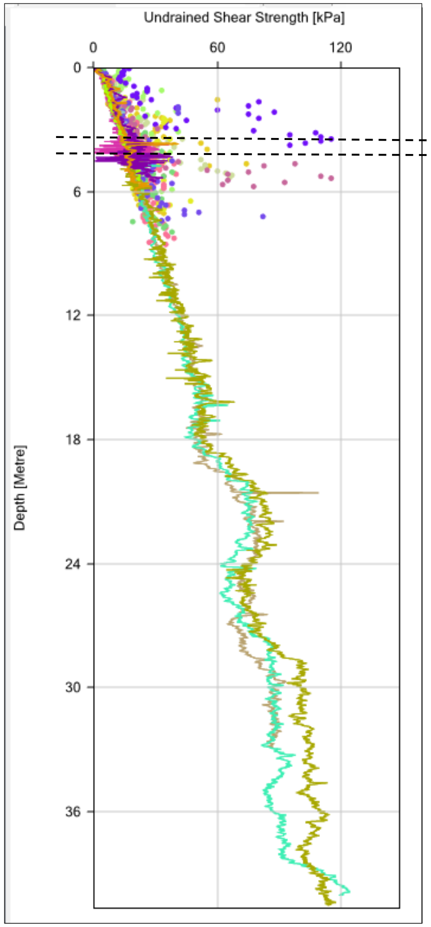
Case Study 1 (geotechnical and geophysical)

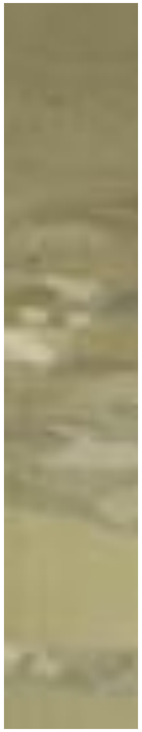
- CPT at single location showing large unexplained spike at 8m
- When complimented with continuous sub-bottom-profiler data it is apparent that the geotechnical spike is driven by intersecting a particular geophysical horizon
- Sub-bottom-profiler data rationalises high resistance spike allowing that geotechnical observation to be extrapolated laterally across that geophysical horizon.



Case Study 2 (geotechnical and geohazard)

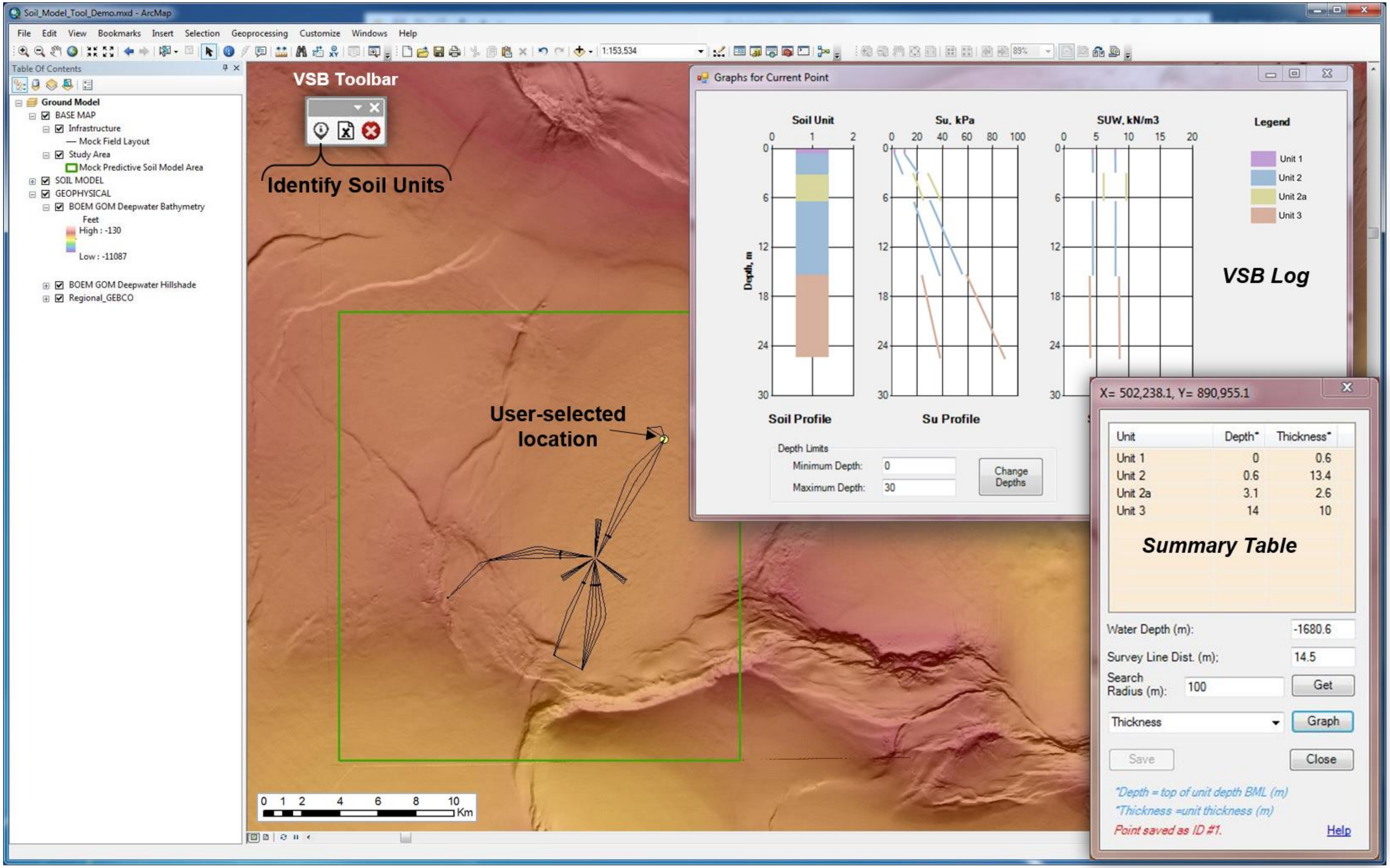
- Start with continuous geotechnical data
- Supplement with discrete test data which reinforces trend
- Further integration of geohazard core log data rationalises the high scatter as this depth range is within a debris flow deposit





Caption: Shear strength variation between 2m and 6m attributed to the differing properties of constituent clasts in the debris flow deposit. (Note geohazard core only ~40cm length).

Case Study 3 (Predictive Soil Model)



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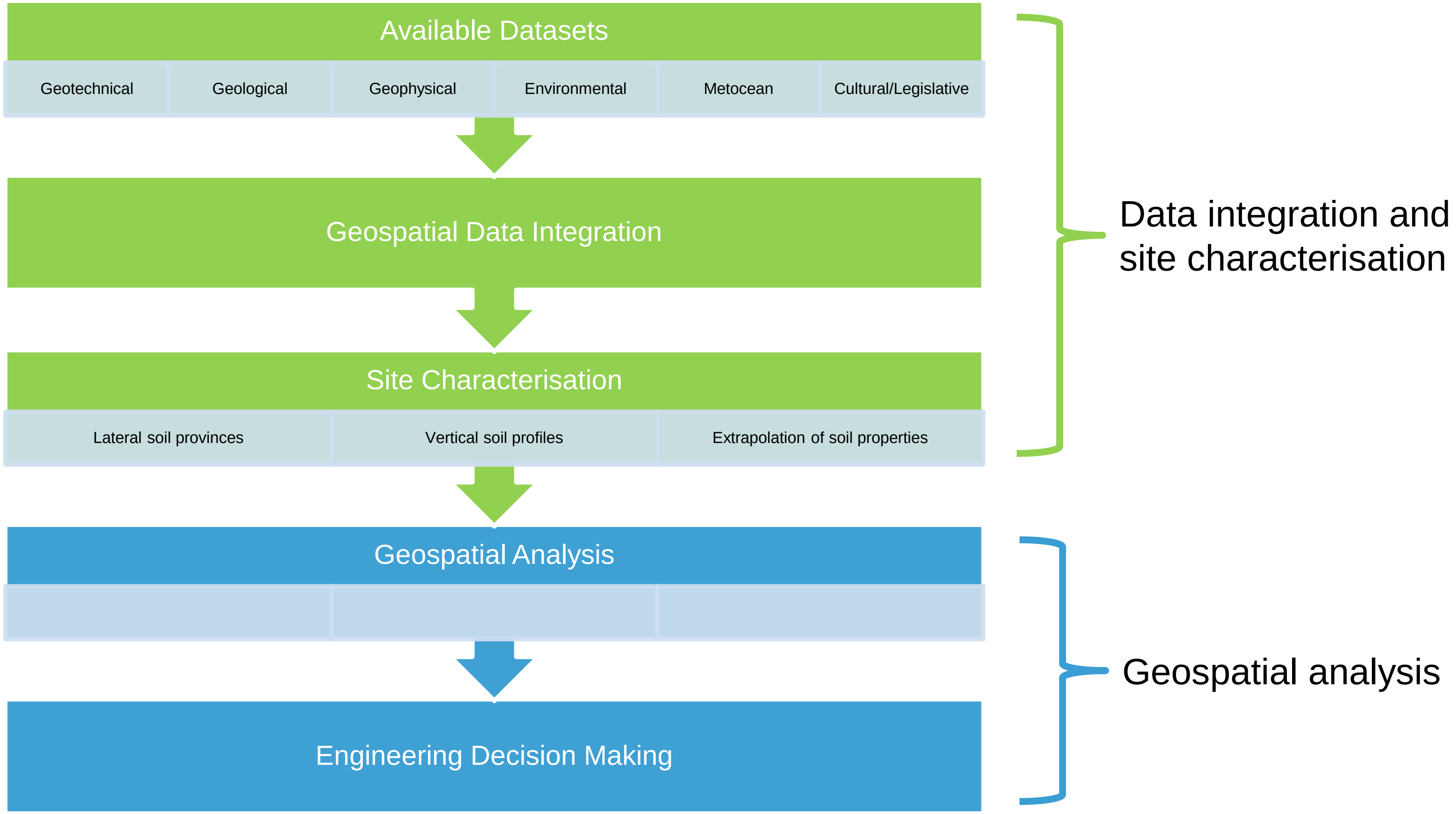
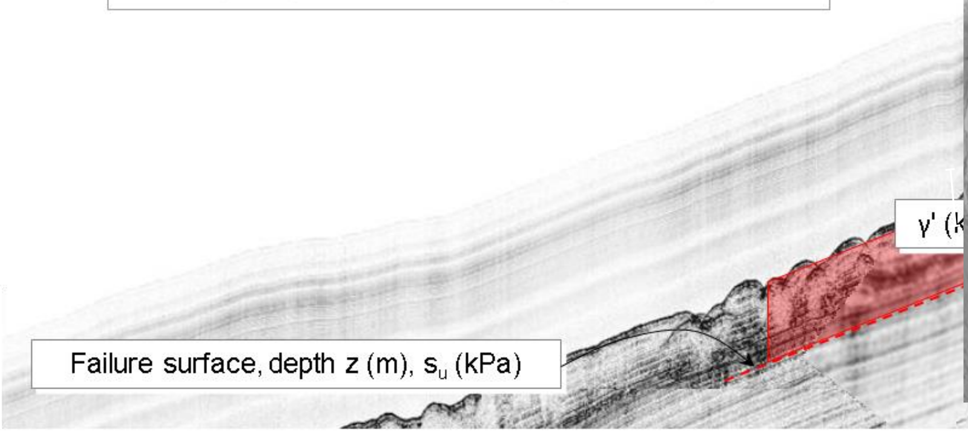
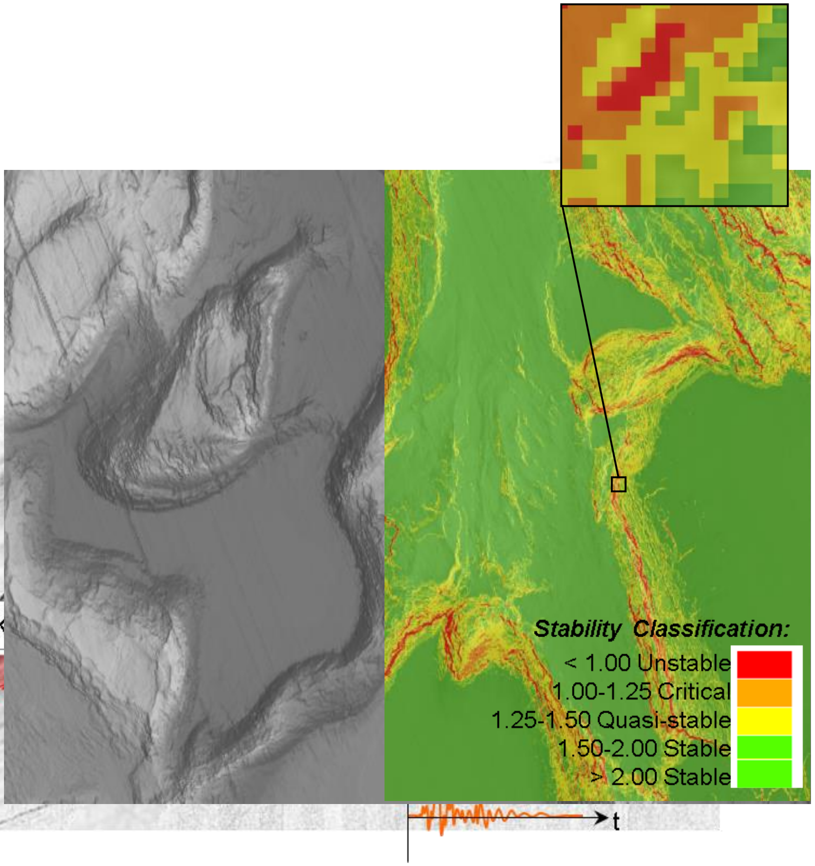
Beyond Site Characterisation



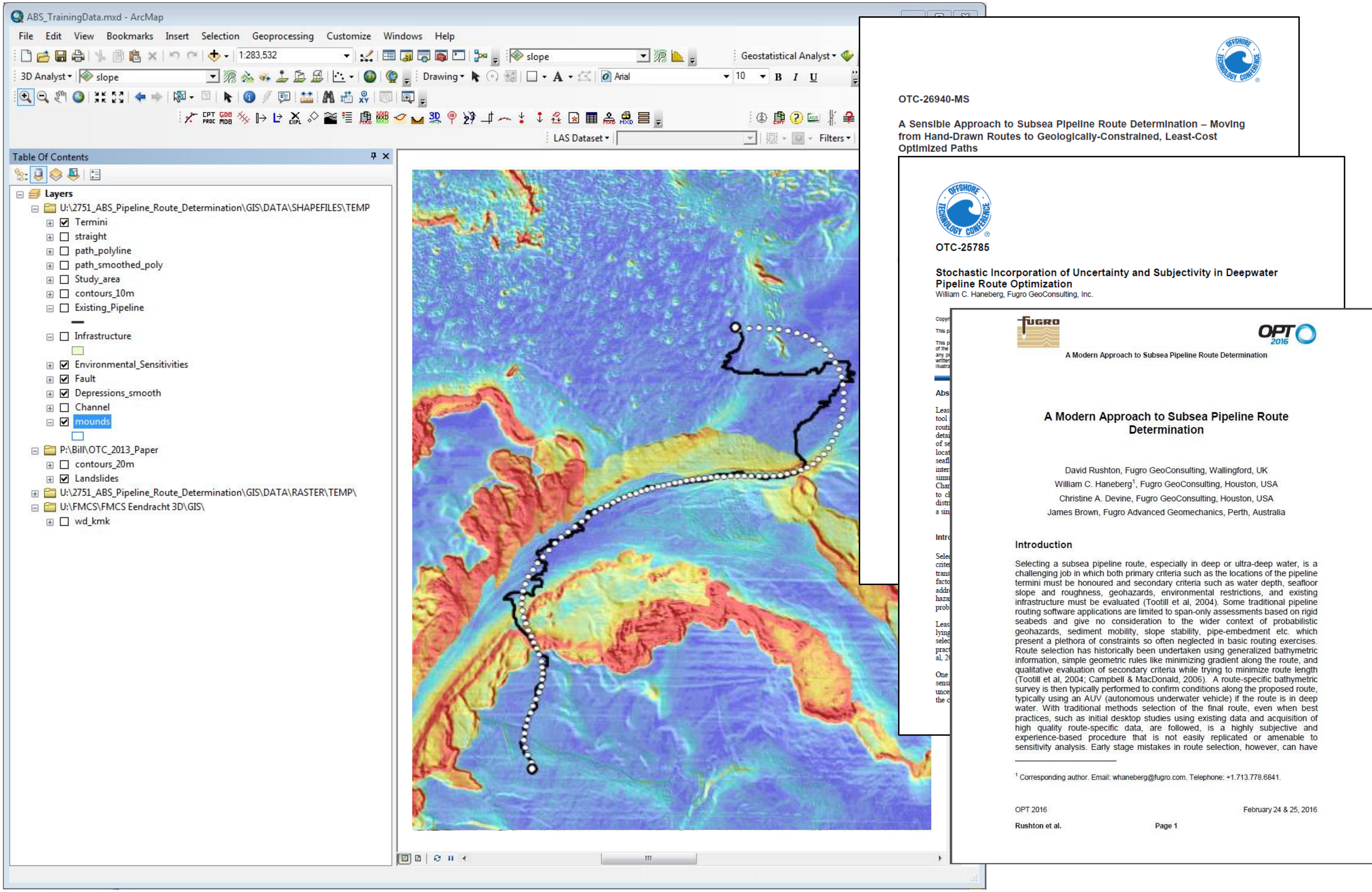
- One dimensional slope stability screening performed using GIS to rapidly assess wide areas
- The aim is to quantitatively assess the likelihood of failure of every slope across an entire site

$$FOS = \frac{s_u}{\left(\int_0^z \gamma' dz\right)\sin(\theta)\cos(\theta) + Ck_{seis}\left(\int_0^z (\gamma' + \gamma_w) dz\right)\cos^2(\theta)}$$





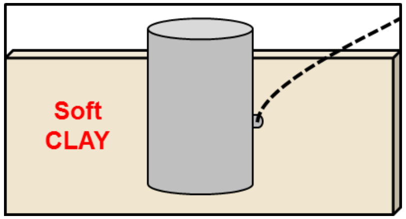
Geospatial Analysis: Cable & Pipeline Routing



Geospatial Analysis: Optimized Infrastructure Sighting

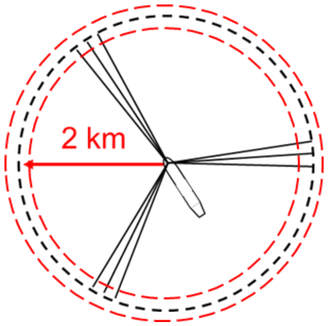
Select optimal FPSO anchor locations

- Variable seafloor
- Holding Capacity

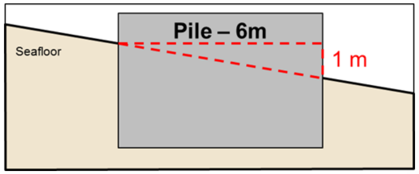


Rapidly evaluate multiple criteria

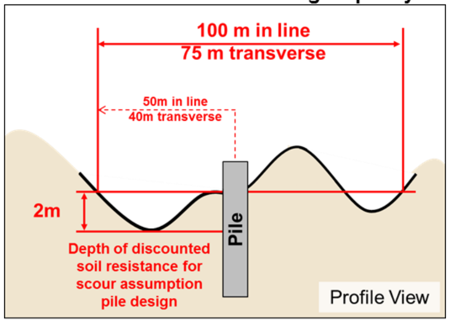
Proximity to nominal location



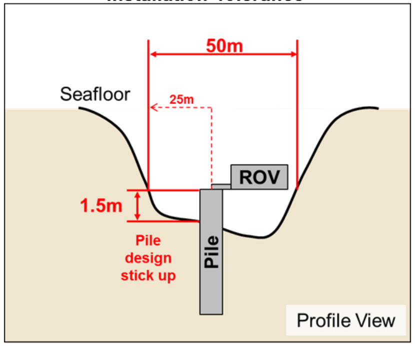
Seafloor slope

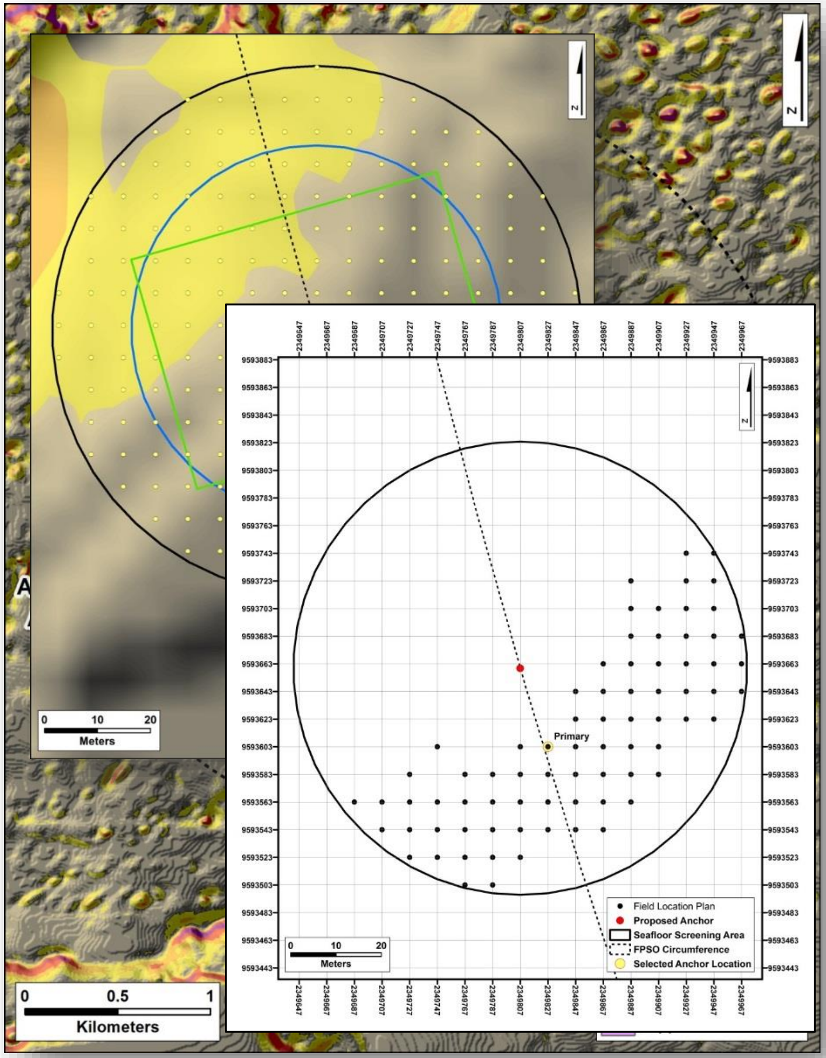


Soil Resistance – Holding Capacity



Installation Tolerance





Geospatial Analysis: Site Favourability Mapper

- Consolidating multiple data layers of varying complexity into useful information for decision making support
- Heat mapping to present favourability

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Conclusions

- The benefits of robust site characterisation are now well established throughout the industry to help in:
  - Survey and site investigation planning
  - Subsequent engineering analyses and decision making
- Site characterisation reduces uncertainty and minimises risk
- Failure to integrate can lead to inconclusive or conflicting conclusions
- The level of integration required for thorough site characterisation is not possible without a highly functional spatial platform such as ArcGIS with which to perform this data integration.

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Thank you