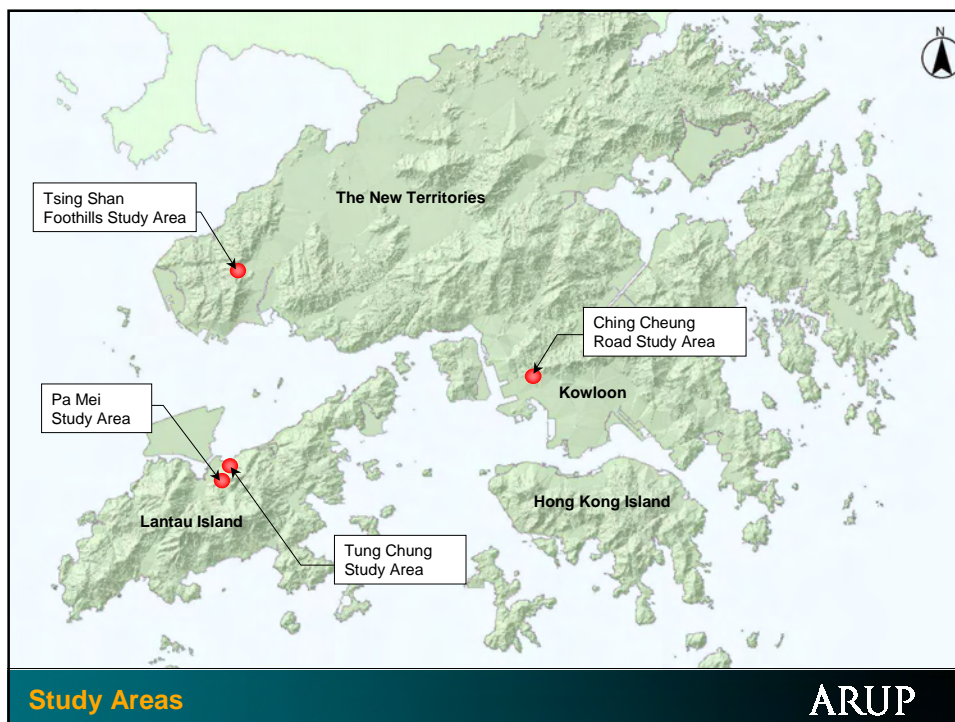


Instrumentation of Natural Terrain Landslides

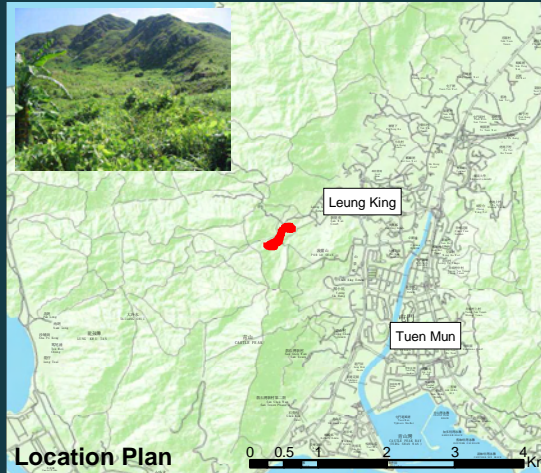
Project Examples from
GEO Agreement No. CE4/2005(GE)

Presented by Stuart Millis

ARUP

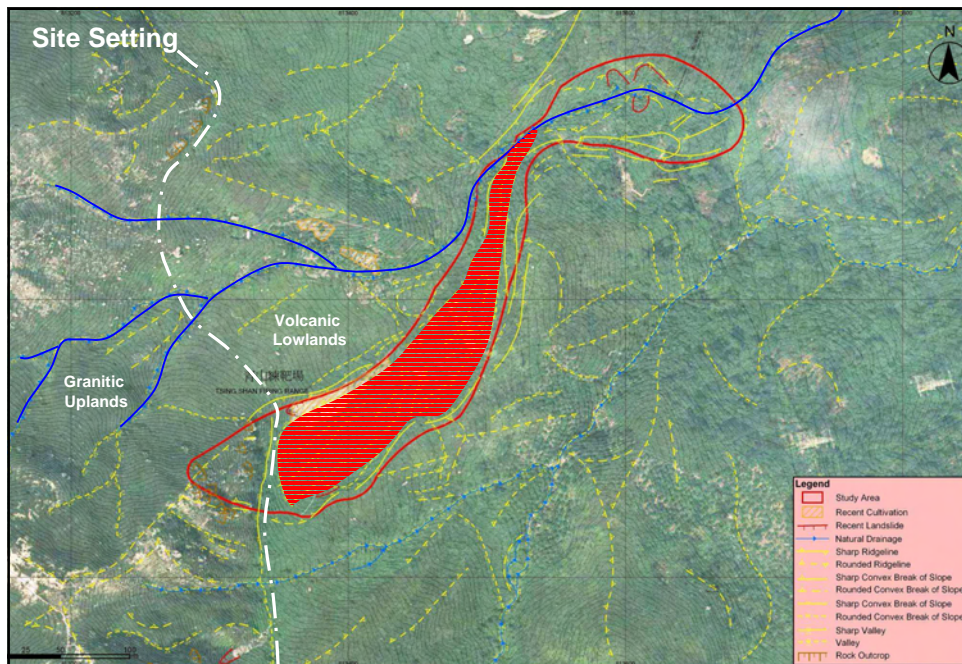


Tsing Shan Foothills Study Area



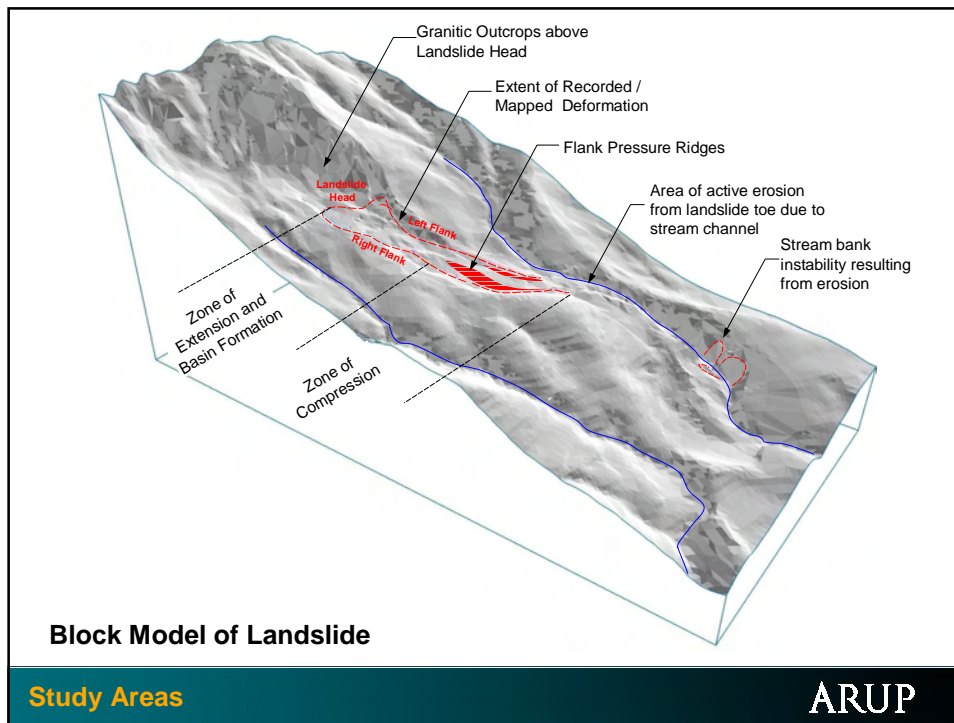
Study Areas

ARUP

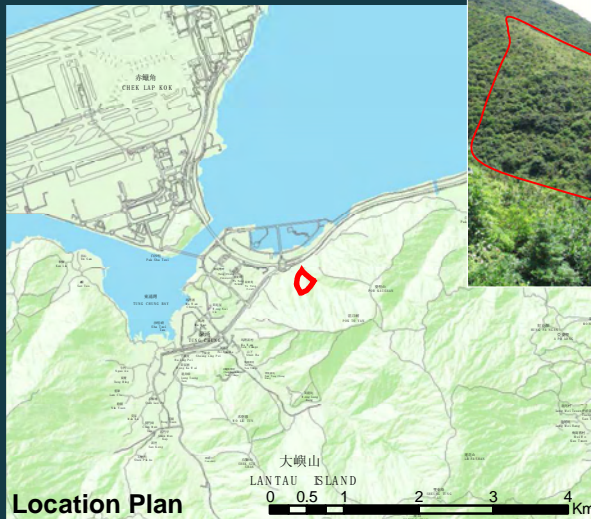


Study Areas

ARUP



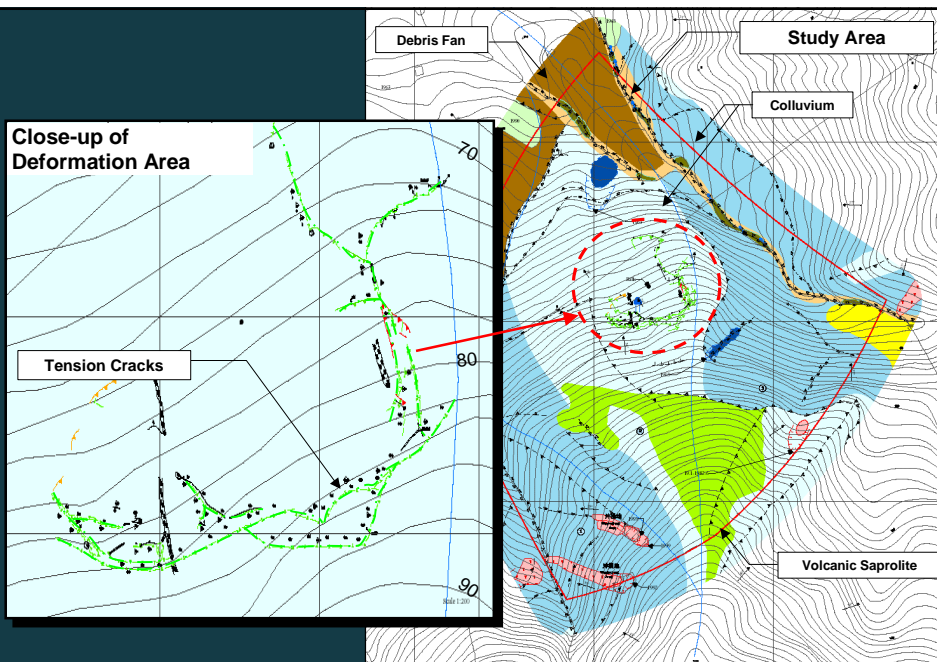
Tung Chung Foothills Site



Study Areas

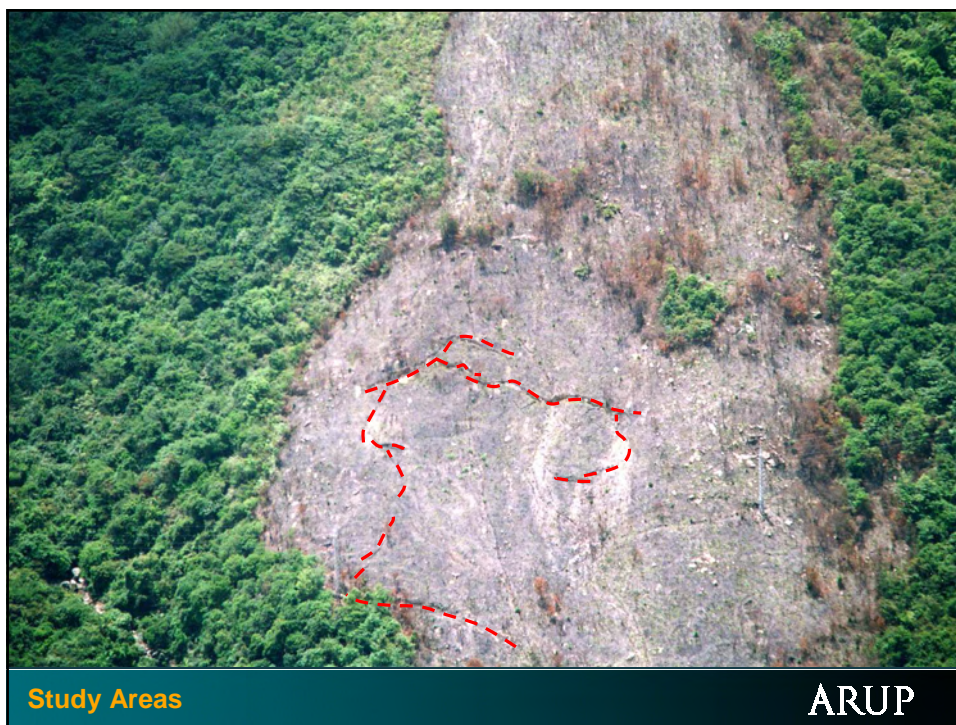
ARUP

Close-up of
Deformation Area

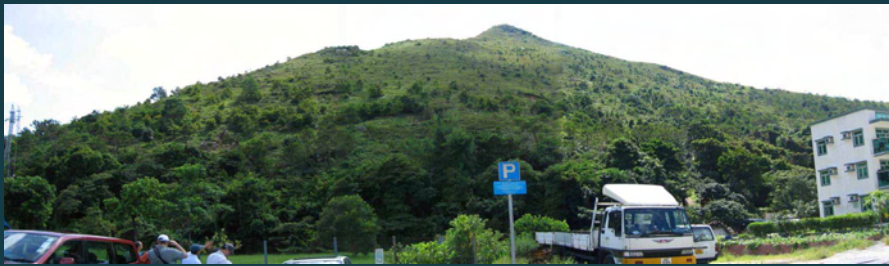


Study Areas

ARUP

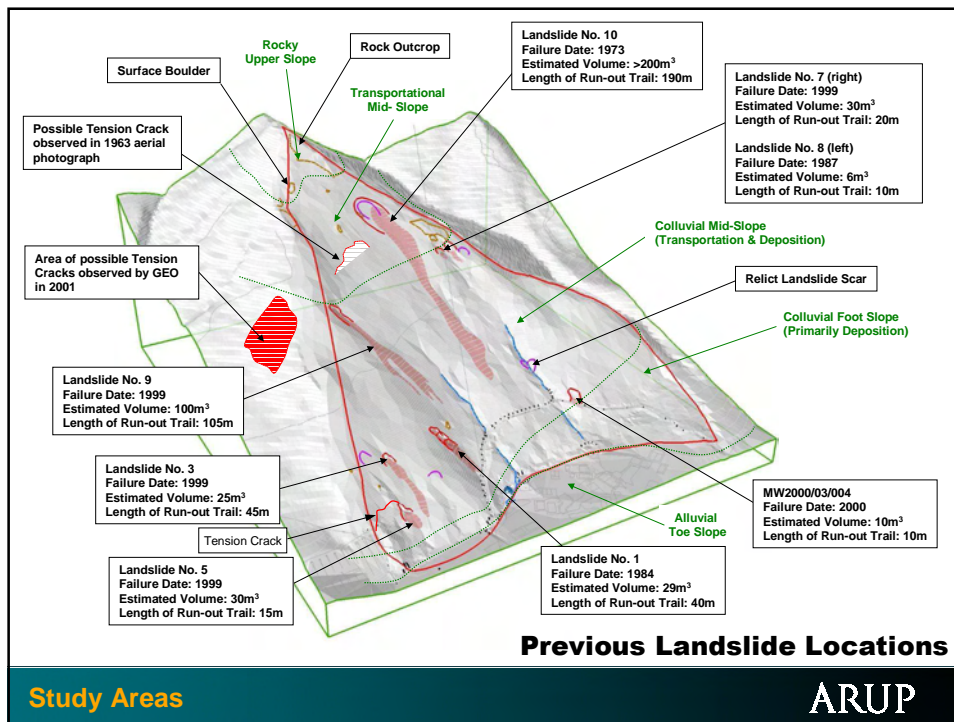


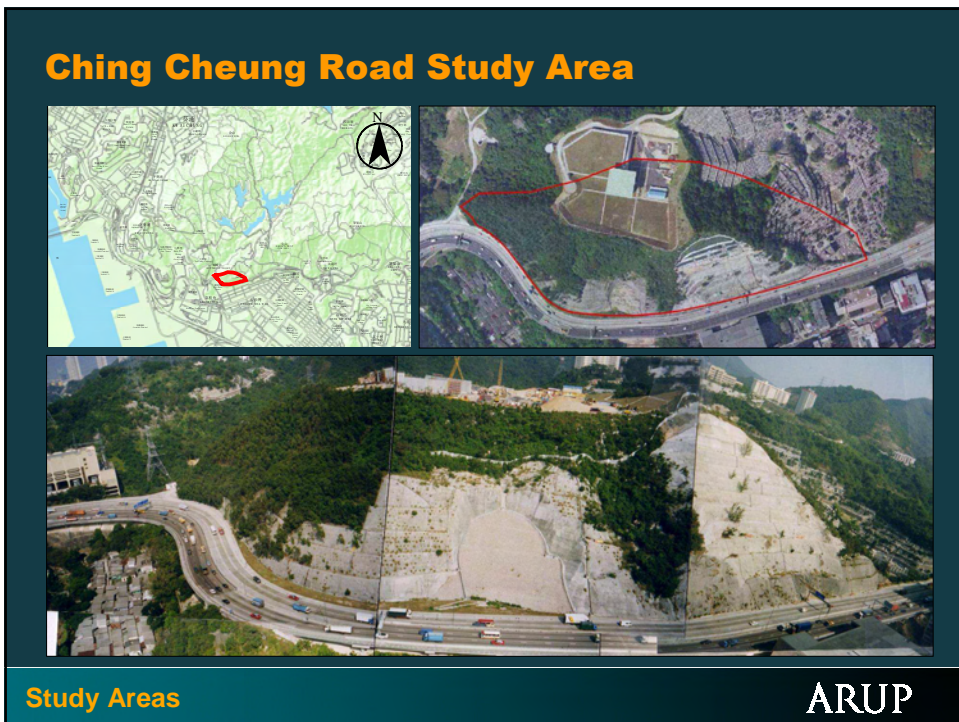
Pa Mei Study Area



Study Areas

ARUP



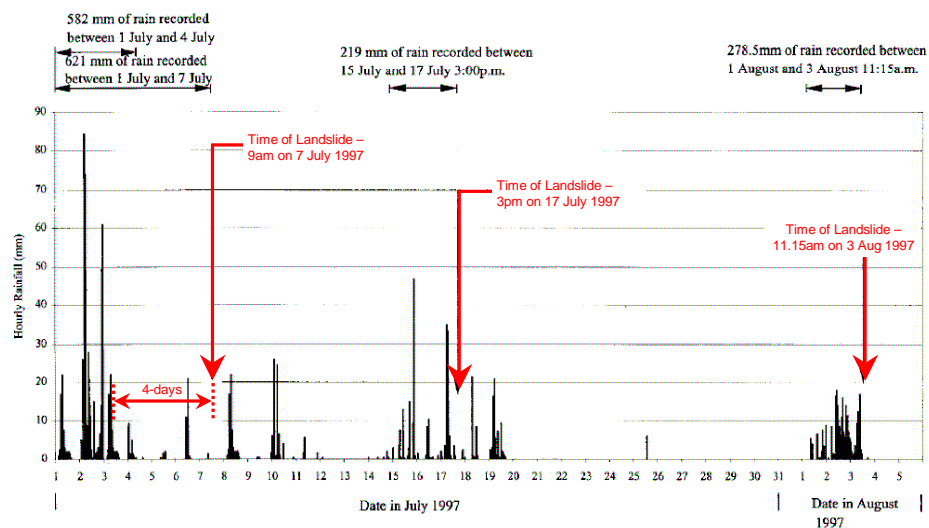


Numerous Previous Landslides



Study Areas

ARUP

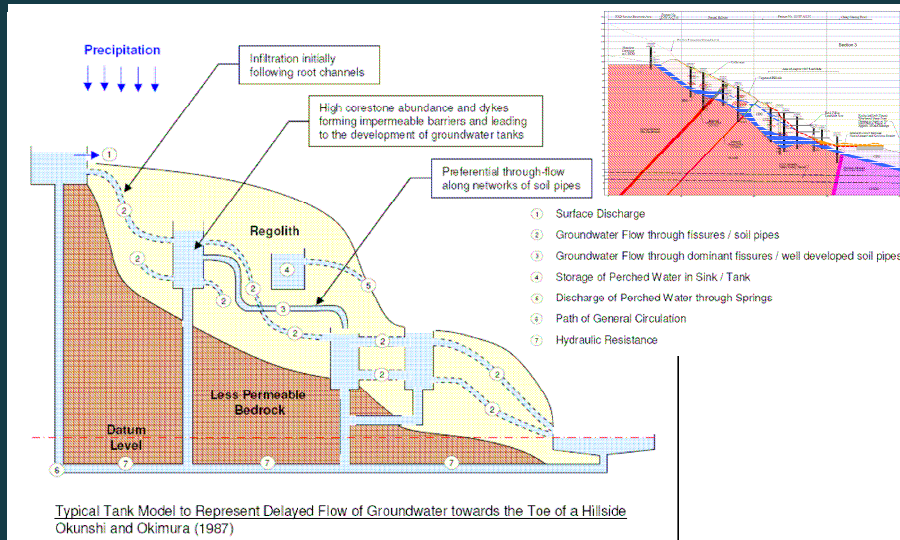


Extract from Landslide Study Report for August 1997 Failure

Study Areas

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Complex Hydrogeological Conditions



Study Areas

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Slope Instrumentation

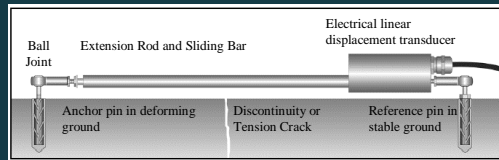
- Surface Movements
- Sub-surface Movements
- Groundwater
- Soil Suction / Moisture Contents
- Other Environmental Factors (Rainfall etc.)

Slope Instrumentation

ARUP

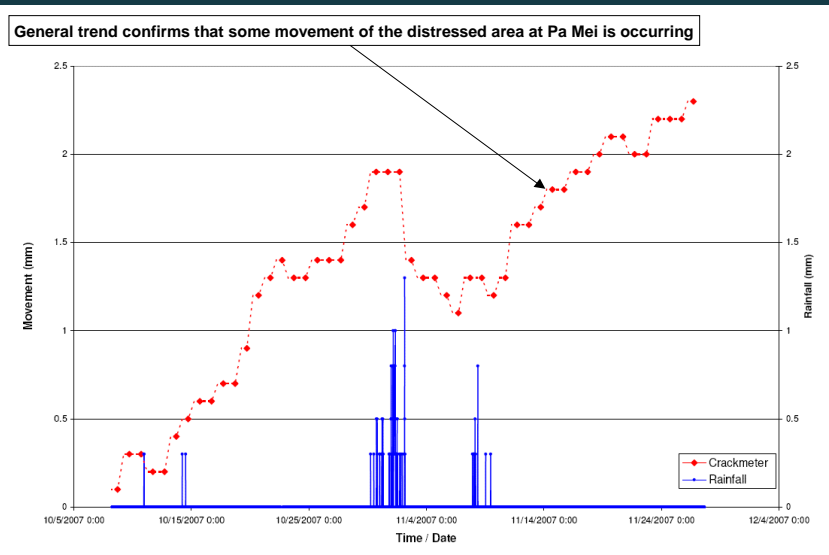
Surface Monitoring

- Crackmeters across specific features (tension cracks etc.)
- Remotes GPS survey stations (real time surveying)



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Crackmeter Readings



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Surface Monitoring

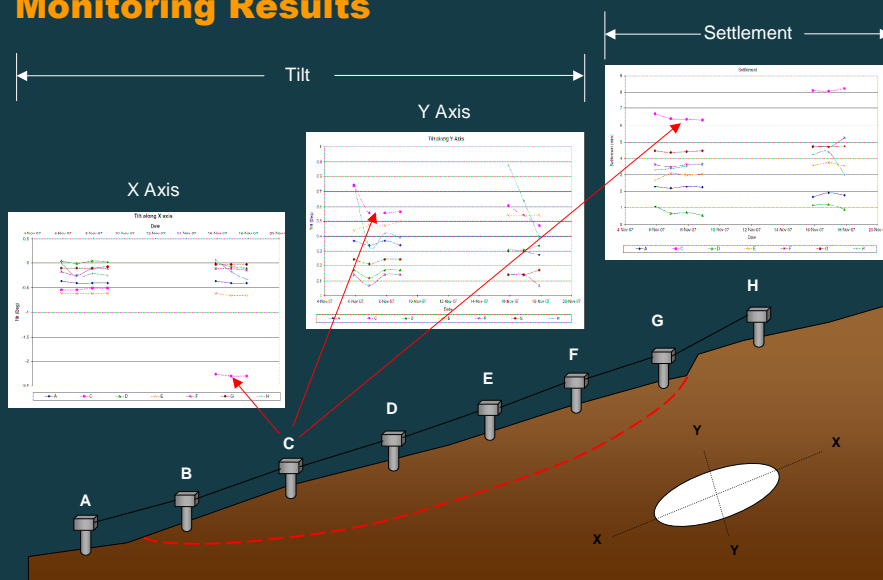
- Translation Rotation Settlement (TRS) Sensors
- Monitor movement of a string of sensors along the slope profile



Slope Instrumentation

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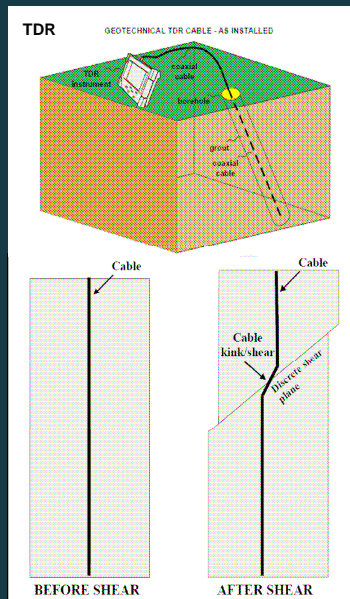
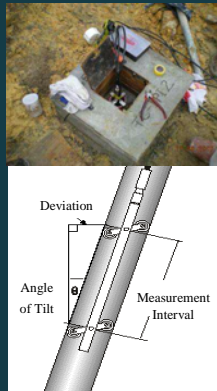
Monitoring Results



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Sub-surface Monitoring

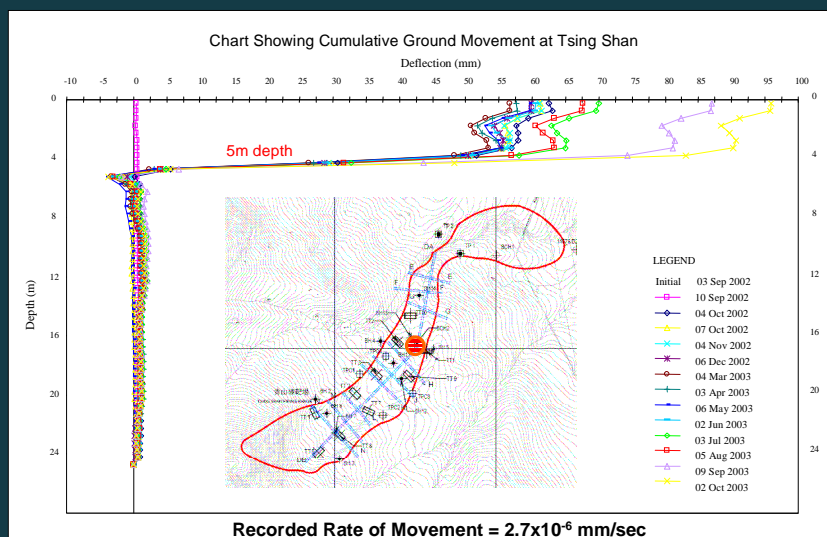
- In-place Inclinometers
- Time Domain Reflectometry
- Optical Fibres



Slope Instrumentation

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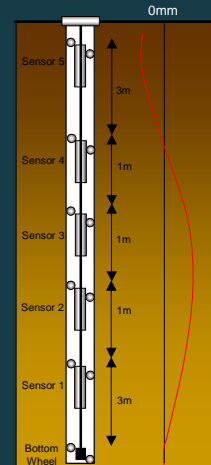
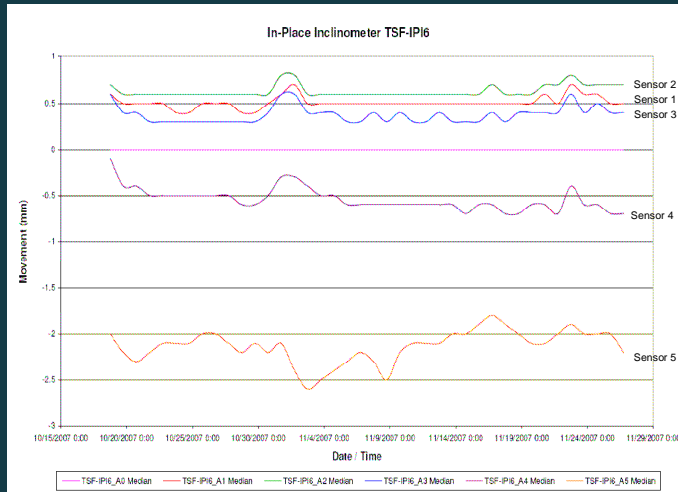
Inclinometer Readings



Slope Instrumentation

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In-Place Inclinatorometer Readings

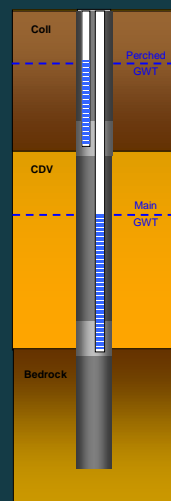
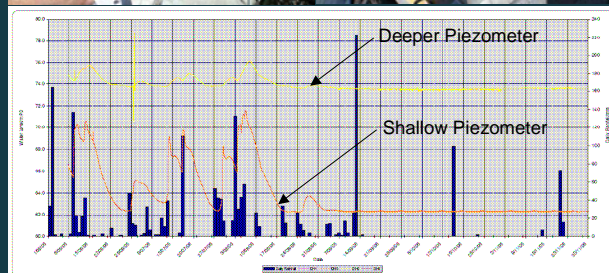


- Maximum deformation occurring between 5m to 6m depth

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Groundwater Monitoring

- Multi-level Automatic Monitoring Devices



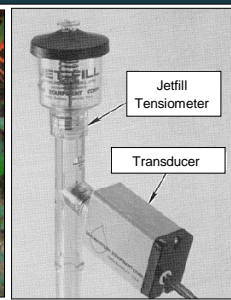
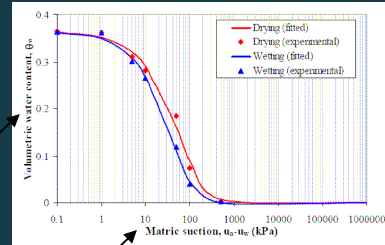
Slope Instrumentation

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Soil Suction / Moisture Content

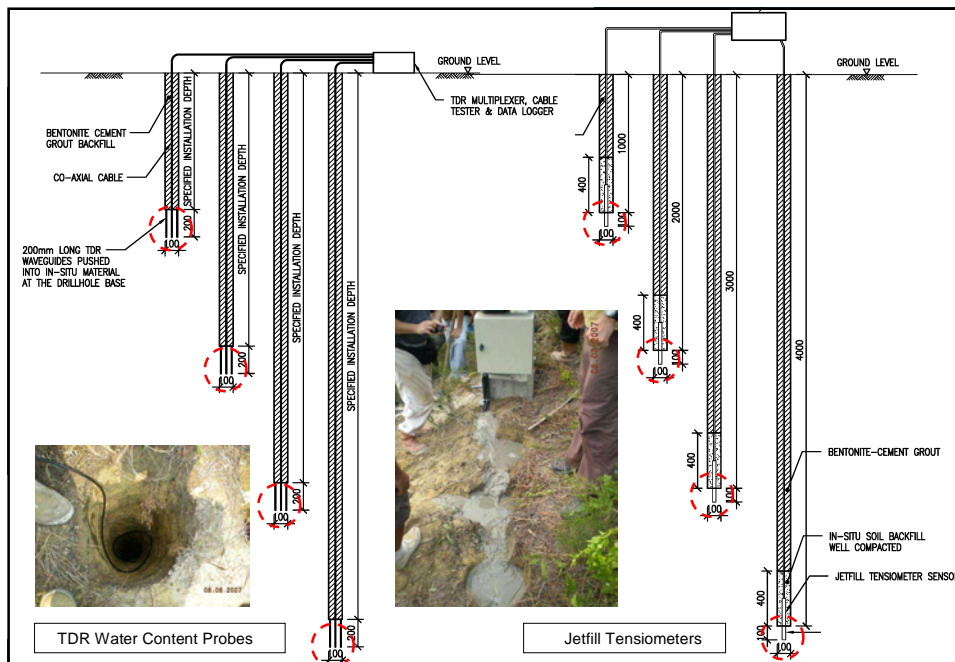
- Jet Fill Tensiometers
- TDR Sensors
- Thermal Conductivity Matrix Suction Sensors

Soil Water Characteristic Curve



Slope Instrumentation

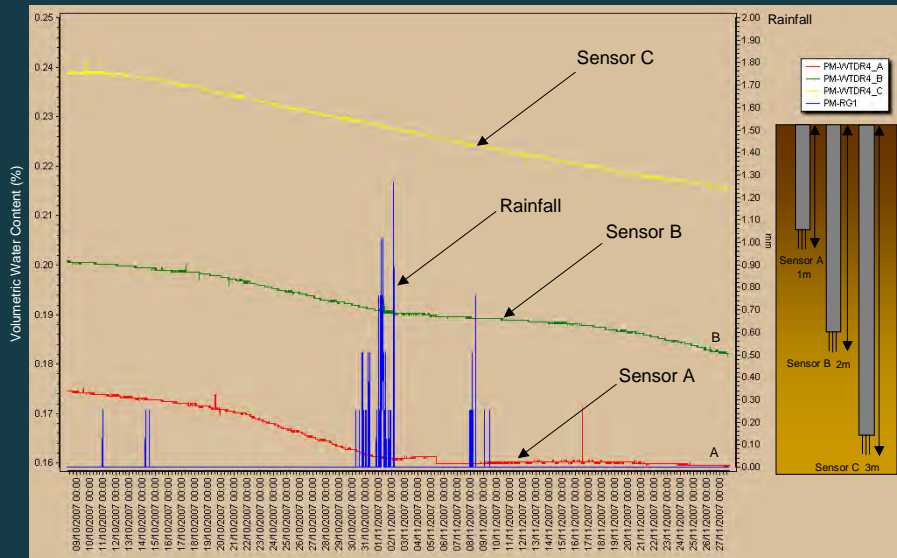
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Slope Instrumentation

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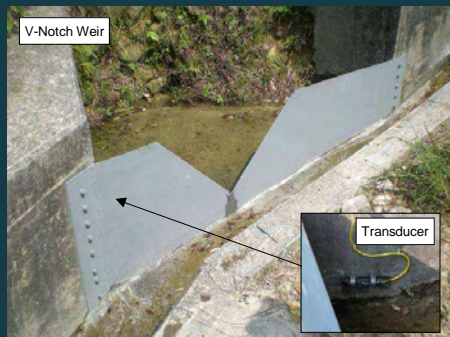
WTDR Monitoring Results



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Environmental Monitoring

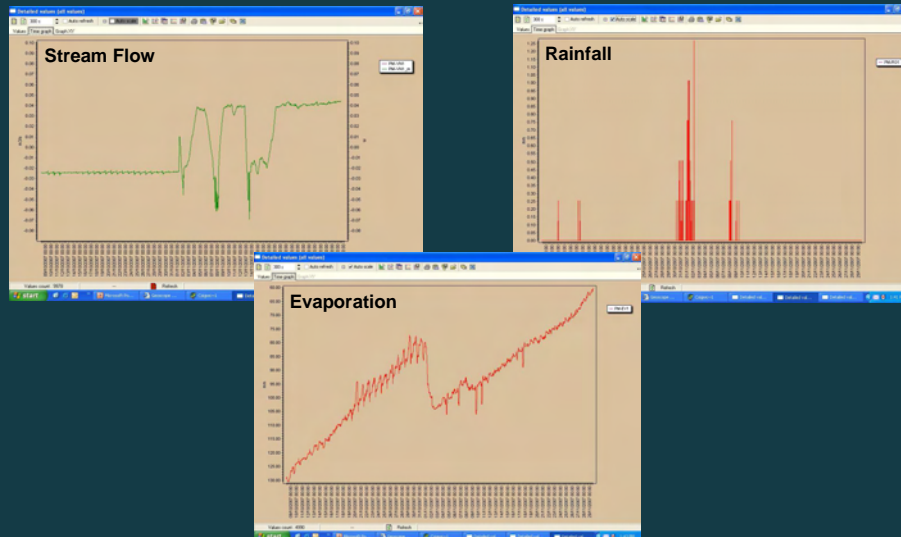
- Rain Gauges (rainfall)
- Evaporimeters (evaporation)
- V-Notch Weirs (surface run-off)



Slope Instrumentation

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Monitoring Results



ARUP

Data Management

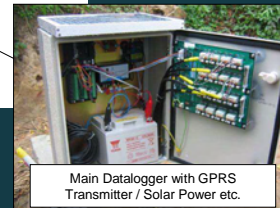
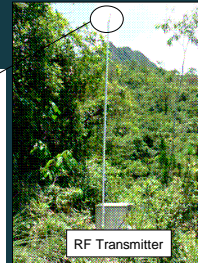
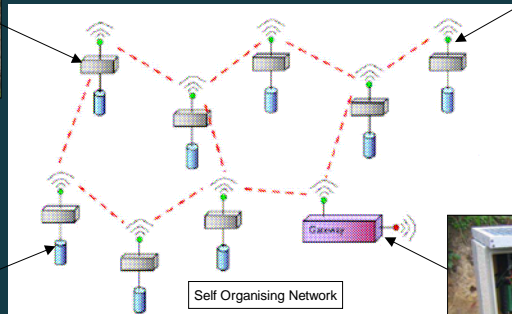
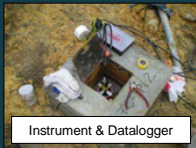
- Remote Data Acquisition
- Wireless Local Area Transmission System within each site
- Wide Area Transmission System between the sites and Database Server
- Internet access to the database server for easy review of monitoring data

Data Management

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Data Transmission

- RF 'line-of-sight' transmission to site-specific main data loggers



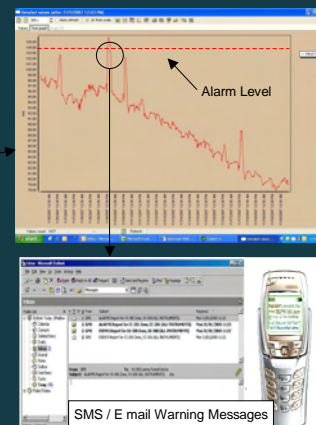
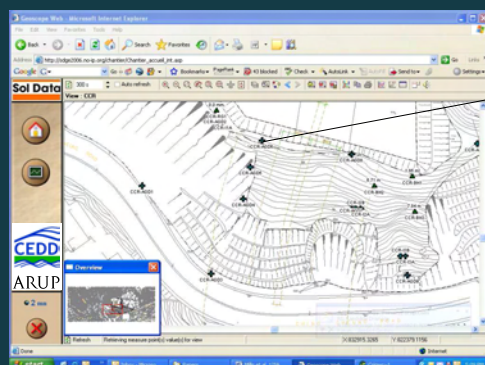
- GPRS / GSM transmission from Main Datalogger to Database Server

Data Management

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Data Management

- Dedicated Database Server
- Internet Accessible
- Alarm Functions

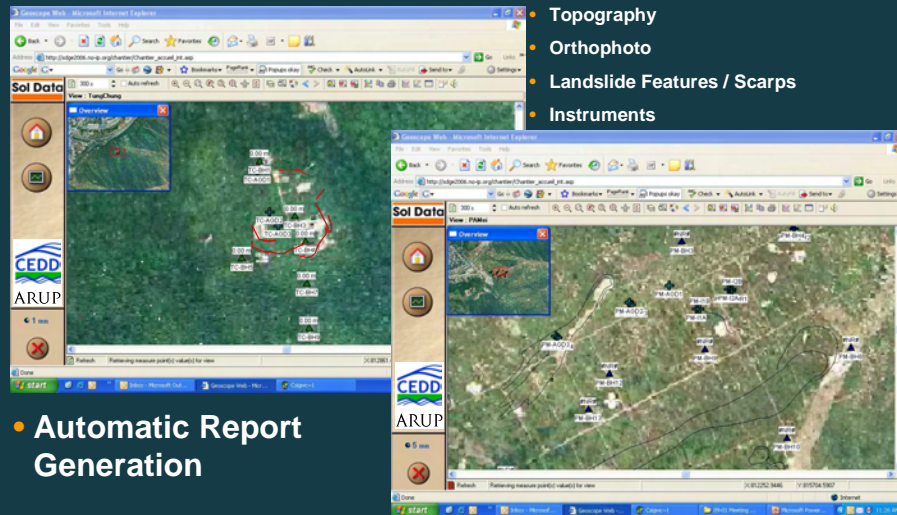


Data Management

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User Friendly Interface

- GIS Platform allows display of various layers



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to be continued

once it starts raining again...

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