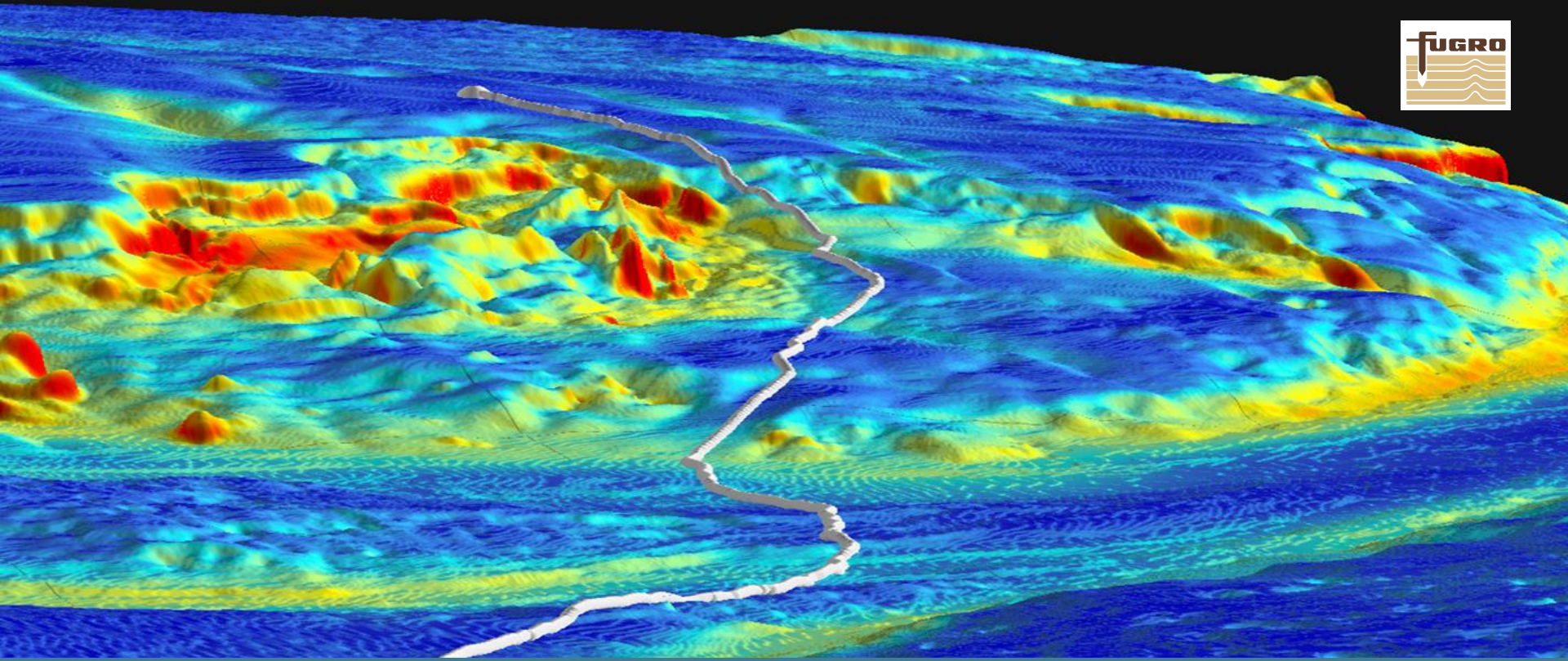


GIS Techniques to Meet Offshore Pipeline Routing Challenges

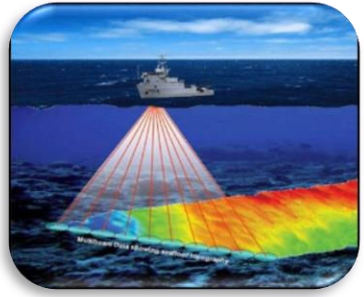
Christine Devine, Fugro

AOG, March 2019

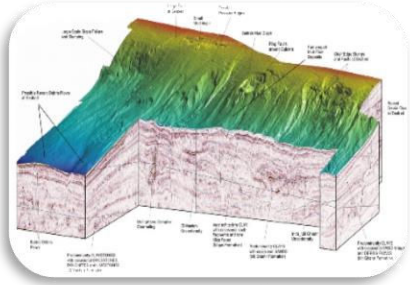
Outline

- GIS and How it is Used
- Geohazard Examples
- Automated Mapping Techniques
- Pipeline Route Optimization Workflow
- Composite Map Development
- Least Geocost Pipeline Routing Analysis
- Summary

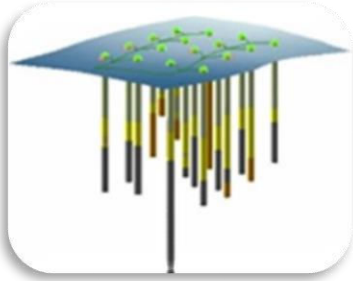
GIS and How it is Used



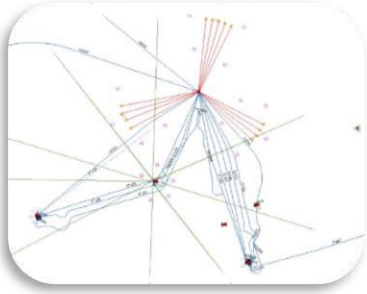
Geophysical Data



Geological Data

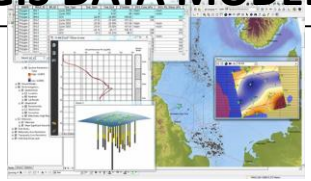


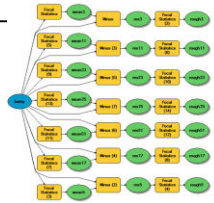
Borings and In Situ Data



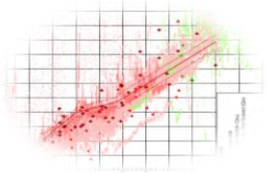
Infrastructure

GIS DATA MODEL

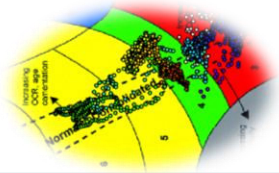




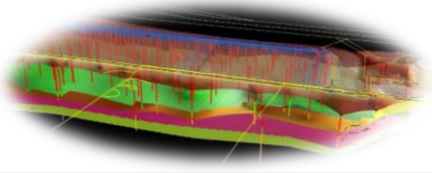
Integrated Geohazards Assessment and Site Characterization



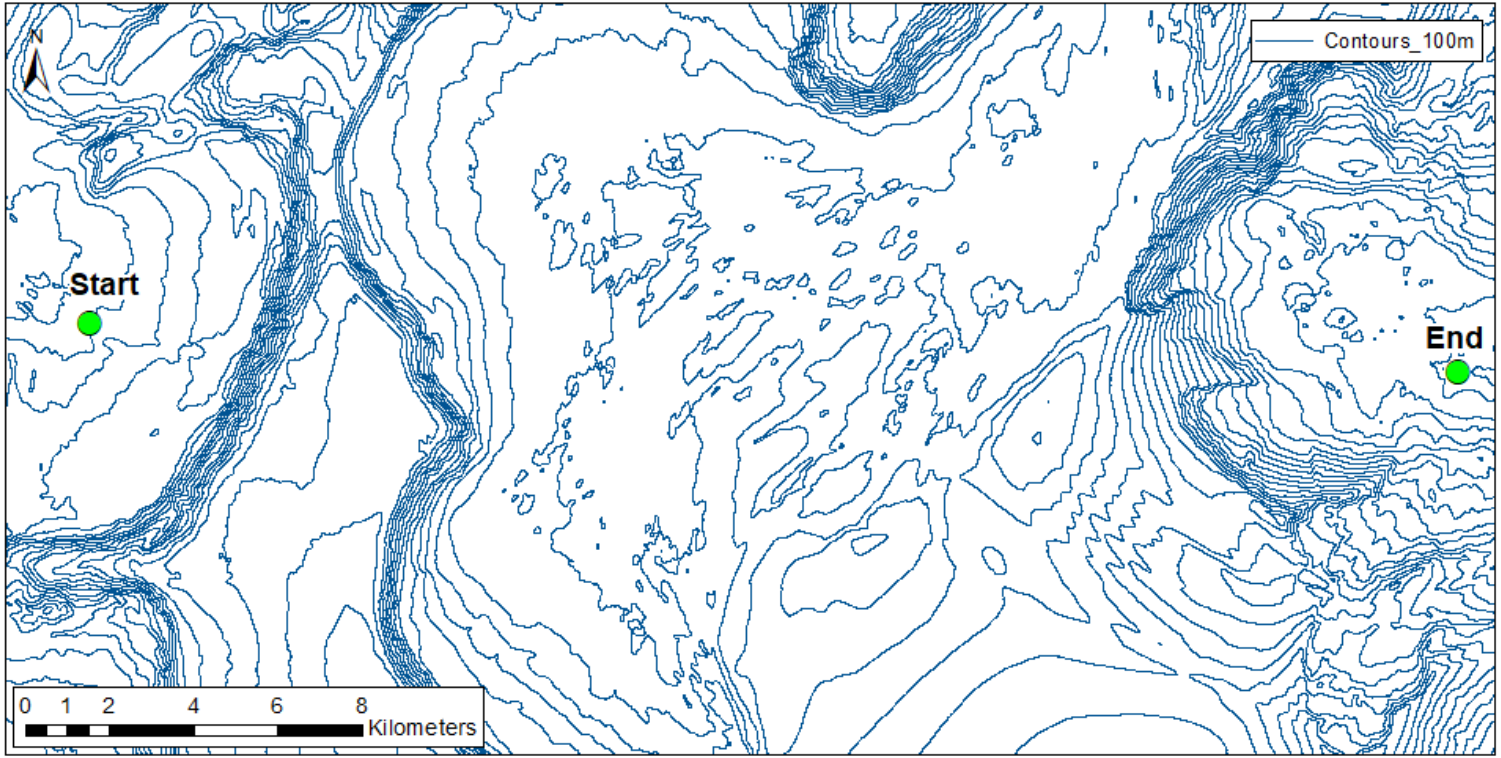
Geophysical Site Clearance Studies & Drilling Hazards Assessments



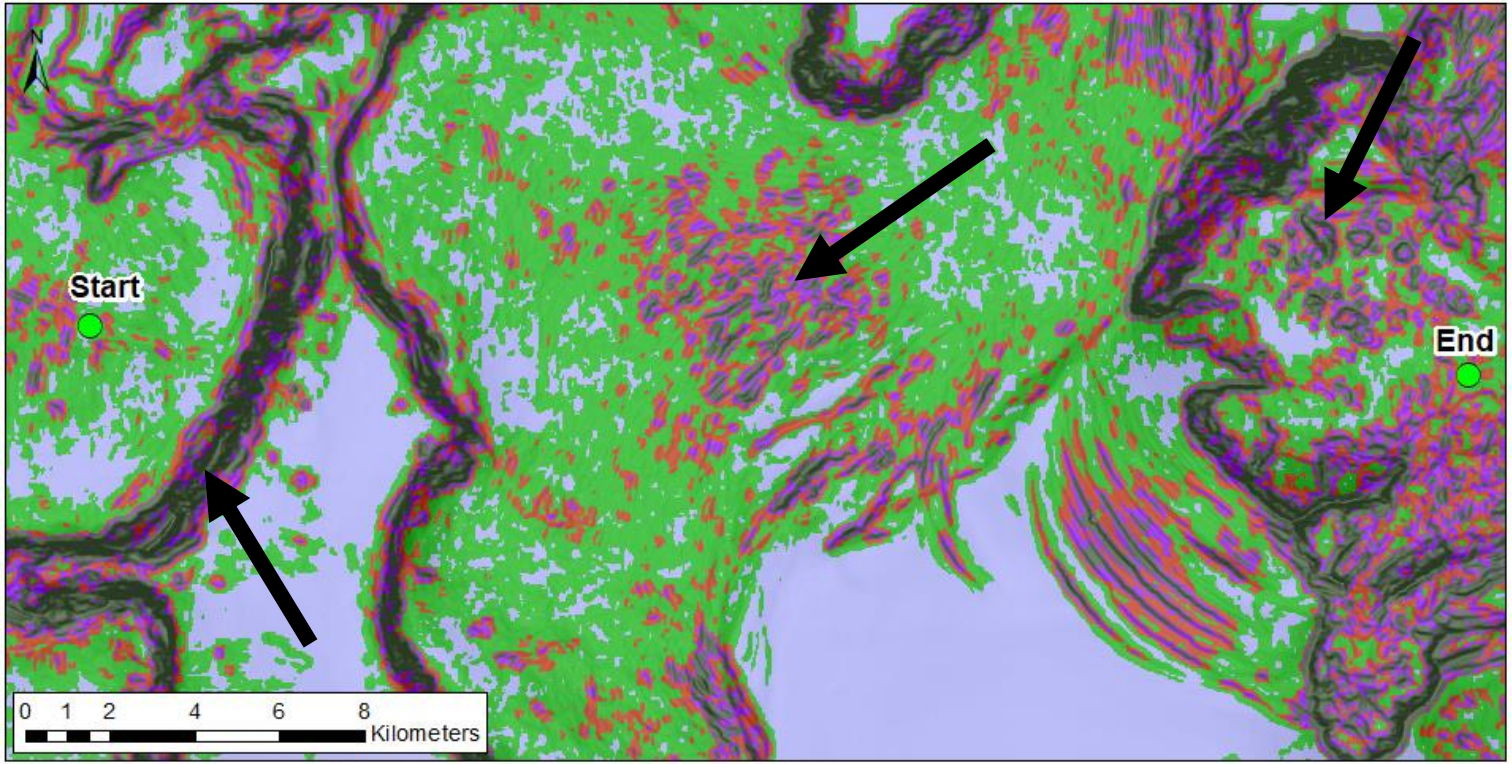
Engineering Design Services Foundation, Sediment Transport, Construction Planning, Pipeline Planning



Seafloor Based on Bathymetry Contours



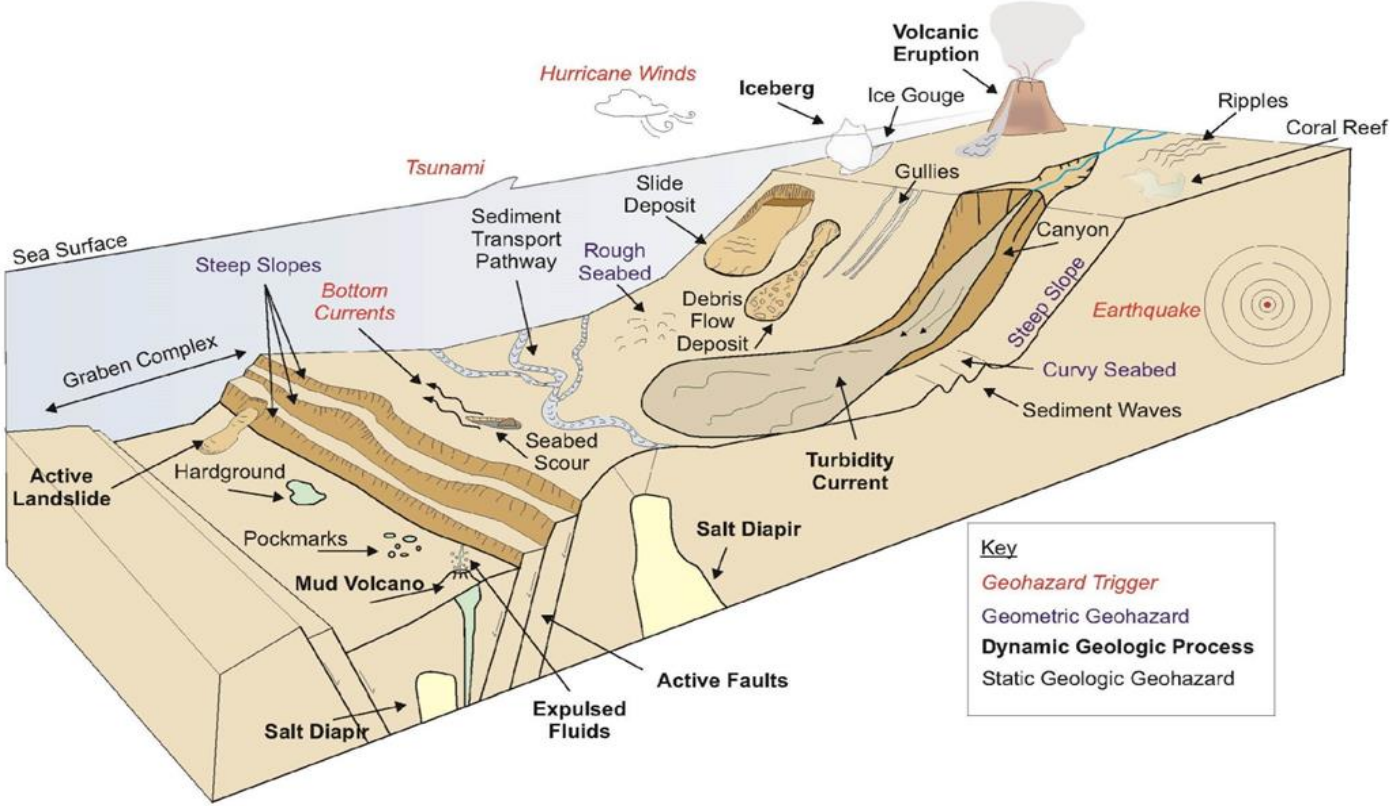
Seafloor Based on Derivative Map (e.g. Slope, Roughness)



Geological Hazards and Constraints

<u>Dynamic</u>
Debris flows
Turbidity currents
Landslides
Faults
Icebergs

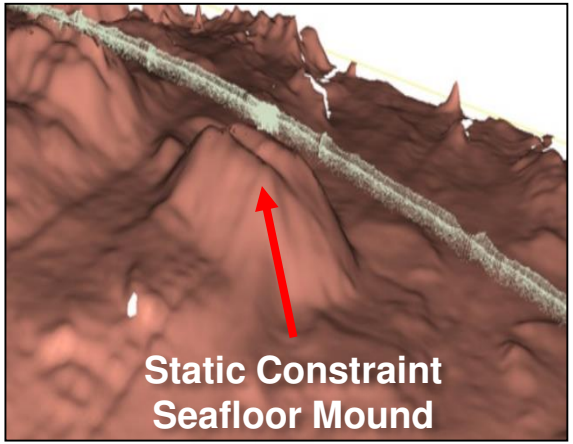
<u>Static</u>
Debris deposits
Landslide deposits
Canyons
Pockmarks
Channels
Gullies/Gouges
Ridges/Mounds

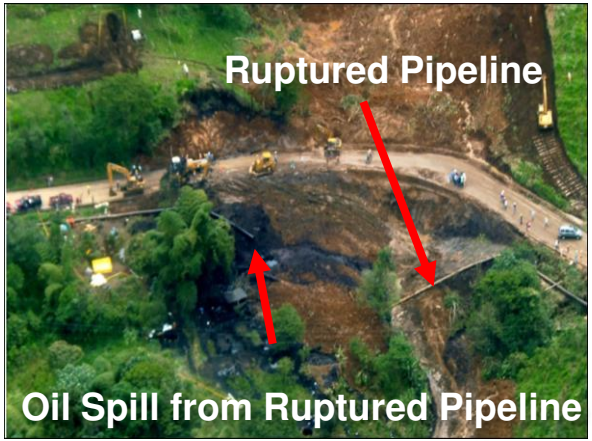


Static Constraints, Dynamic Hazards, and Effects on Pipelines

Static Constraints Effects on Pipeline
• Free-spans • Overstress • Shortening or buckling • Differential embedment

Dynamic Hazards Effects on Pipeline
• Displacement • Burial • Scour • Rupture



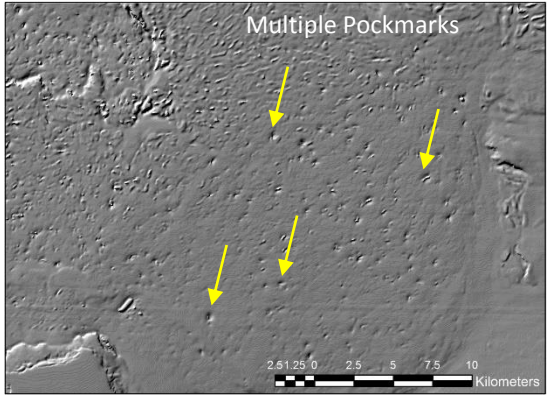


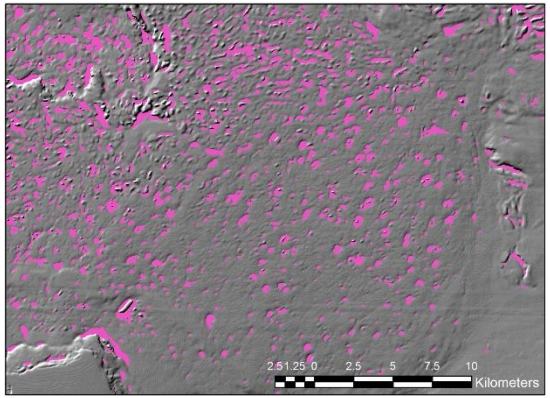
GIS Automated Mapping

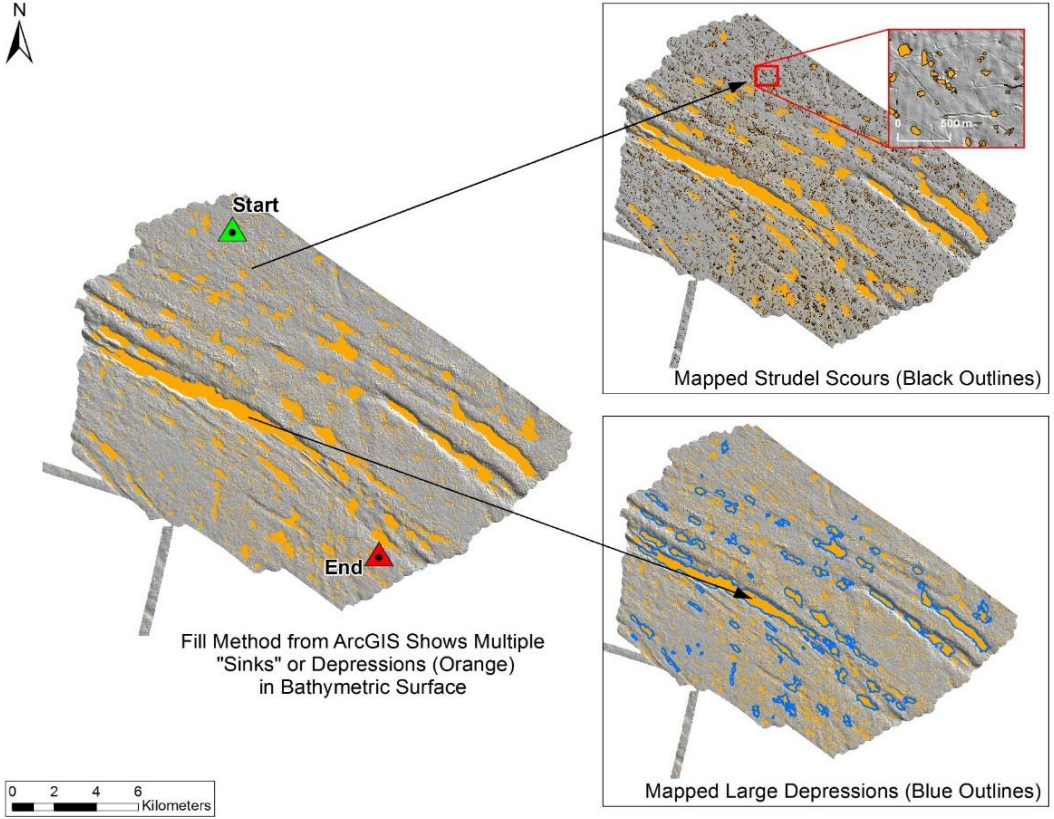
Automated mapping can quickly and efficiently map various geological features to:

- Obtain the size, shape, and spatial extent of features to understand the past or present geological setting and depositional processes and to predict future geologic events.
- Identify geological hazards and the potential risk they may pose to the public, infrastructure, or the environment.
- Identify zones (i.e. exploration) of potential economic significance such as oil and gas or mineral commodities.
- Accommodate specific client requests to identify features of interest

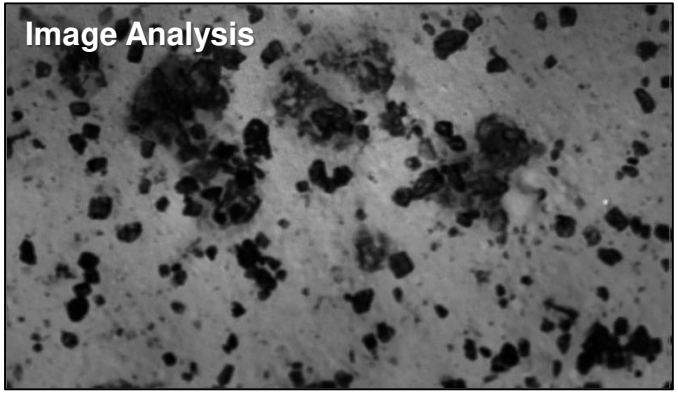
Automated Feature Mapping (Depressions, Pockmarks etc.)

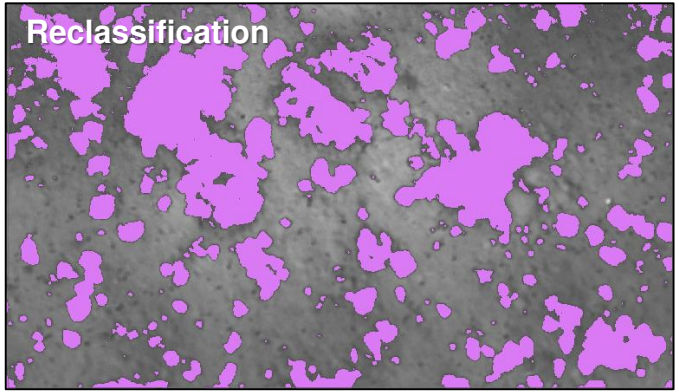


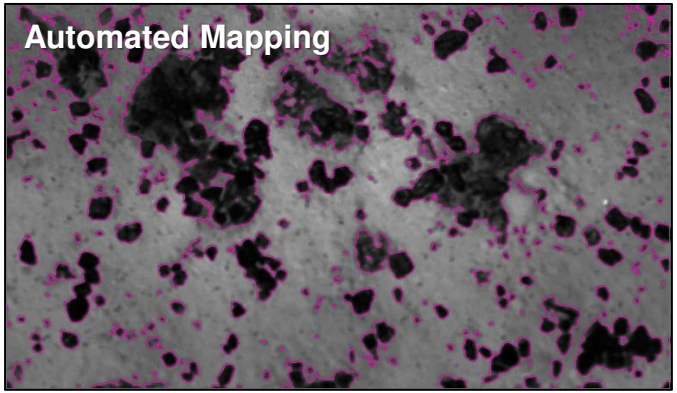


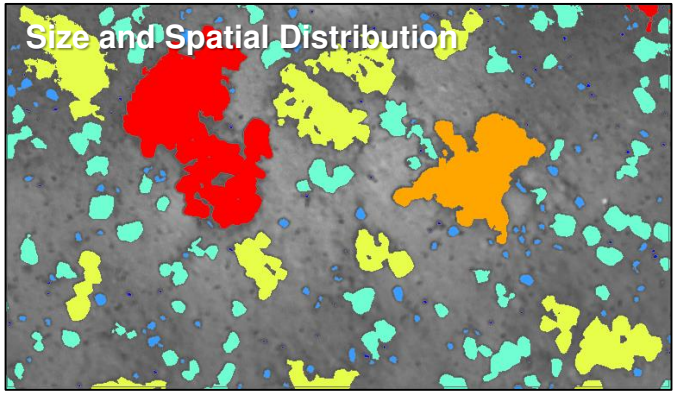


Automated Feature Mapping (Boulders, Mounds, etc.)

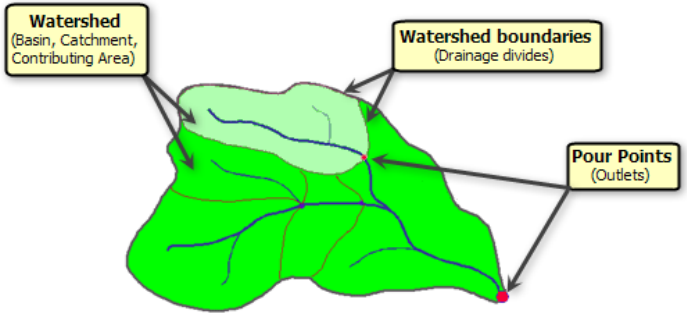




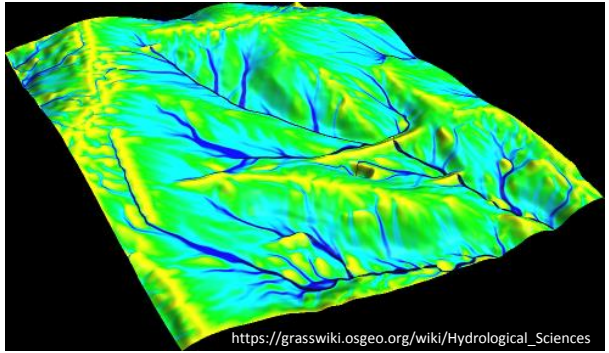




Automated Feature Mapping (Channels, Gullies, etc.)

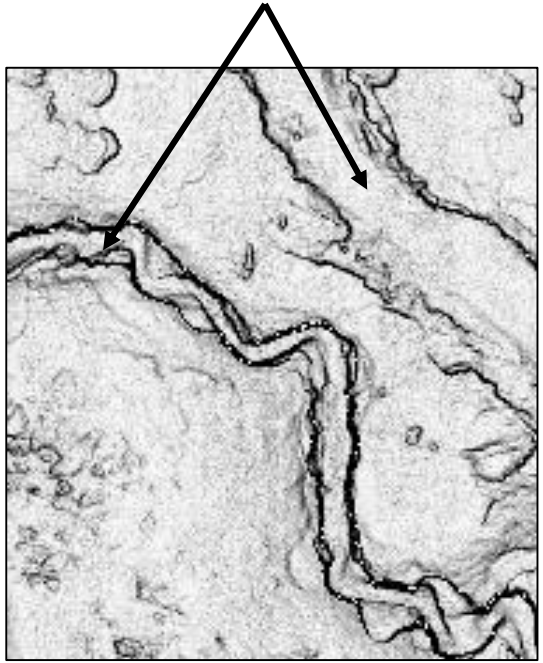


http://webhelp.esri.com/arcgisdesktop/9.3/printBooks_topics.cfm?pid=6050

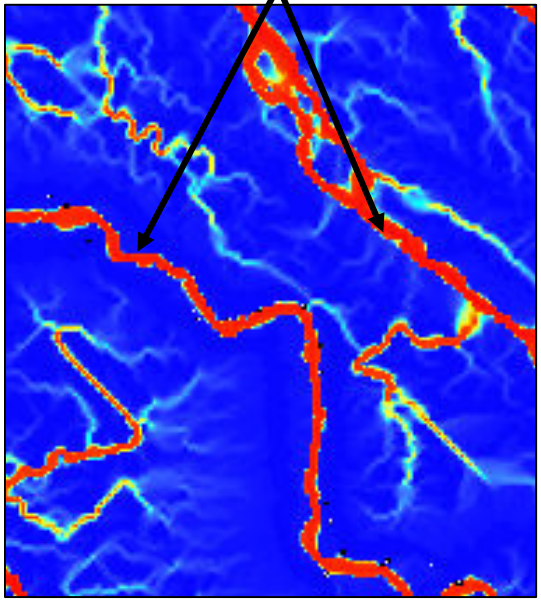


https://grasswiki.osgeo.org/wiki/Hydrological_Sciences

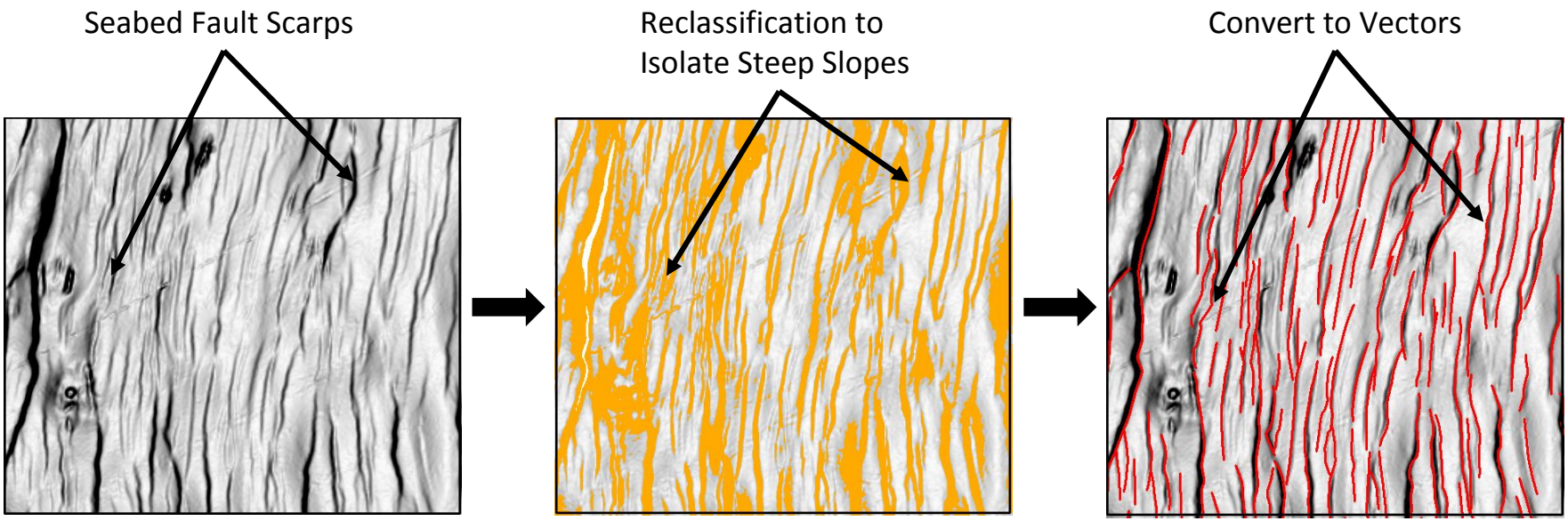
Subsea Channel Networks



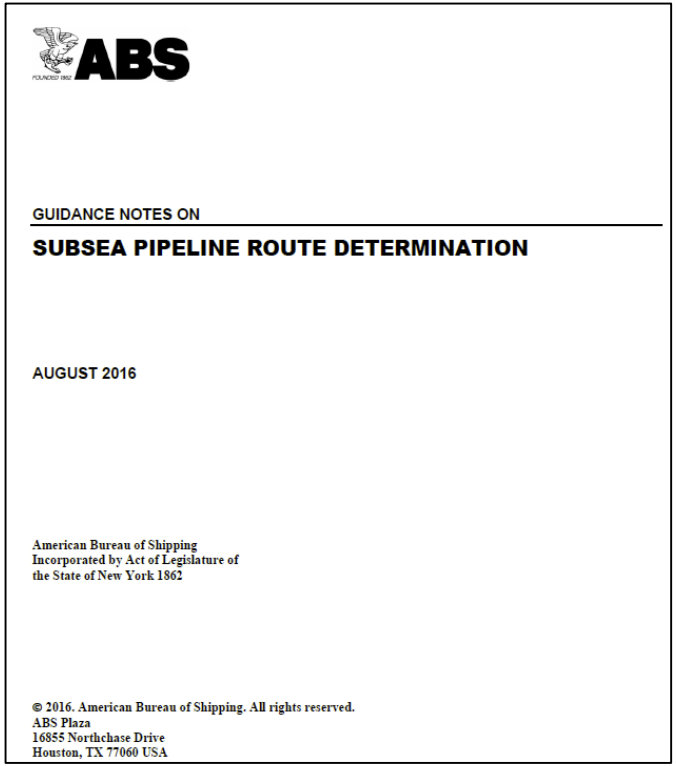
Refined and Mapped Thalwegs



Automated Feature Mapping (Faults, Linear Bedforms, etc.)



Pipeline Route Optimization Workflow



ABS

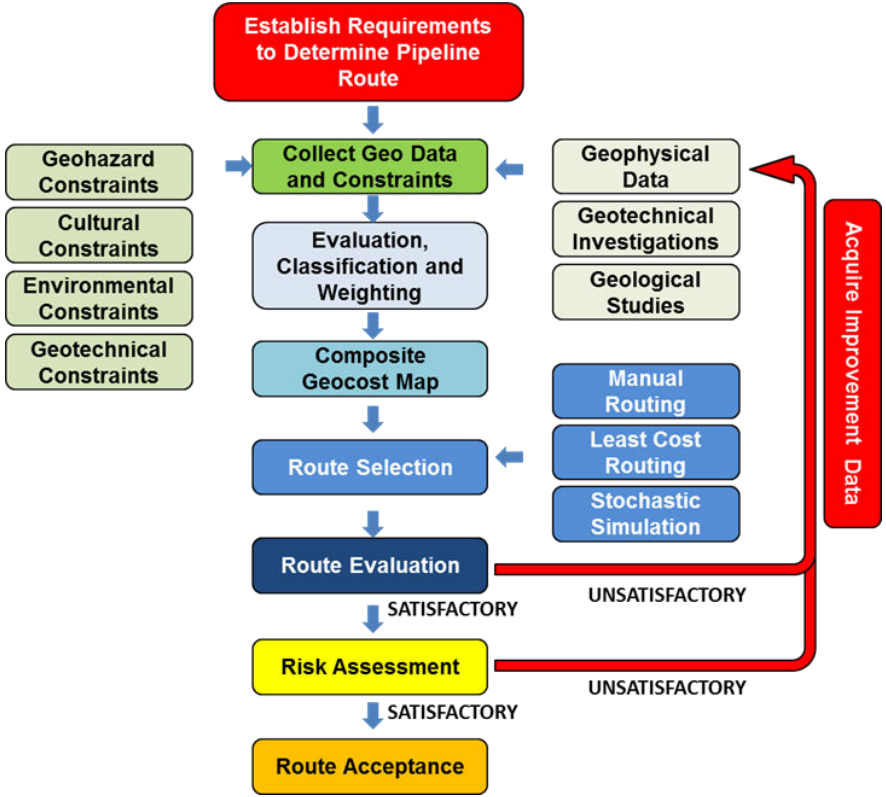
GUIDANCE NOTES ON

SUBSEA PIPELINE ROUTE DETERMINATION

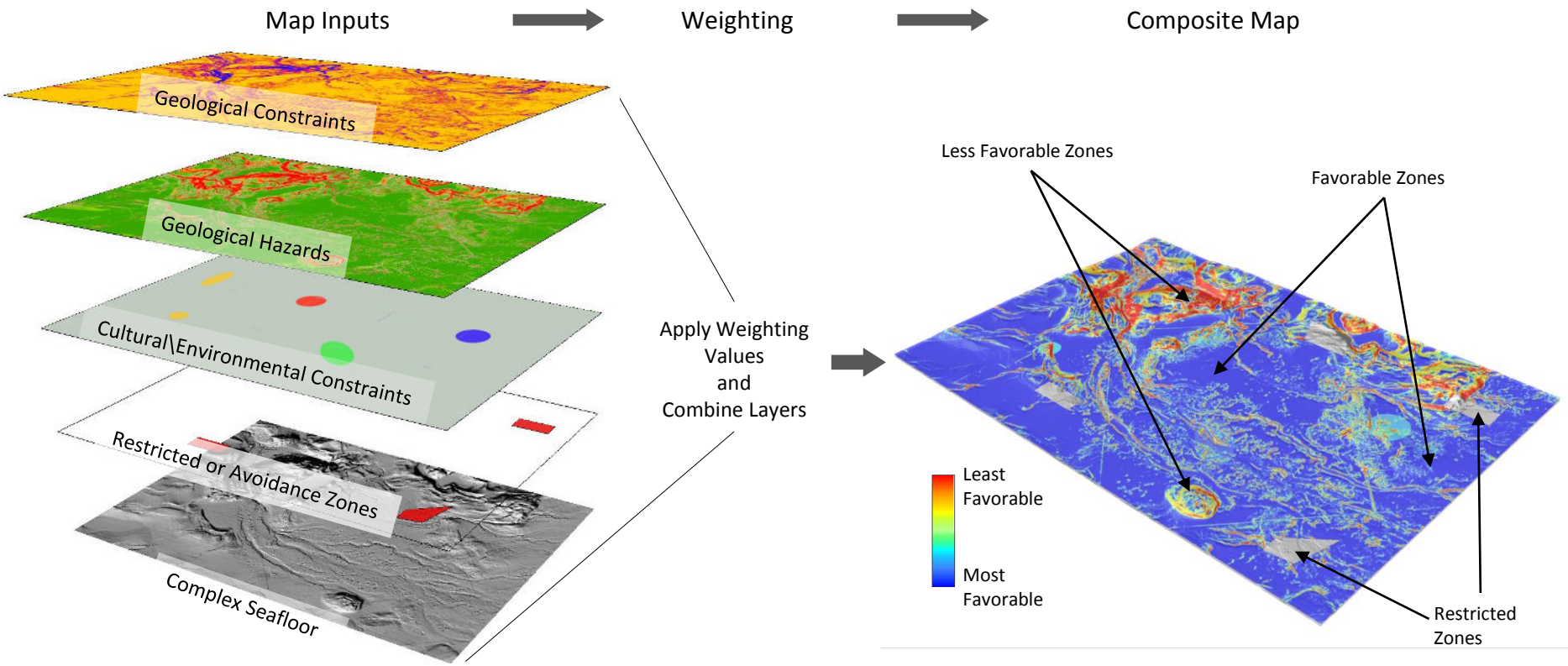
AUGUST 2016

American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

ABS Plaza
16855 Northchase Drive
Houston, TX 77060 USA



Composite Map Development



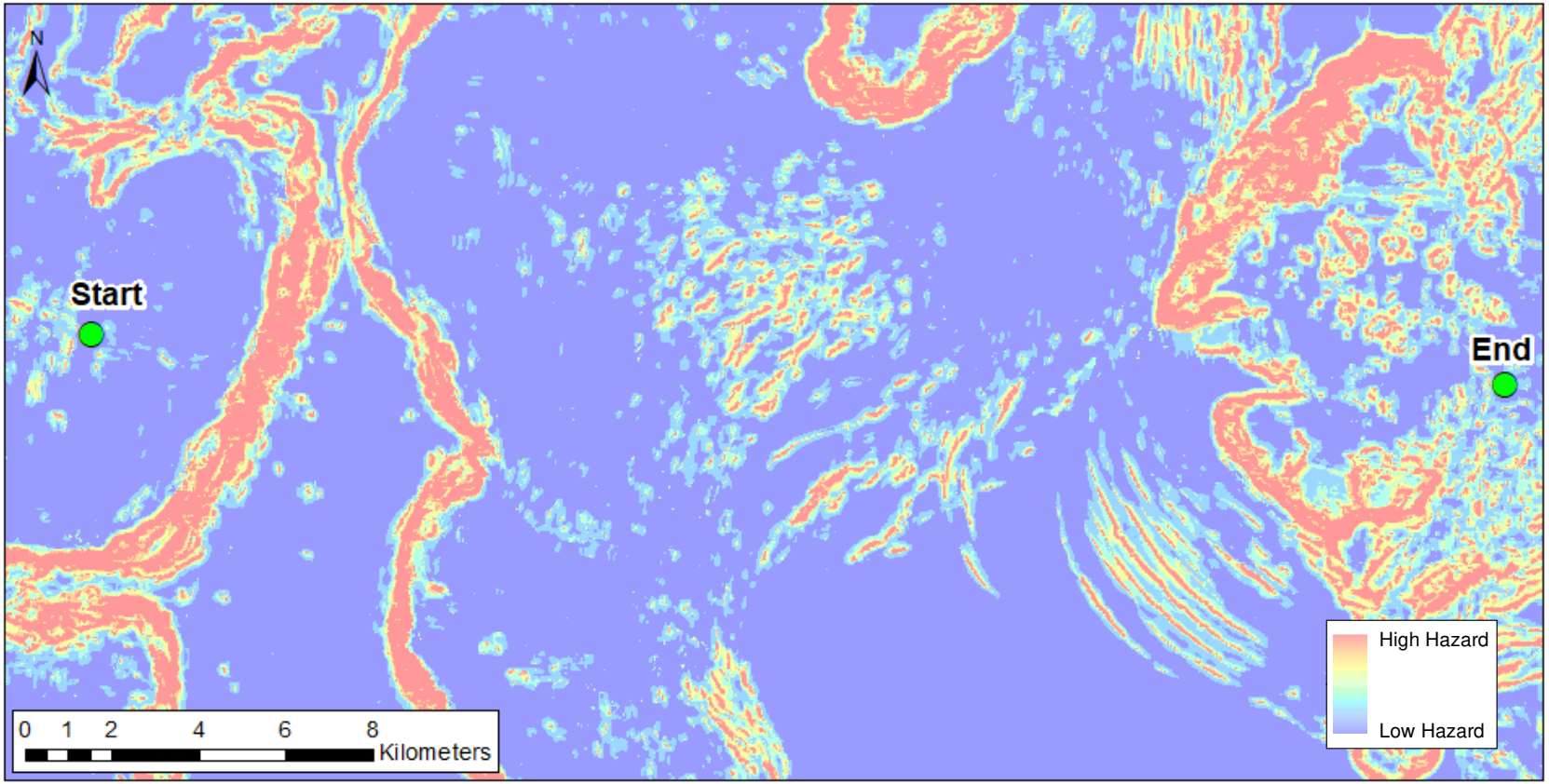
Weighting

- Geohazards, cultural and ecological constraints can be classified and weighted after they have been mapped.
- Values (e.g. 1 to 10) are arbitrary.
- All geohazards must comply with a consistent numerical assignment based on the potential severity and likelihood of future occurrence as they may impact the performance or safety of seafloor infrastructure.
- Weights should be developed by an interdisciplinary team with expertise in geology, engineering, and development.
- Because each project will be different, not all hazards will be encountered in all projects nor will they always receive the same weights.

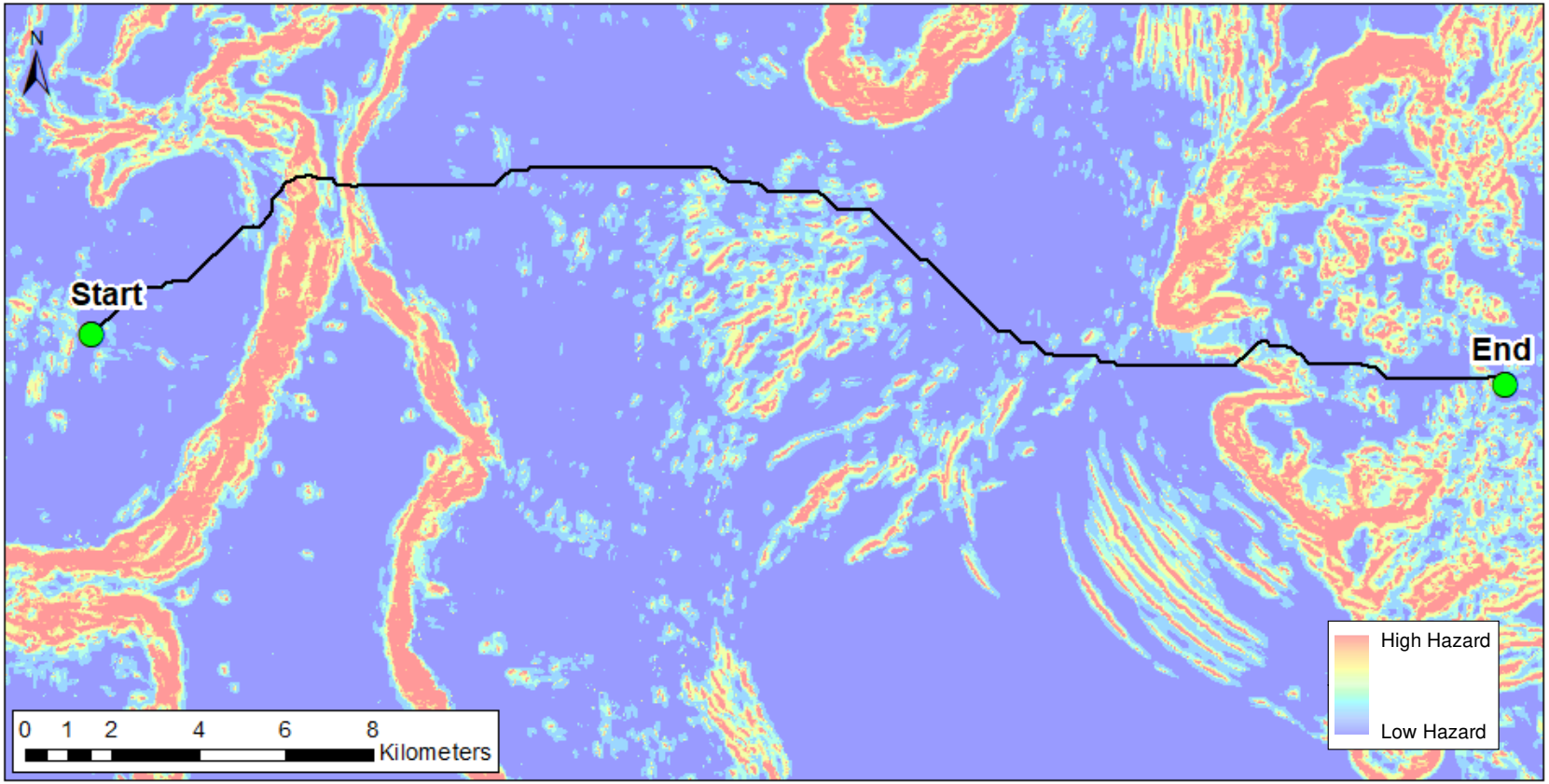
*Geohazard Weight**	*Hazard Level*	*Geohazard Example - Landslide Deposit*
1	Negligible	Smooth surface, inferred to be geologically very old, radiometric age dates suggest no geologically recent movement.
2	Low Hazard	Smooth surface, inferred to be geologically old, no radiometric data available.
3		
4		
5	Moderate Hazard	Rough surface, inferred to be geologically young, geological evidence (seafloor fractures) suggests movement in the past 11,000 years.
6		
7		
8	High Hazard	Rough surface, inferred to be geologically very young, radiometric age dating suggest evidence of geologically recent movement, geological evidence of recent movement (numerous seafloor fractures).
9		
10		
N/A	Impermissible Zone	Geological evidence suggests frequent occurrence of landslides, area deemed to be impassable.

From ABS Guidance Notes on Subsea Pipeline Route Determination

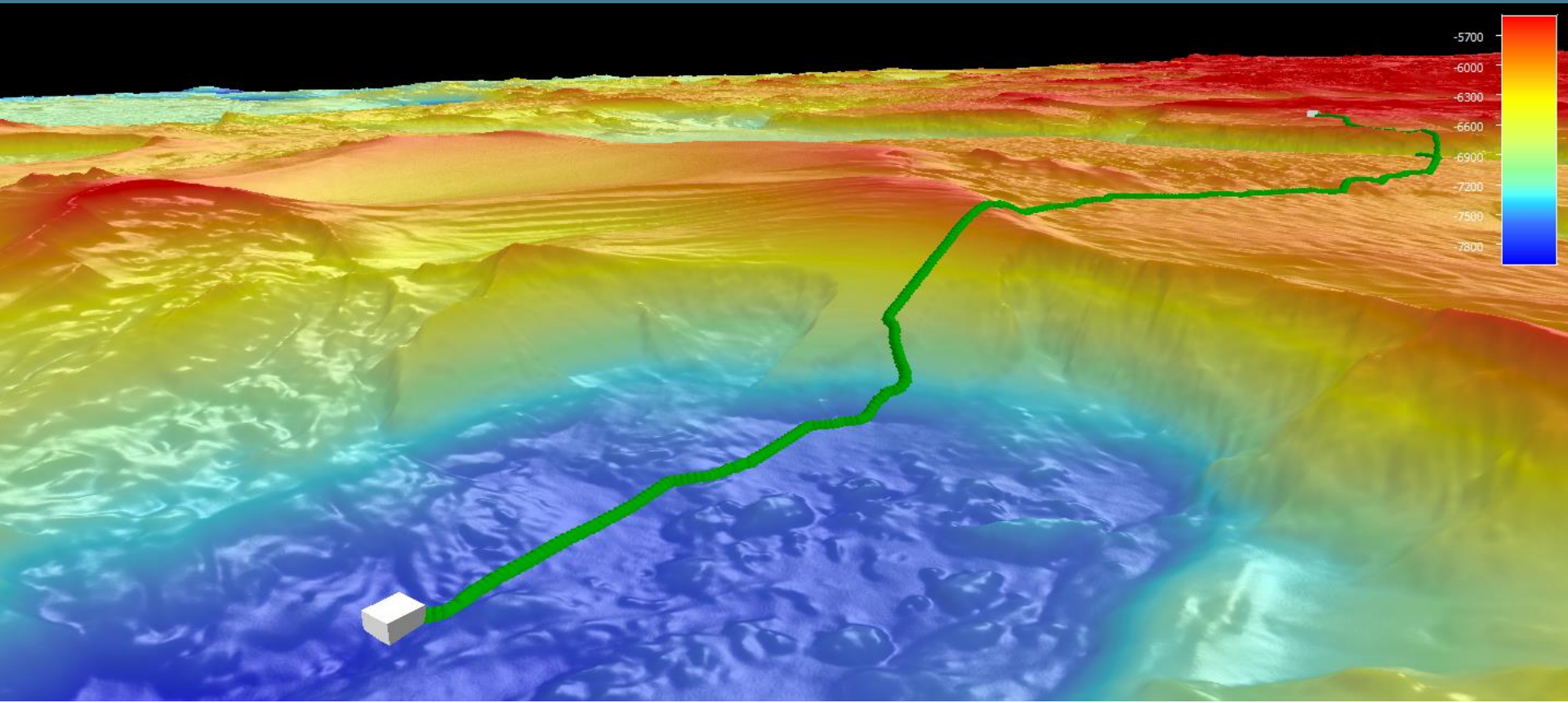
Least-Geocost Pipeline Routing



Least-Geocost Pipeline Routing



Pipeline Route Results



Summary

- Data can be housed in a GIS data model for access to multi-layered project information and techniques and tools can be used in GIS to accommodate specific client needs.

- Geohazards are everywhere and need to be identified, defined, and assessed to fully appreciate the risk to project development.

- Automated mapping techniques can quickly and efficiently map various geological features / geohazards.

- GIS techniques such as pipeline route optimization are important for to meet client needs and objectives in complex geological environments.

Thank you!

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Fugro Australia Marine

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