Watershed Sciences 4930 & 6920
GEOGRAPHIC INFORMATION SYSTEMS

WEEK Five
TERRESTRIAL LASER SCANNING
(AKA GROUND BASED LiDAR)

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PURPOSE OF TODAY’S DEMONSTRATION
• Introduce you to TLS
• Demystify TLS & LiDAR

TODAY’S PLAN…

I. What is TLS?
II. Let’s see this thing in action
III. What can be done with it?
IV. Is this the future?

ACTIVE AND PASSIVE REMOTE SENSING

RECALL LiDAR
• Airborne-LiDaR
WHAT IS TLS?
- LiDaR from the ground
- Terrestrial Laser Scanner (a.k.a. ground-based LiDaR)

SORT OF LIKE A TOTAL STATION...
- Normal total station needs a reflector target...
- Reflectorless, just looks for a return off any surface
- TLS, like reflectorless... on speed.

RECALL TOTAL STATION SURVEYING

FIRE THE SMART ONE...
- Who’s the smarter one?
Who’s on the dumb end of a stick now...

A GUN AND A ROD...
- Gun shoots and record
- Prism on rod reflects
- Technically an example of active remote sensing...

TS CALCULATES - DISTANCES
Slope Distance is Calculated:
- Gun shoots beam
- Beam reflected back off prism
- Time is recorded
- Based on speed of light, slope distance is calculated

\[ SD = t \cdot V_{\text{Light}} \]
THE PRISM or REFLECTOR (WHAT IS SHOT)

They go on top of the pole...
- Standard unidirectional prism
- Fancy, 360° prism
- Multiple prisms (for long distances)
- Nothing (reflectorless)

Allows: a) lower intensity laser, b) greater distances, c) non ambiguous returns

TS MEASURES - ANGLES

- Measures horizontal angles (azimuths or bearings)
- Measures vertical angles (zenith)

Can only do this relative to a horizontal plane
Horizontal plane exists because instrument is ‘leveled’

TOTAL STATION SURVEYING – HORIZONTAL DEFINITIONS

This diagram shows how you get your x & y coordinate values at each surveyed point...

TOTAL STATION SURVEYING – VERTICAL DEFINITIONS

This diagram shows how you get the z coordinate R_z of the point you want to survey

SO A TLS IS LIKE A REFLECTORLESS TOTAL STATION... ON METH

≈
DIFFERENT INSTRUMENTS & SOFTWARE

Different instruments help address different scales of questions (same technology)

Leica
- Shorter range (up to 300 m)
- Higher Resolution & Accuracy (2-5 mm)

Riegl
- Longer range (up to 2 or 8 km)
- Lower Resolution & Accuracy (10 mm)

LOTS OF OPTIONS OUT THERE

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RADIOHEAD – HOUSE OF CARDS

- No cameras or lights used....
- Just a Terrestrial Laser Scanner

SOME APPLICATIONS ALREADY IN USE:

- Quantifying 3D-Structure of Wildlife habitat
- Mapping forests fuels for fire modeling
- Quantifying forest growth rates to estimate above ground carbon sequestration
- Calculating growth rates
- Mapping stratigraphy and structural geology
- Lichenometry
- Complex hydraulics in bedrock rivers
- Quantifying form drag & flow resistance from complex morphologies and vegetation
- Calculating surface roughness
- Morphological Sediment budgeting
TLS SCALE-FREE?

- High sampling rate enables landform recording at scales from the grain up to the reach in one single, integrated dataset
- Captures everything (three orders of magnitude more data)

Registered Feshie 2007 Scans

- >250,000,000 xyz
- Photorendered Point cloud
- 12 scans registered
- Density (median) = ~1400/pts/m²
- >250 coincident tie-points
- RMSE: Control = 7 mm
- Check = 8 mm

MAPPING PARTICLE GRAIN SIZES

REACH SCALE GSD MAP: RIVER FESHIE 2007

GLASGOW CITY MODEL
CHARACTERIZING HYDRAULIC HABITAT

From Large & Heritage (2007)

CHARACTERIZING VEGETATED ROUGHNESS

- Relate projected area (frontal area drag) from TLS to Airborne LiDaR
- Map roughness spatially over much larger areas...

From Manners et al. (In Prep)

A CHALLENGE...

- NearIR LiDaR does not penetrate the water surface

ONE SMALL PROBLEM...

WATER SURFACE TOPOGRAPHY

COASTAL CLIFF EROSION

WATER SURFACE TOPOGRAPHY

COASTAL CLIFF EROSION

Plate 17: Spatial distribution of biomass projected to the contributing area defined by laser scan water surface roughness measurements (Large & Heritage, 2007)

Plate 18: Author and photo of the grant box safely across the River (Rivers) and amythst.

Plate 19: Projection plane view of the southern face of the Mulheron syncline core (see Figures 11.5-11.7) with close-to-scale vertical exaggeration. Note the presence of a cubic scale micron structure visible in the projection plane. This feature is not easily visible in the field, and is only clearly visible in vertically exaggerated data. The feature is provided for discussion purposes in Figure 11.7.
TRACKING INDIVIDUAL FAILURE EVENTS

OTHER APPLICATIONS
- Architectural
- Pipe-networks
- Animation industry
- Crime-scene/accident inventory
- Archeology
- Heritage Scanning
- Civil Infrastructure

FUNDAMENTAL CHANGE IN PROBLEM
- From an era of being fundamentally data poor to being data rich
- Too much data can be just as bad as the real world...

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SOME WEBSITES...

Groups:
• ISPRS: http://www.isprs.org/technical_commissions
• Laser Scanning Forum: http://www.laserscanning.org.uk/

Projects:
• Rees Scan: http://www.reesscan.org
• Guang Zheng’s Forestry Research: http://staff.washington.edu/guang/Forest%20inventory%20characterization%20from%20GBL.htm

Manufacturers
• Leica: http://hds.leica-geosystems.com
• Riegl: http://www.riegl.com/
• Trimble: http://www.trimble.com/trimbleag stagn
• Optech: http://www.optech.ca/3dhome.htm

GOOD BOOK ON TLS

• Laser Scanning for the Environmental Sciences
• Most of text online: