



Minutes – June 19<sup>th</sup> and 20<sup>th</sup>, 2006

### Technical Workshop:

#### Exploration of Hydrology Models with High Resolution Digital Elevation Models (LiDAR derived)

##### Ken Durst, Tembec

- Provided overview presentation of enhanced forest inventory project from Tembec's perspective...
- Strategic level inventory to operational level inventory
- Business practices – can't take chances... not willing to take risks – know your resources
- Better inventory – precursor products - major shift in approach; high resolution digital imagery in RGB and NIR, plus LiDAR DEM
- Forest Info/Inventory Mgt. systems with Ontario Centres of Excellence – need to manage data properly in a standardized system
- Great advantages, savings and improvement in operations – LiDAR derived DEM
- Need to convince management people in government and industry that this is valuable
- Before/After/Savings/Advantages (improved management including ecosystem) – if you want to convince the managers...
- Comparative figures – show it off in terms of savings and advantages – improvements over existing data (OBM DEM), data analysis and approach...
- Engineering vs. planning our business...
- More concrete examples of improvements and advantages...
- Ecosite prediction, ecosite and silvicultural ground rules
- Need biologists, different mixes of people, explore advantages...
- One metre DEM doesn't necessarily have to be LiDAR derived
- ITC, textures, spectral signatures, etc. to get individual tree counts, etc.
- Tree height model (bare earth DEM subtracted from canopy DEM)
- More spatial accurate re base features
- Suite of tools to work with data – ArcGIS, Taudem, Global Mapper, Microdem, etc.
- Vital part of operations now...
- Surficial geology, aggregates, soil types, erosion prediction, etc.
- Predictive drainage/hydrology – message back from operations guys is that this works, keep it up...
- RGB vs. NIR, compare and contrast...
- Stereo Pairs... 3D anaglyphs, etc.; visually making sense...
- Predictive Ecosites... soils, geomorphology, etc.
- FERIC - Mark Partington – linked to machine tracking (navigation?)
- Competitive advantage, new ideas, potential...
- Need an honest cost at scale... (Need anecdotal plus/with science and peer-reviewed support)
- Need a comprehensive and large partnership – to share the cost...

##### Emmanuel Tran, FERIC

- Save \$ and improve forestry operations relating to hydrology
- Complete base map/navigate machines
- Emmanuel presented plotted maps comparing different outputs from Taudem and Tass – different parameters
- Problems at edge of mapsheets
- Some disagreement between software models

- Data sharing agreement is in place – no problem to provide Emmanuel with data needed
- Mark Partington took a look in the field at some of the suspect features
- Tarmo is going to take a look at what he reported
- Operational anecdote – 4 to 5 fingers – might be a little wet – where they meet/junction – start to get true streams; operations guys were starting to interpret what Ken was providing...
- Higher density LiDAR to help get even better idea of hydrology/stream network – what are the standards???
- ArcMap 9.1 – hydrology features are present and ready to be used...
- Need field checking – determine how to use the software models; standards
- Check some of the weird locations – locations where the model is suspect...
- GPS culvert locations, walk watershed completely – transects – find out how complete it is...
- Compare models predictions to field...
- One three day delay resulting from an unmapped stream results in about \$12,000 in losses plus approx. 600 m<sup>3</sup> of wood; every crossing eliminated is about \$6,000 to \$7,000...
- Small-scale sampling will give a good indication from stream network extraction; search for research \$ to get more done...
- Expand the research to a larger scale in next two years – standards
- Emmanuel is taking detailed notes that will guide/help operations and planning
- Still working/playing with it a bit...
- Not perfect, but improvement/helpful...
- Tune these things right, they bring a lot of improvement...
- Quoted Paul Arp paper – streams fell within forty metres of runs with his model... opportunity to improve...
- GeoFor being developed by FERIC
- Emmanuel to re-work his instructions for use of Tass/Taudem, etc. – part of this workshop product...

### **Murray Woods, OMNR**

- Enhanced Inventory in GtLSt.L forest region using digital imagery and LiDAR
- Automated interpretation/ITC, etc.
- Very large scale project, many players, etc.
- Don Leckie and Francois Gougeon (CFS); and SilvaTech contracted to do operational runs and R&D component
- Extensive ground network for validation and calibration of ITC piece
- Some work just on biomass, basal area from LiDAR alone
- Drive to the tree level (LiDAR density)
- Paul Treitz, Kevin Lim, Neal Pilger, Ben Kuttner
- Show value of higher resolution DEM (LiDAR derived) for hydrology modeling – demonstrate why 1 metre vs. 20 metre is better... and why...
- Tie into source water protection – leverage \$ potential
- Limitless LiDAR – software trial/plug-in with Arc9.1 - \$3,000 for fully licensed version...
- Overview of GtLSt.L project
- Ultimate goal is a semi-automated ITC inventory
- Use imagery and LiDAR
- Reality is that we have created new intermittent streams – old cuts/skid trails
- May have been improper skid layout
- Different levels of attribute layers...
- 1:1 relationship for predicting BA, etc.
- Freeware – PointView software – downloadable for viewing LiDAR point clouds

### **Tarmo Rimmel, York University**

- Assistant Professor now at York – geomatics and remote sensing...
- Use data and info from projects in education/courses at York; simple data sharing agreements; credit to Tembec and the FRP

- Working very closely with Kent Todd for some time now on hydrology, DEM, etc.
- New academic partner for the FRP
- Preparing report; looking to peer-reviewed paper this fall
- Look at LiDAR standards for Hydrology mapping as Part 2 of this project (get more \$ for study)
- Stringer and Mykiss Lakes – not looked at yet; Jim should have a good map of what is there already through his work (physical mapping?); good opportunity to compare...
- ESRI – based on old GRID module
- Taudem has a limitation – 4,000 X 4,000... old DOS version doesn't have limitation
- Gave presentation from FERIC session in the Sault, and images/graphics from the report he and Kent Todd are working on...
- Moisture regimes – soil mapping, etc.; where is moisture going to accumulate?
- Topography, subsurface conditions, soils – factors influencing flow...
- Areas of study within RMF clipped – plenty of opportunity for multiple watersheds, etc.
- Significant hydrology already exists on sites (OBM)
- Crossing are indicated re roads and streams
- Review of analysis approach of points (TINs, IDW(2), Spline, etc.)
- Filled depressions, slope and aspect maps, specific catchments areas, watersheds and streams, topographic wetness index
- surficial hydrology – clean up surface (filling) – standard algorithm that filled minor depressions on the surface
- Generally very small – irregular... compensate the surface
- OBM data – 7 sinks; LiDAR Dem – 300,000+ sinks
- Depth: 8.68m max; 1.38m max
- Coarse, rectangular streams from OBM; same general locations as LiDAR, but LiDAR is giving local detail, local meander – real feel of what stream looks like in the field
- Can reduce or prune back detail
- Stream statistics (Strahler stream order); next order only after two of the previous orders join (i.e. two ones join to become a two)
- Compared 3 different interpolation techniques (spline, idw, tin) – relatively same results with all three interpolations; local variations only
- Inverse distance weighting (IWD)
- More variability at higher order streams...
- Mean basin size is most variable
- LiDAR DEM – sinks avoided by machinery (based on tracking data) – wet areas/prone to rutting...
- Could potentially flag areas to save time/give better heads up – whole range of operability issues
- Topographic wetness index... may not have a stream, but may be a wet area, depression – Mark Partington is investigating/validating...
- Same approach as Skid Trail study – coloured wet pixels – did skid trails impact...
- Comparing to OBM layer – does one show and one not show??
- Detail government needs to provide vs. what is provided by companies, etc.
- Need this source water protection...
- IDW – doesn't work the best – goose eggs...
- Subtract combinations of interpolation methods – very little difference over-all
- Old OBM coarse level not good for hydrological modeling; contour artifacts
- LiDAR derived DEM – a lot more detailed, significant elevation differences with OBM DEM
- Points are randomly selected
- Same pattern when superimposed – slight variability locally – very similar
- Stats, appearance, same location, etc. all very similar
- Doesn't really matter re interpolation or use of taudem and Tass
- Perfect alignment with the imagery on higher order streams – validation!!!
- Soil moisture probes at 1<sup>st</sup> and 2<sup>nd</sup> order streams – field work – likely to be wet if there is a rain-storm... (Emmanuel's work)...
- Wetness index layer compared to imagery – next step...
- Take it from anecdotal to parameters/stats
- Won't get this with the OBM – angular streams, etc.
- Need to target the managers with this... (Planners, Bob, Brian, etc.)...

- Push this out to the Brian Naylor's
- Geologist involved in research at some point
- Topographic wetness index
- Same thing shown in many different ways by datasets – something is there either filled with water or likely to be filled with water if a precipitation event occurs...
- Wetness indices really mesh with the streams
- Wet areas not always avoided by machines – great to look at...
- Ties into ecosites – same thresholds – same questions....
- Possible fit into Treitz proposal?? – add Tarmo/Buttle in???
- Comprehensive tool for forestry – hydrology and wetlands – wetness index...
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- For hydrological work, microdem is not the tool; best for 3D visualization...
- Tass, once you figure out user- interface and layout of tools, very powerful – can also go to ArcGIS...
- Taudem, although nicely streamlined with ArcGIS – larger areas are a problem; 4000X4000 limitation...
- Multiple pieces of software, learning curves – at some point arrive at a forestry hydrology model that plugs into ArcGIS – would be very time-saving, efficient, etc.
- People who use don't have to be hydrologists...
- Which Journal do we publish in...?
- TIN is probably best – based on Tarmo's personal preference...
- Report is ready in two weeks...
- Peer reviewed paper – all of us to review
- Figure out parameterizations, guidance, and run on a Zenon workstation for the RMF over a weekend...

## Hydrology Technical Workshop Action Items

- A/I – Project paper, traveling road show – advantages/improvements resulting from LiDAR and high res. imagery...sell to all/management
  - A/I - Ken to connect Emmanuel with Lino – re AWS blocks on RMF this coming year
  - A/I - Need field workers/helpers... (July – one week of field work) John to see if he can find someone who can help Emmanuel...
  - A/I – Ken will get Paul Arp to run his model on a portion of the RMF... Ken and Emmanuel to collaborate...
  - A/I - LiDAR and DEM Standards for Source Water Protection in Forestry Planning and Operations... see below – check with Paul Treitz...
  - A/I – send EOIs and the draft project proposals to Dave; Dave to become a project partner if he wants
  - A/I – tablet with Phelps and Orlig data for Executive (John or Dave)
  - A/I – reconvene group once we get predictive ecosite information for RMF
  - A/I - Two Master's theses – Ken and Hamish – PDF's to the group...
  - A/I – plot out some razzle dazzle for the Executive for Phelps and Orlig – 3D high density LiDAR, DEM and images...(Murray and me)
  - A/I – Ken will take a look to see if the new FRI for Block 18 is ready/available for Tarmo
  - A/I – Need a Tree Tip!!!! Based on/synthesized from Tarmo and Kent's report...
  - A/I – Tarmo to approach Jim re mapped streams for Stringer and Mykiss
  - A/I – John to approach Jim re budget; \$ to Emmanuel for field work
  - A/I – collage of images, data graphics, etc. for Block 18 TreeTip to replace map
  - A/I – Ken to share tech notes with the group
  - A/I – Bio's and Geologists to the table...
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- A/I – Emmanuel and Tarmo to draft straw-dog instructions/recommended parameters – file naming convention important; 3 or 4 pages max.
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- How do we use- how does it make things better? How does it link to other things... fisheries, wildlife, habitat, etc.