
Onshore Pipeline Engineering Course

Advanced Remote Sensing Techniques

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Overview

History of
Remote
Sensing

Principals of
Satellite
Imagery and
Interpretation

Remote
Sensing
Applications

Digital
Elevation
Models

DEM
Applications

Satellite Imagery

History of Remote Sensing

First Remote Sensing Satellites:

Explorer VII – October 1959

Landsat 1 – July 1972

Resolutions:

Landsat 1: 60

WorldView: 0.5m



Satellite Imagery

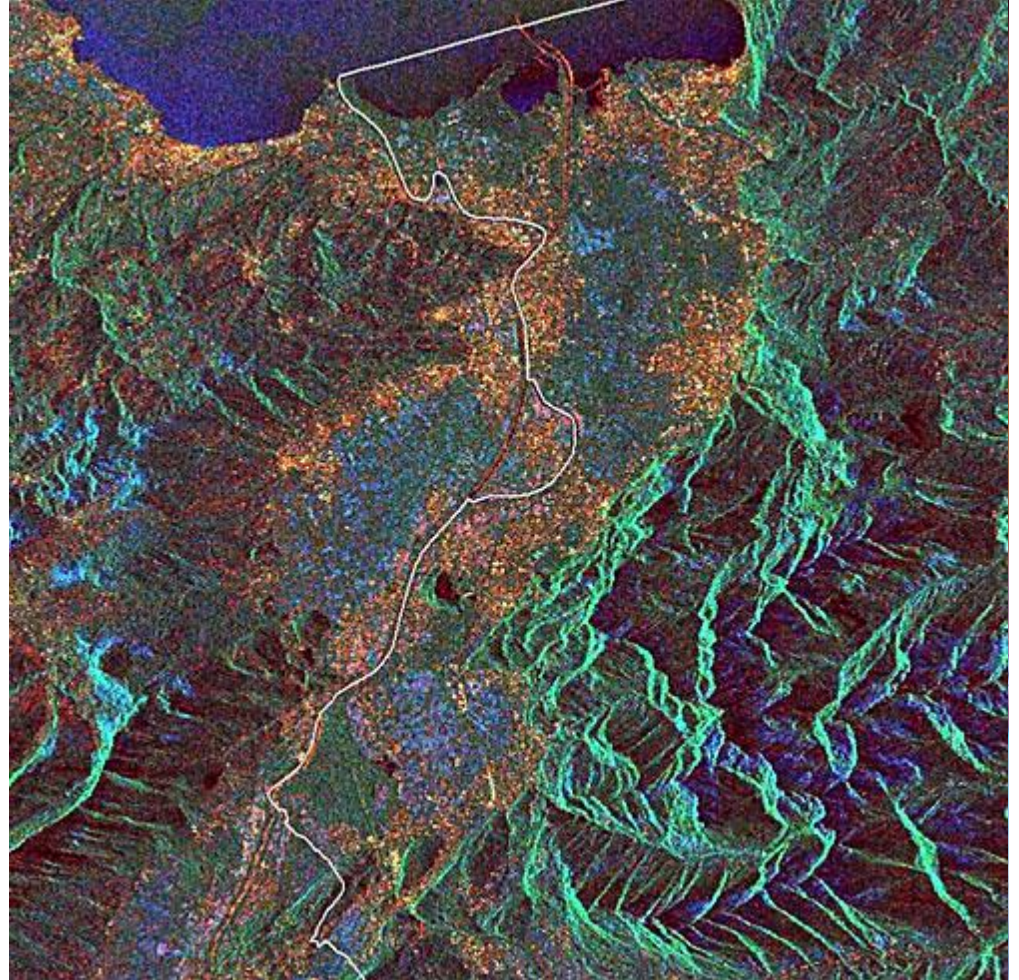
Types of Sensors

Passive:

Optical, Thermal / IR

Active:

Radar, InSAR, LiDAR



Satellite Imagery

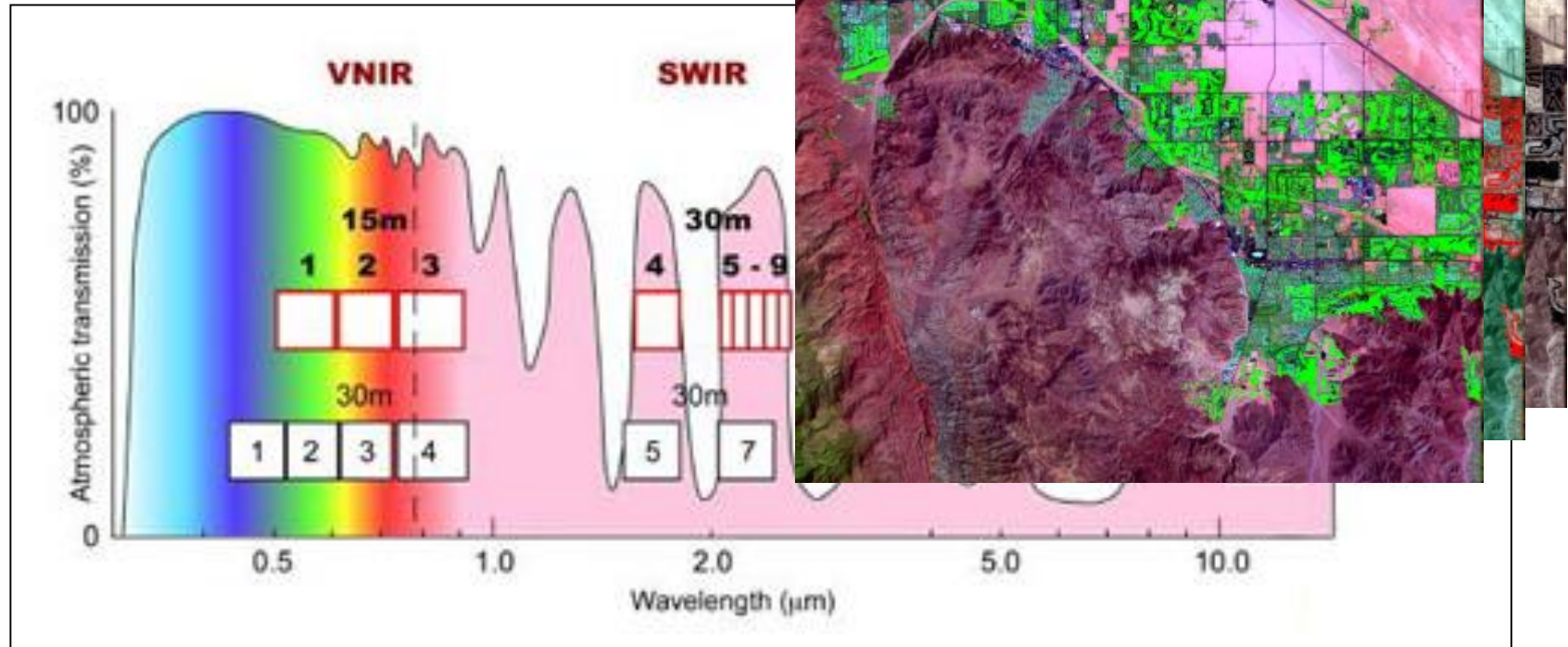
Imagery Resolutions

Project Stage	Scale	Image Resolution	DEM Resolution
Feasibility	1: 500 000 – 1: 100 000	142.5m – 15m	90m
Front End Engineering Design	1 :50 000 – 1: 10 000	15m – 2.5m	30m – 20m
Detailed Design	1:10 000 – 1: 2 000	2.5m – 70cm	1m
Monitoring	Various	Various	Various

Satellite Imagery

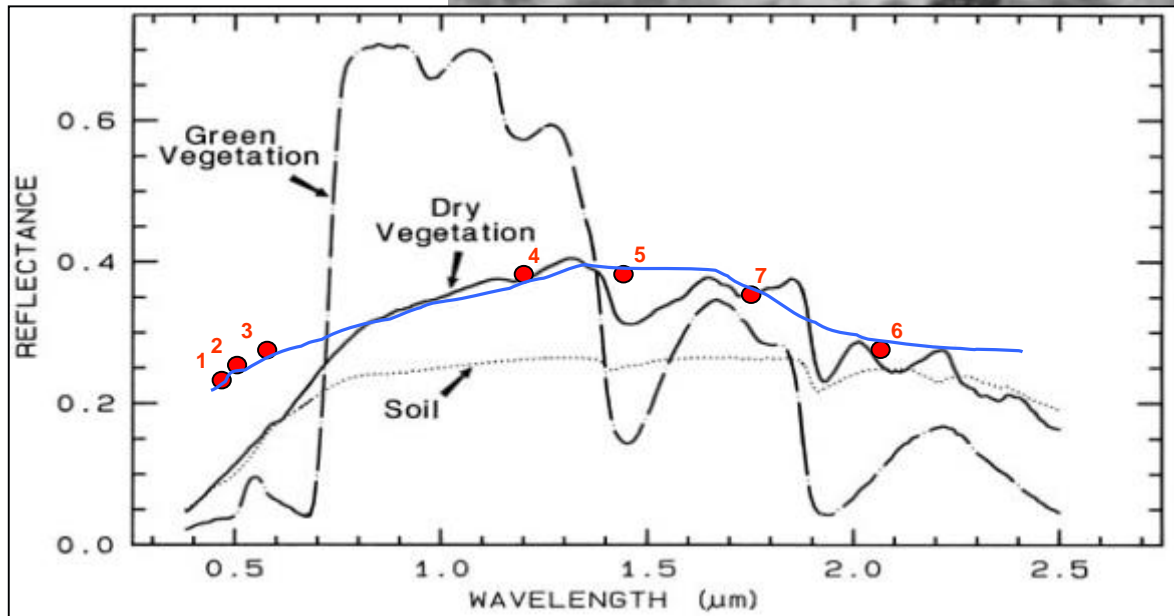
Image Interpretation

- Operating Bands
- Band Combination



Satellite Imagery

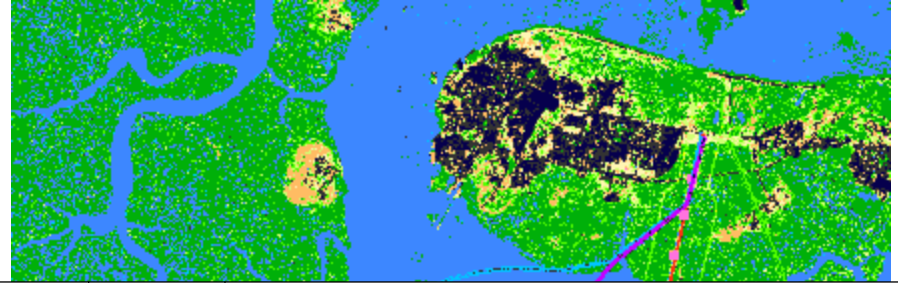
Image Interpretation



Remote Sensing Applications

Environmental Mapping

- Classification based on environmental importance
- Automatically measuring affected area of each class
- Saving time on environmental assessment of pipeline route

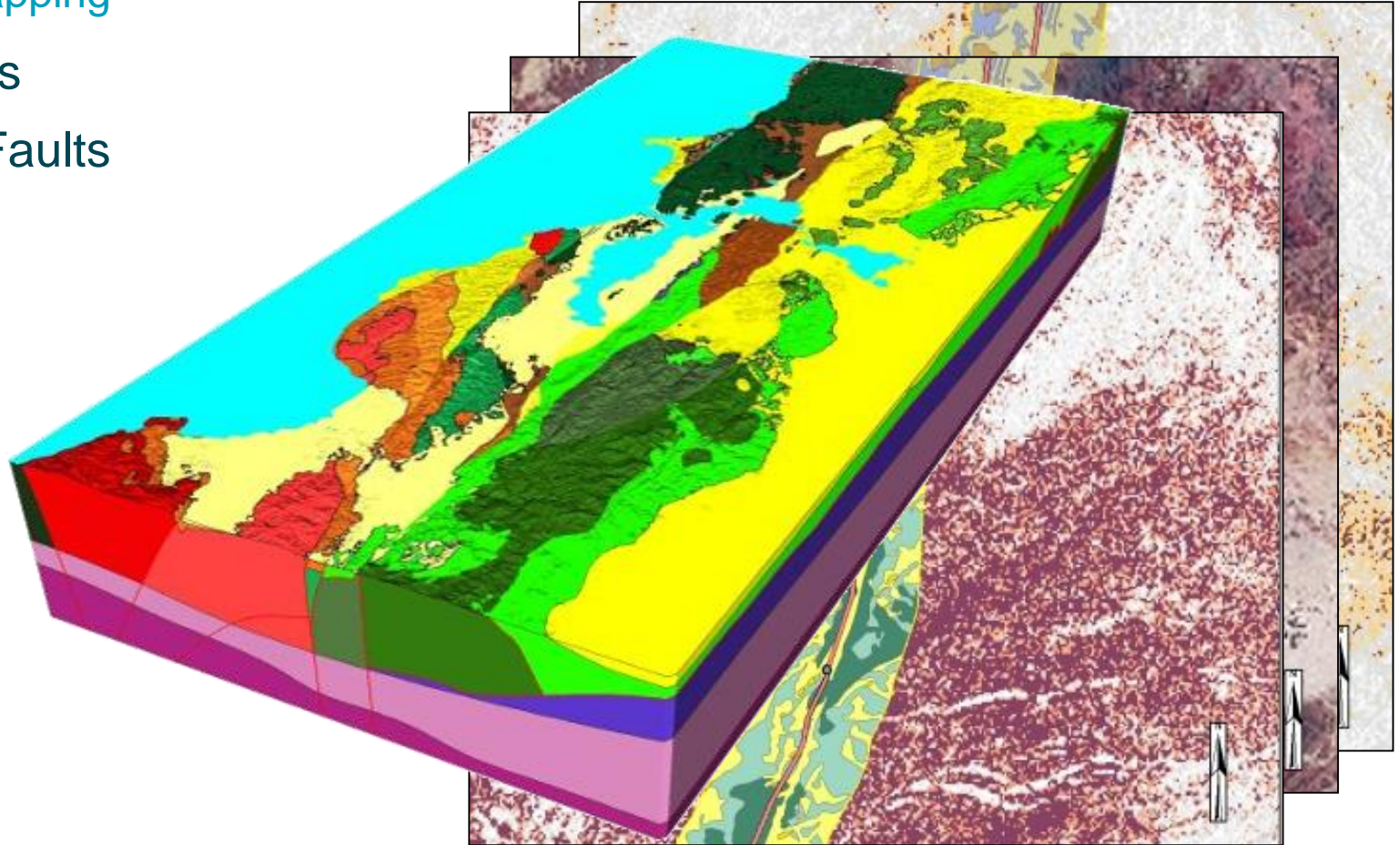


Routes	Length (m)	Land Cover Area (Sq.km within 200m Corridor)				
		Mangrove	Grassland	Water	Bare soil	Built-up
Option-1	9955.93	1.77	0.48	0.46	1.29	0.08
Option-2	7698.93	1.00	0.21	1.72	0.13	0.11
Option-3	7377.7	1.38	0.30	0.52	0.79	0.06

Remote Sensing Applications

Geological Mapping

- Soil Types
- Surface Faults



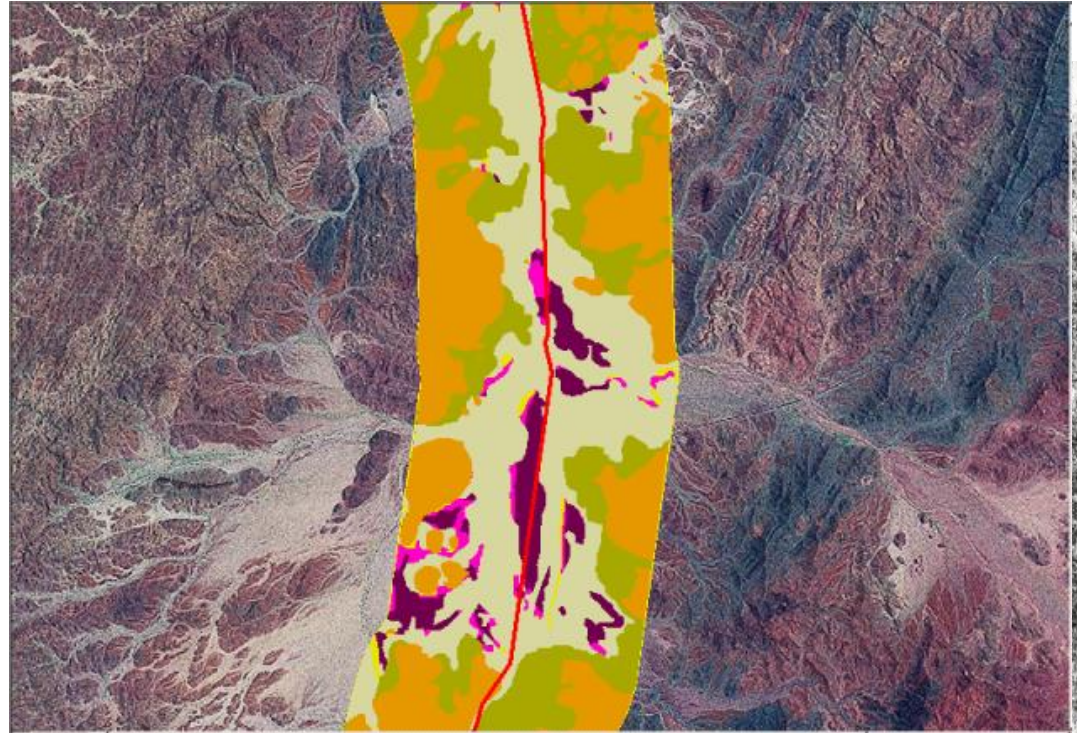
Remote Sensing Applications

Rock Mapping

- Radar penetrates into the topsoil layer, down to 1m approx.
- Rock outcrops and shallow rocks detected.
- Buried pipelines detected along the route.

Result

- Less number of trial pits and soil samples required
- Geotechnical investigation works shortened by 6 months.
- Cost of Geotechnical investigation reduced by \$1.5m.



Remote Sensing Applications

Leak Detection with Thermal Imaging

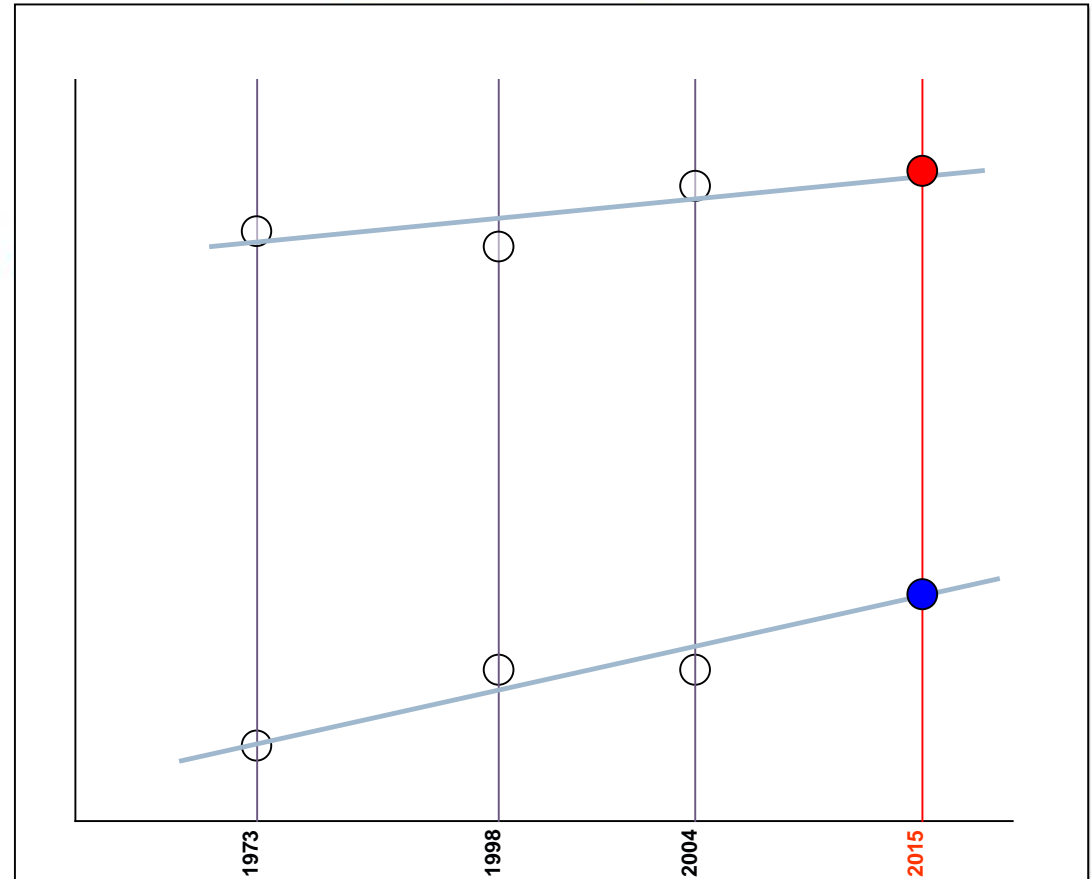
- Thermal imagery sensors: Airborne, ground-based, satellite
- Can detect temperature difference of less than 1°C
- Detects pipelines due to temperature difference
- Detects smallest leak and indicates extent of the plume



Remote Sensing Applications

Riverbed change detection

- Use of historical imagery
- Crossing width measurement



Digital Elevation Model

Stereo Pairs

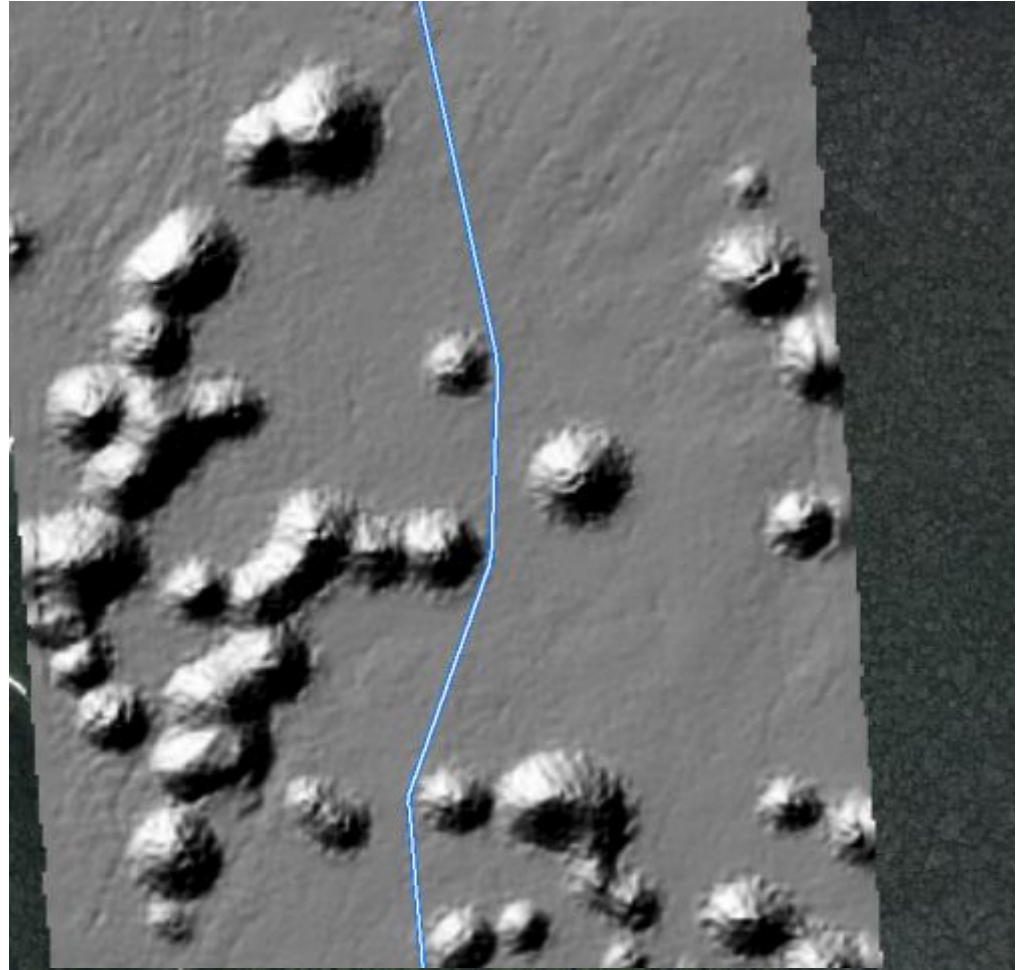
- 2~100m grid size
- Suitable for all project phases

Radar

- 30~90m grid size
- 10~20m vertical accuracy
- Suitable for Feasibility and Pre-FEED

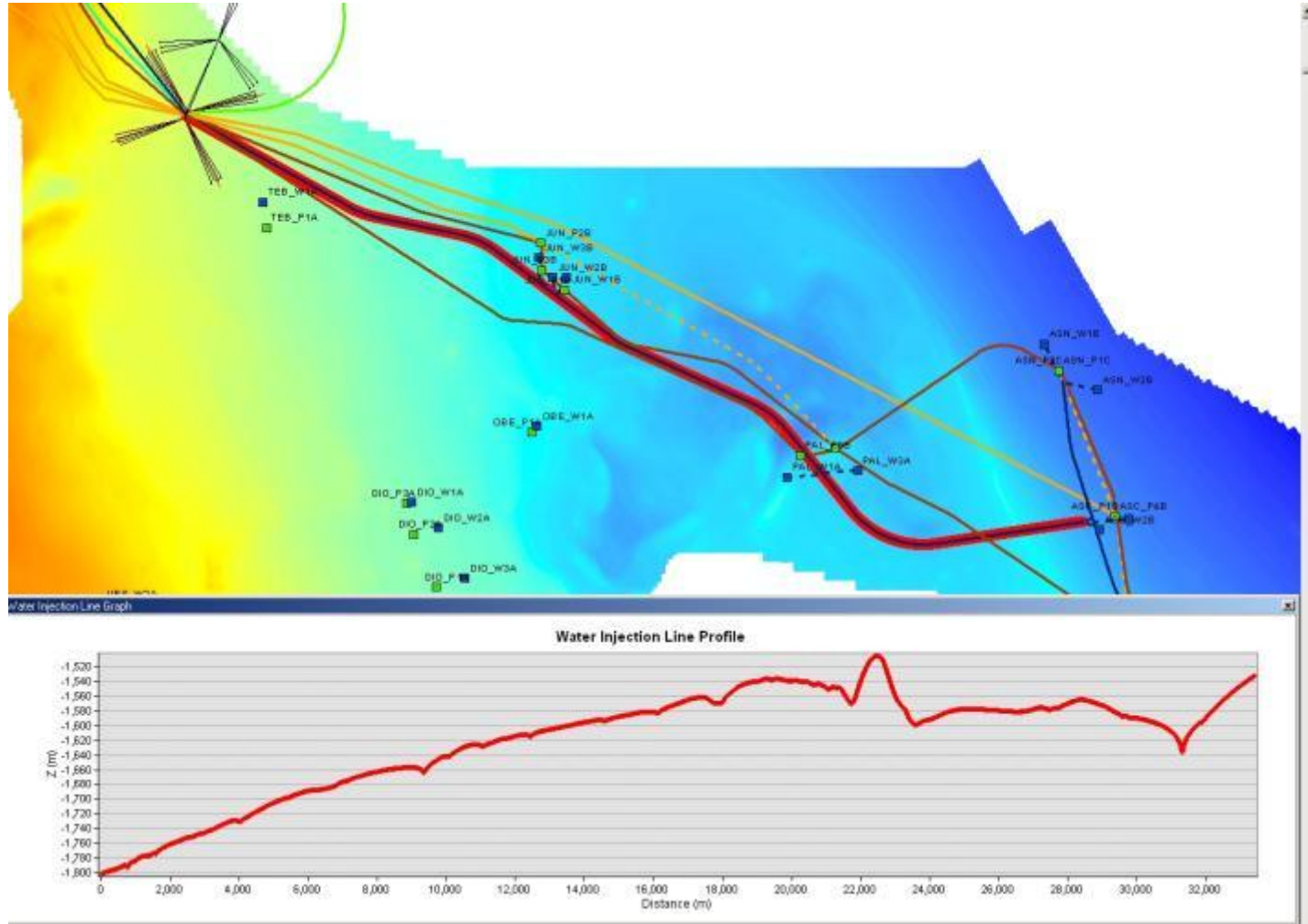
LiDAR

- < cm vertical accuracy
- < m grid size
- The only solution for dense forests
- Enables Geology interpretation
- Suitable for Detail Design



Developing DTM Data

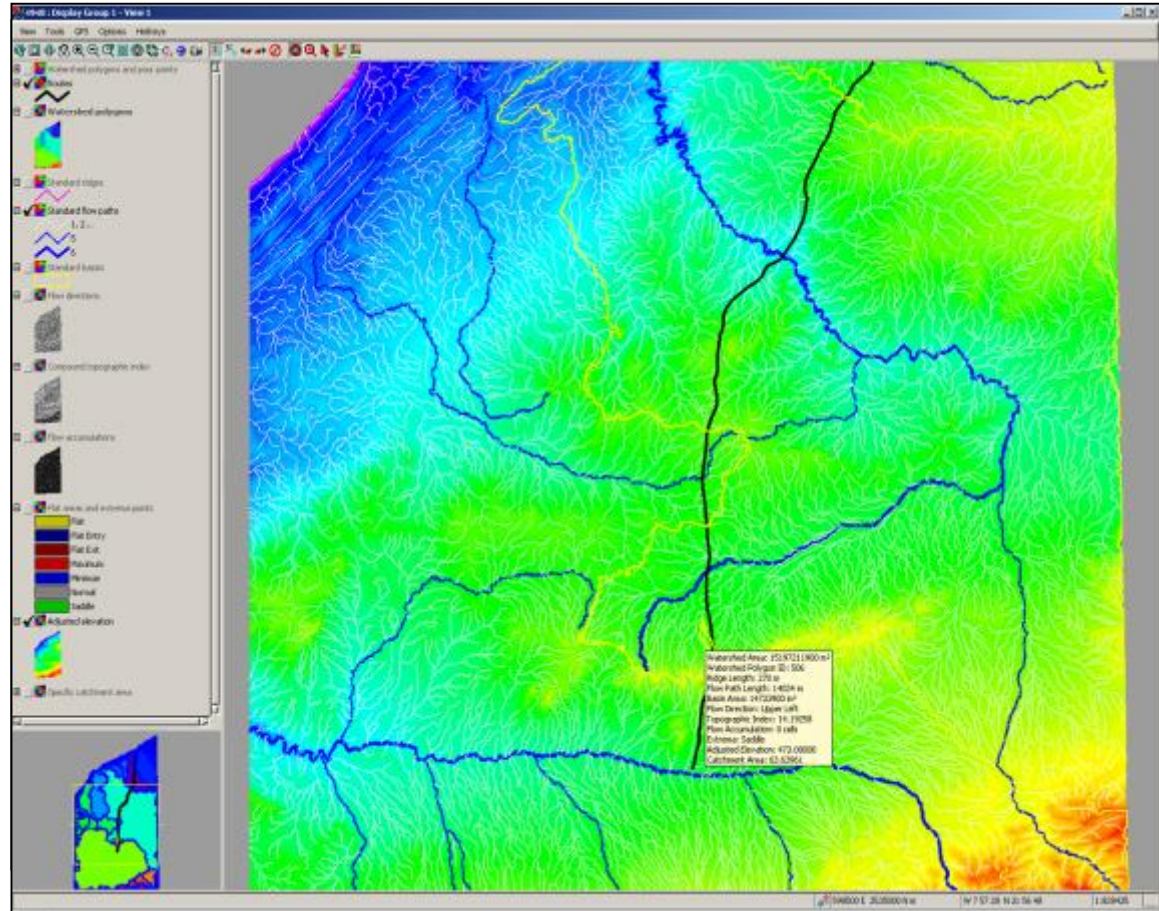
Survey X,Y,Z data
Translation to DTM
Slope Extraction
Hill Shade
Profile from DEM



DEM Applications

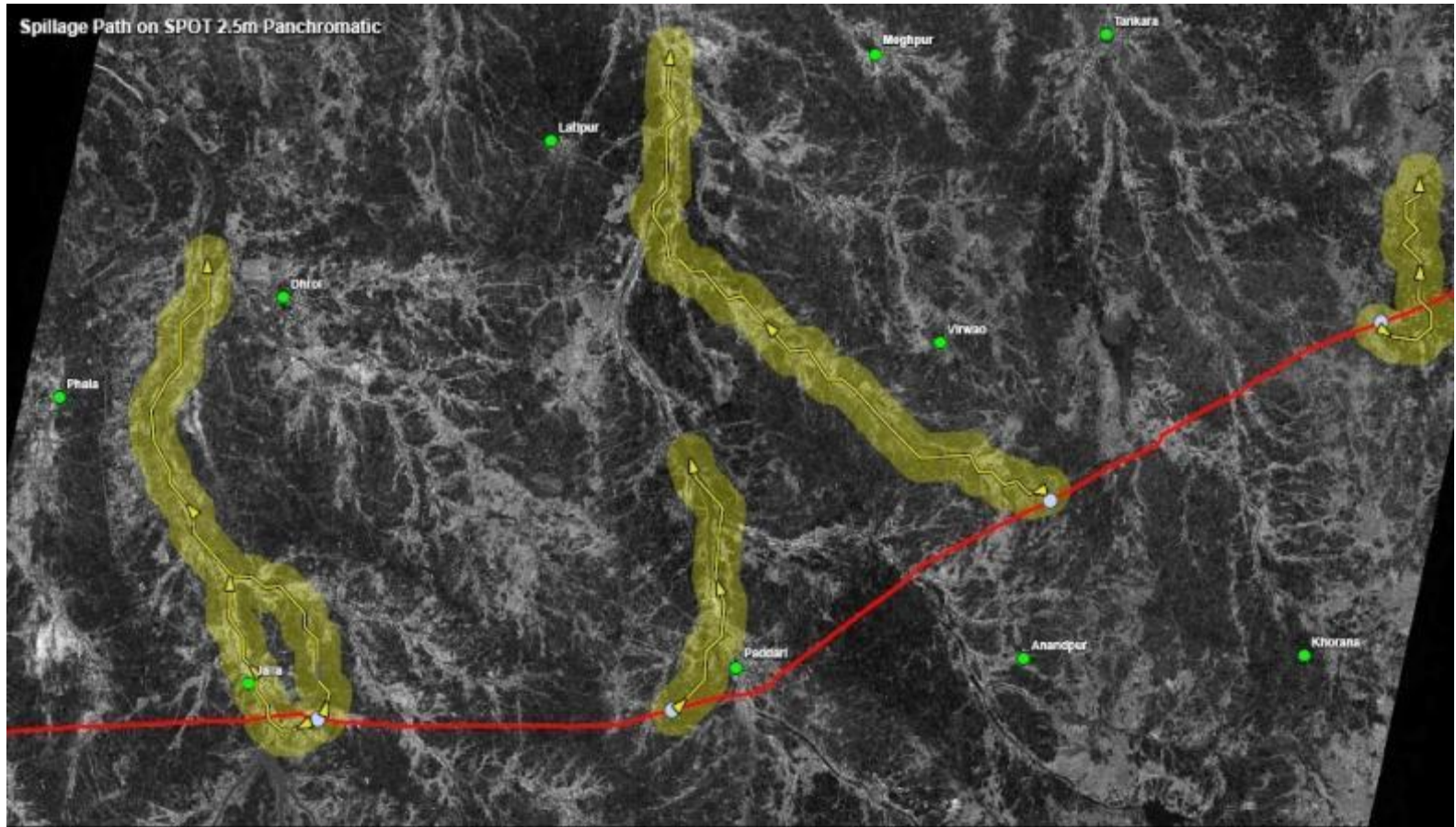
Hydrology Analysis

- Natural drainage network
- Calculate catchment area
- Defining flood plains, Maximum and average flow



DEM Applications

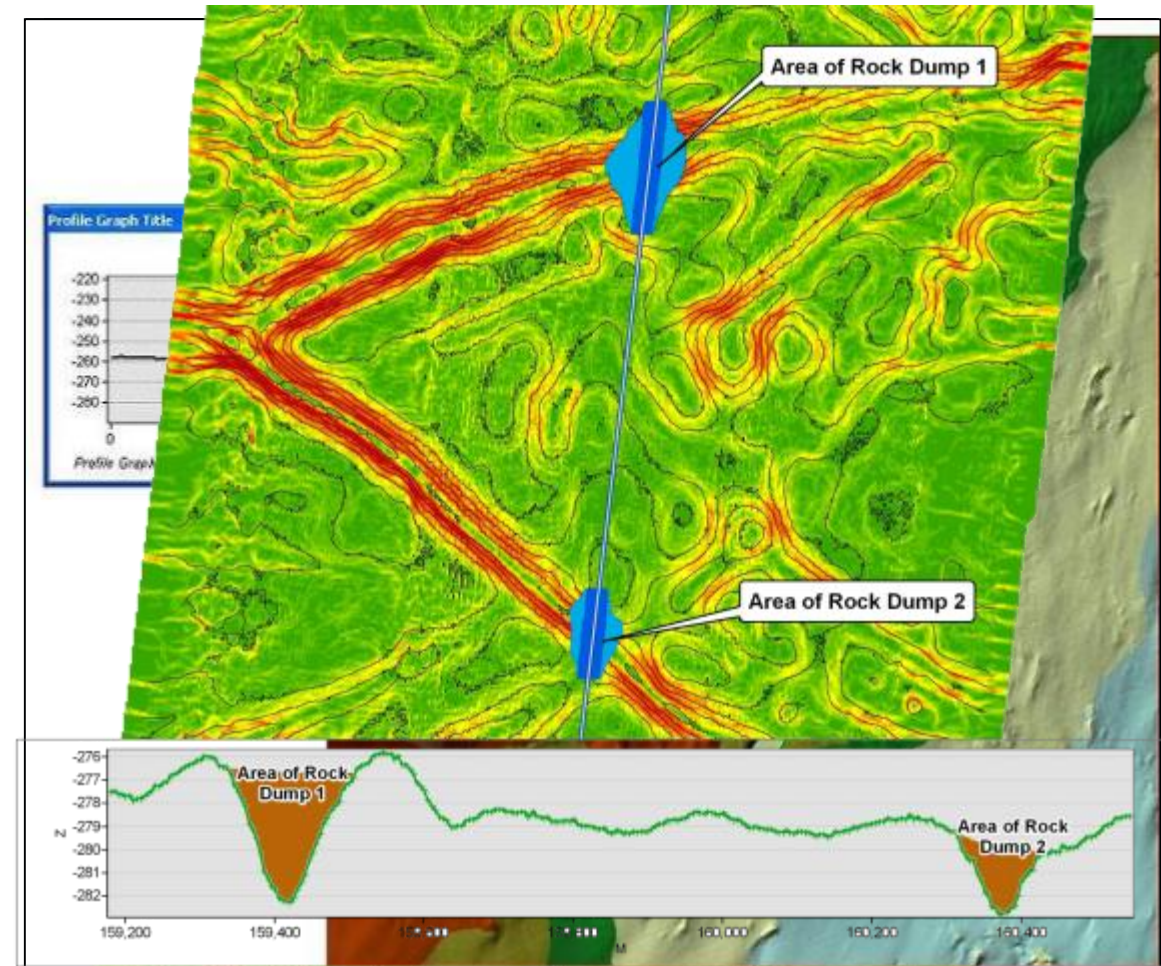
Pipe leak simulation



DEM Applications

Cut/Fill Volume Calculation

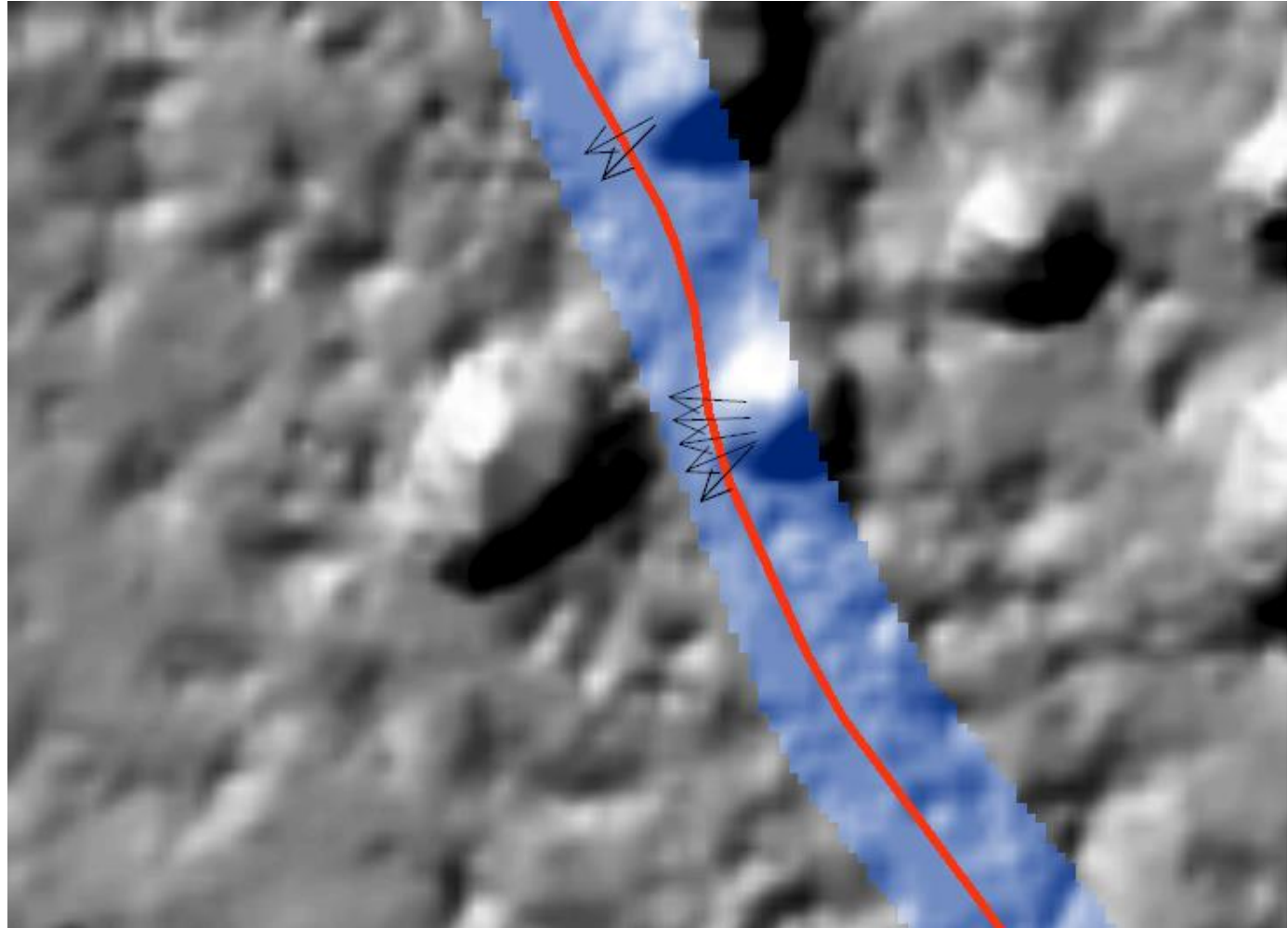
- Prompt and accurate
- Earthworks optimization



DEM Applications

Side-Slope Analysis

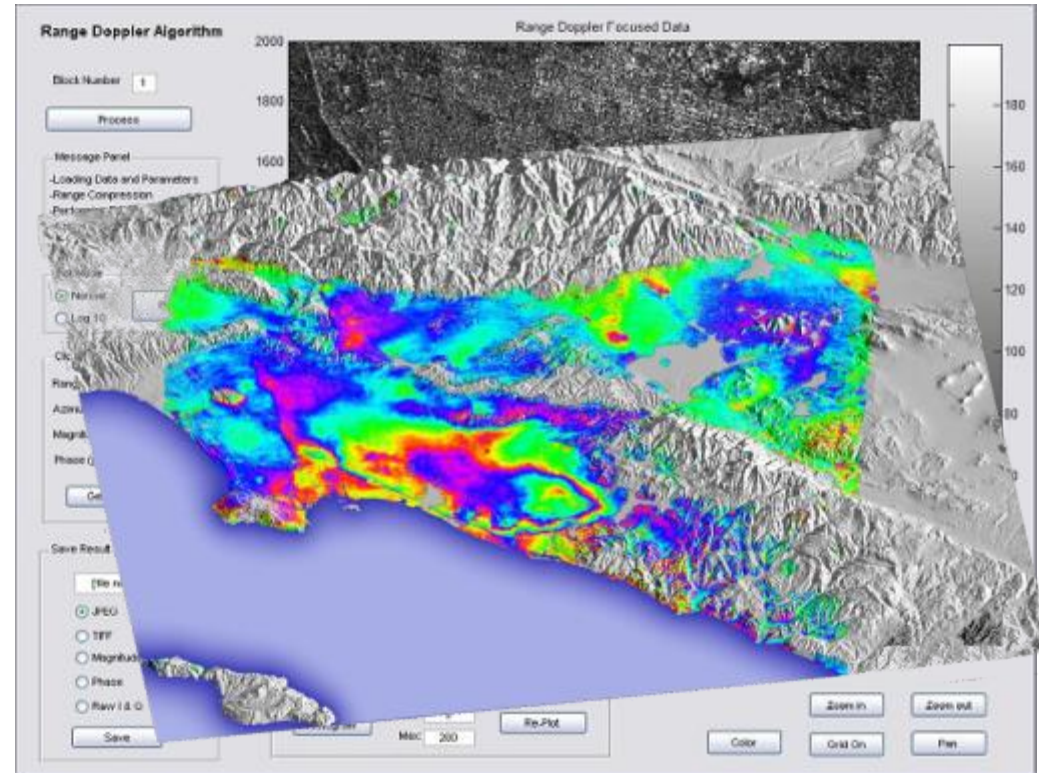
- Early detection
- Optimum routing



DEM Applications

Land Deformation Monitoring

- Interferometric Synthetic Aperture Radar (InSAR)
- A Pair of Radar images are used to generate elevation model
- Comparing two pairs taken in different dates indicates ground movement
- Capable of monitoring land settlements (oil fields and plants) with centimetre accuracy
- Ideal for mapping wetlands and sediments



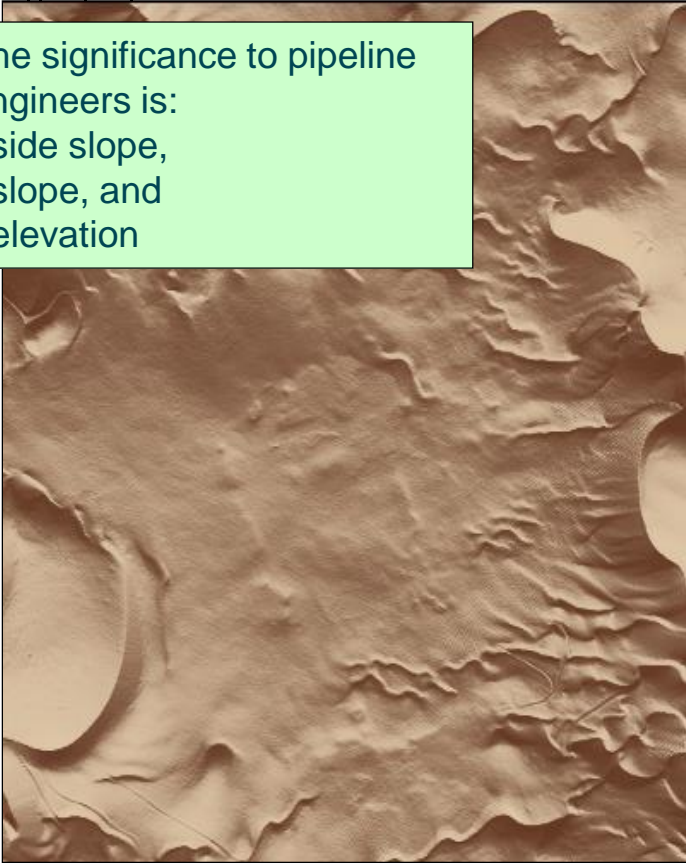
Elevation Model

Slope Map

X Y Z

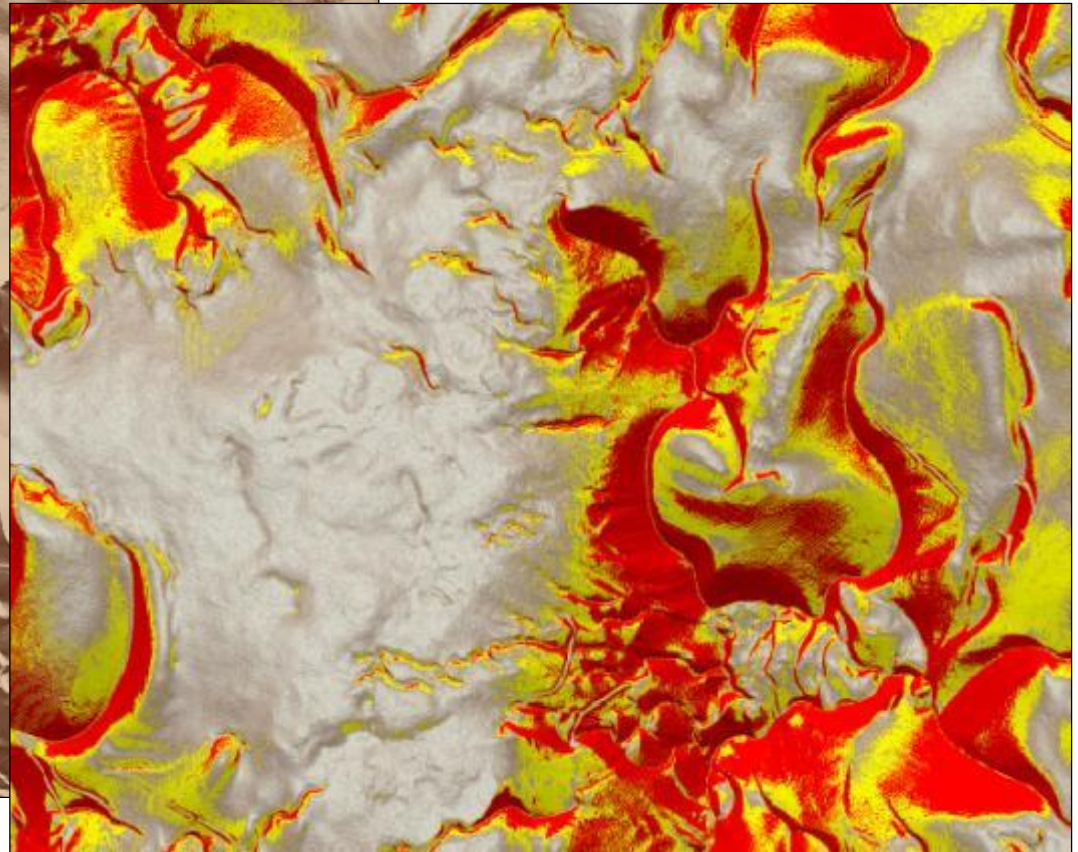
The significance to pipeline engineers is:

- side slope,
- slope, and
- elevation



Laserscanner derived DEM

Slope map



Building the Spatial Data Stack

Remote Sensing

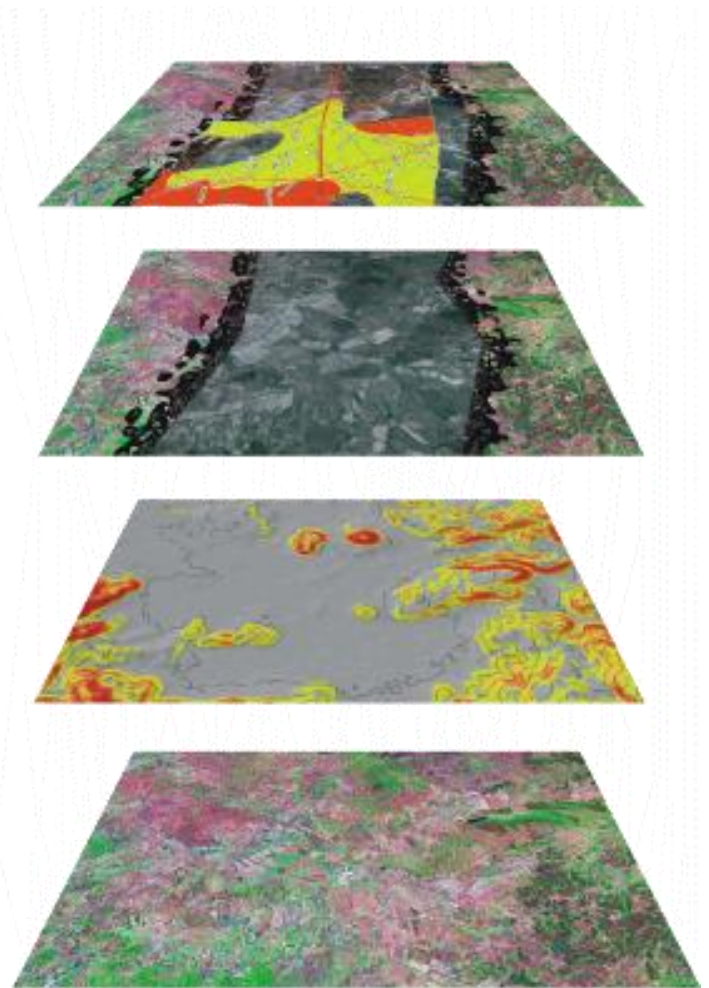
- Satellite and aerial imagery
- LIDAR
- Radar
- Multi-spectral

Electronic mapping

- National mapping
- Constraints mapping
- General purpose public domain mapping

Imagery and GIS analysis and interpretation

Digital elevation modelling (DEM)



Thank you

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