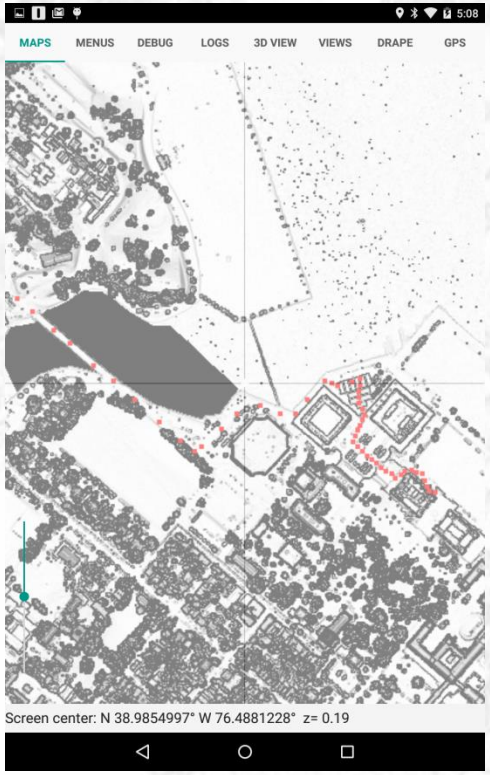
Virtual Field Assistant: Terrain analysis in the field with geologically focused GIS on a smartphone or tablet



Professor Peter L. Guth
Department of Oceanography
United States Naval Academy
Annapolis MD, USA
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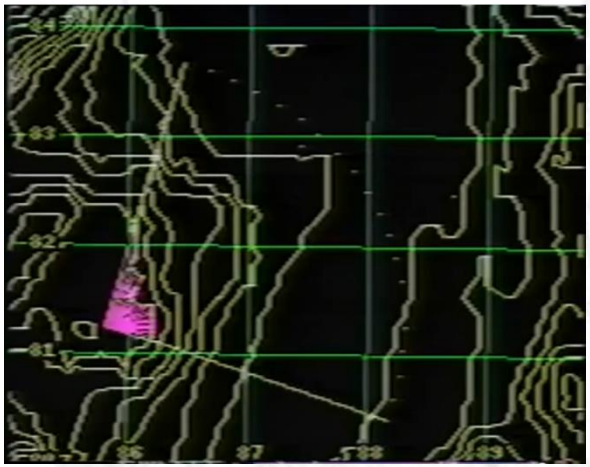
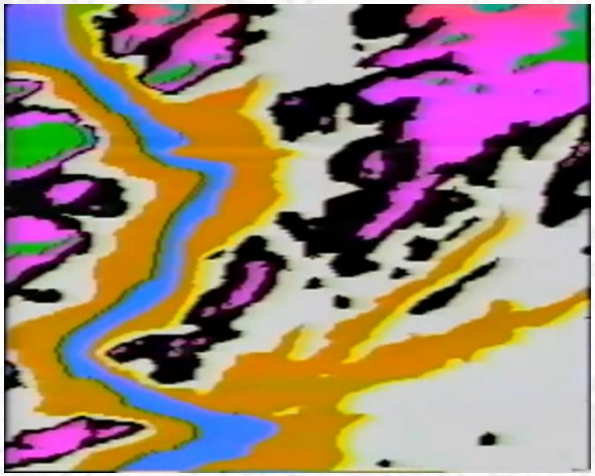
Session T70. Digital Technology in Real and Virtual Geoscience Experiences
November 1, 2015

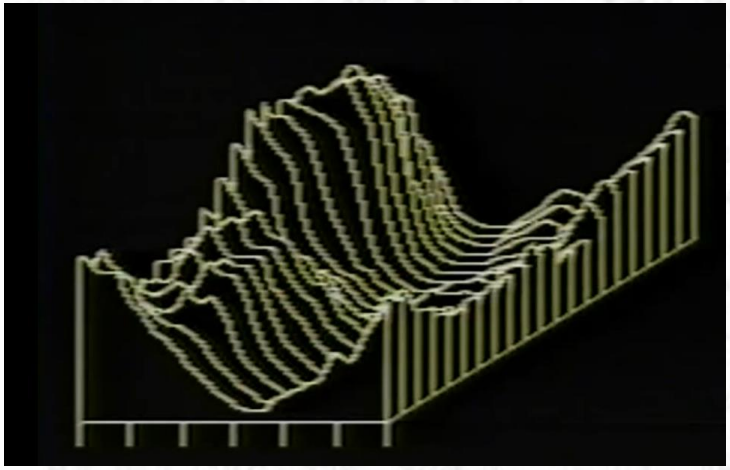
1-4 NOVEMBER
GSA 2015
Baltimore, Maryland, USA

1985 Apple II

Field Terrain Analysis







MicroFix—fielded Army system

https://www.youtube.com/watch?v=OMsQkzpNLDg

Using Handhelds in the Field

Data entry

Digitization

Dip and strike measurement

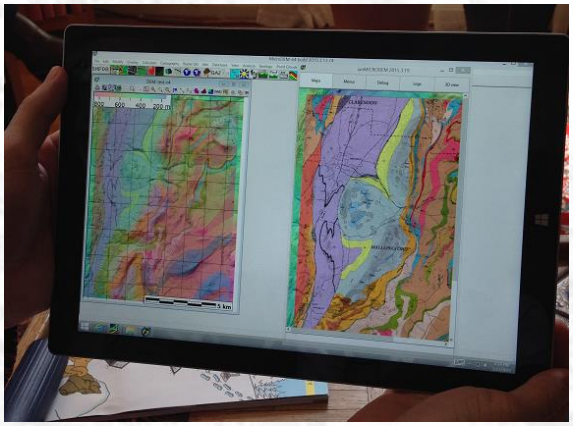
Map and image display

Compute location

***Terrain analysis**

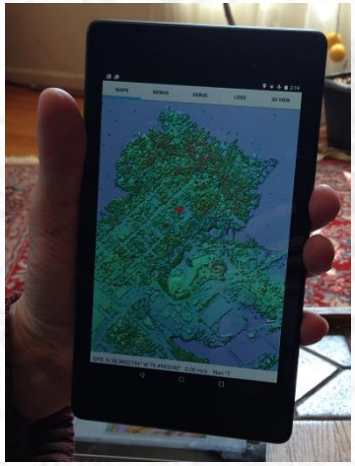
***Geologic computations**

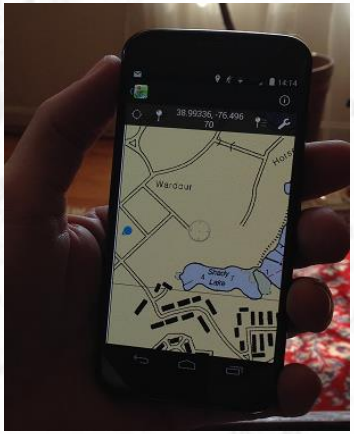
After Mookerjee and others, 2015



Today's Field Platform?

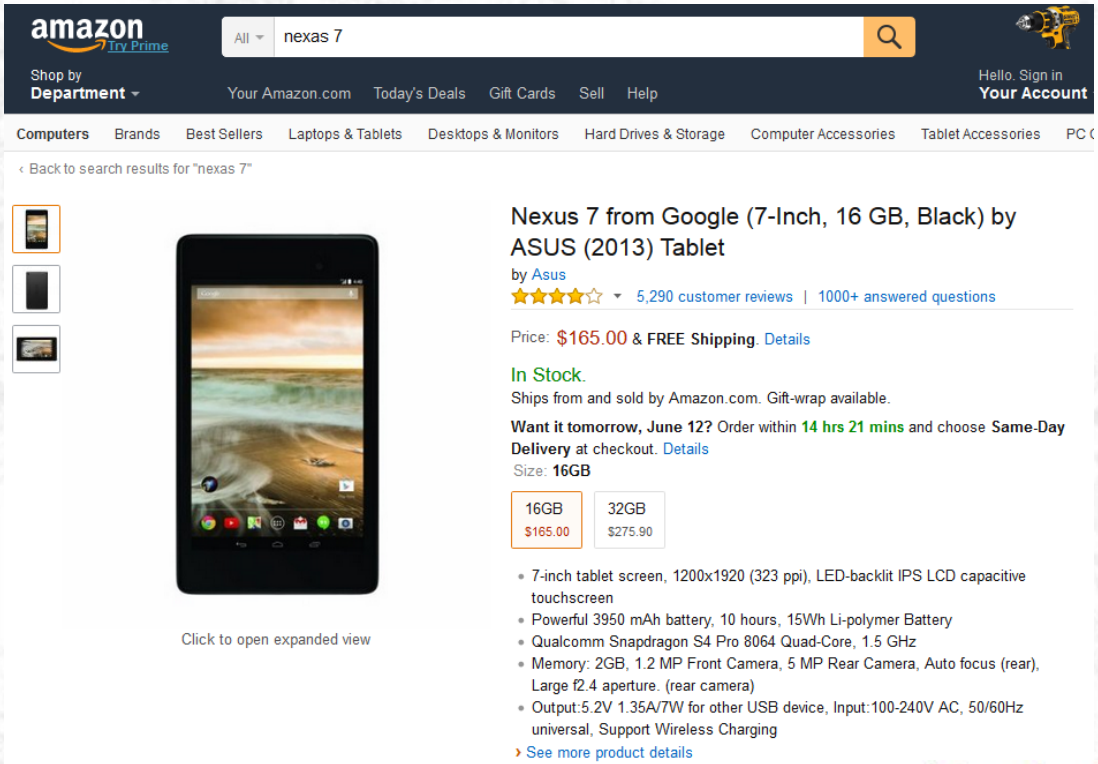
OS	Device	Screen	Resolution	Dimensions (in)	Weight (gm)	Battery Life	GPS
Windows 8.1	Surface Pro 3	12"	2160x1440	11.5x7.93x0.36	800	9 hours	No
Windows 8.1	Dell Venue 11 Pro	10.8"	1920x1080	11.72x6.96x0.4	772	8-10 hours	No
Android	Nexus 7	7"	1280x800	7.81x4.72x0.41	340	9 hours	Yes
Android	Moto X	4.7"	1280X720	5.09x2.57x0.41	130	4 hours	Yes





Or These?

All Android



What do you want to pay for?

Hardware	
10	Visually pleasing screen
3	Lightweight and comfortable
3	Waterproof and ruggedized
3	Connects with other sensors
2	Quality camera
2	Reliable/accurate sensors
1	Long battery life

Software: data management	
9	Easily syncable to database, backup to the cloud
9	The ability to access/download existing data
4	Data is easily exportable in useful, agnostic formats
2	Efficient workflow
1	The ability to share data easily
Software: foundational	
11	Open source ("community ownership") and free
7	Available on all platforms (e.g., Mac, PC, tablet, phone)
6	Open Geospatial Consortium (OGC)/standards compliant
1	Extensibility (designed for future growth)

Software: Tools	
16	**Accurate Measurements:** orientations, GPS, projections
11	**Feels like a field notebook** (starts with a blank page look)
11	**Maps:** pre-load, interactive layers, tools (pts/lines/polys)
10	**Sketches/photographs:** georeff, edit, annotate
8	**Voice recognition:** offline, map symbols
4	**3D/Augmented Reality**
3	**Select rock types from diagrams** (e.g., a ternary diagram)
3	**Operate offline**
3	**A companion Desktop app:** curate/customize mobile app
3	**Connectible to various other sensors**
2	**The ability to build a stratigraphic column**
2	**Easily customizable/modular use of screen real estate**

Mookerjee, M., D. Vieira, M. A. Chan, Y. Gil, T. L. Pavlis, F. S. Spear, and B. Tikoff (2015), Field data management: Integrating cyberscience and geoscience, Eos, 96,doi:10.1029/2015EO036703.

ianMICRODEM, Nov 2015

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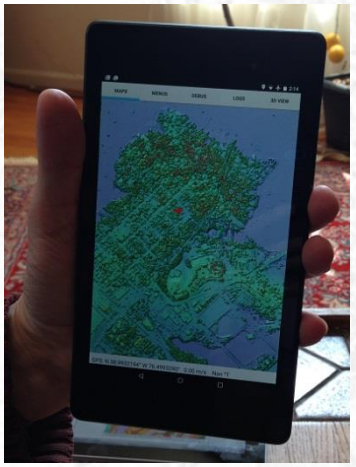
What do you want to automate?

What's on field handheld?

What's on desktop at base camp?

Design Philosophy



Entirely offline

- “Cheap tablet” with no net connections
- Locations off the net
- No mouse, keyboard, stylus

Partner with desktop/laptop GIS

- Download data
- Subset, reformat data
- Use keyboard, mouse

Incremental

Start with basics

- GPS location on base map
- 3D graphics of current location
- Geologic computations like 3 point problem

Pair with other programs

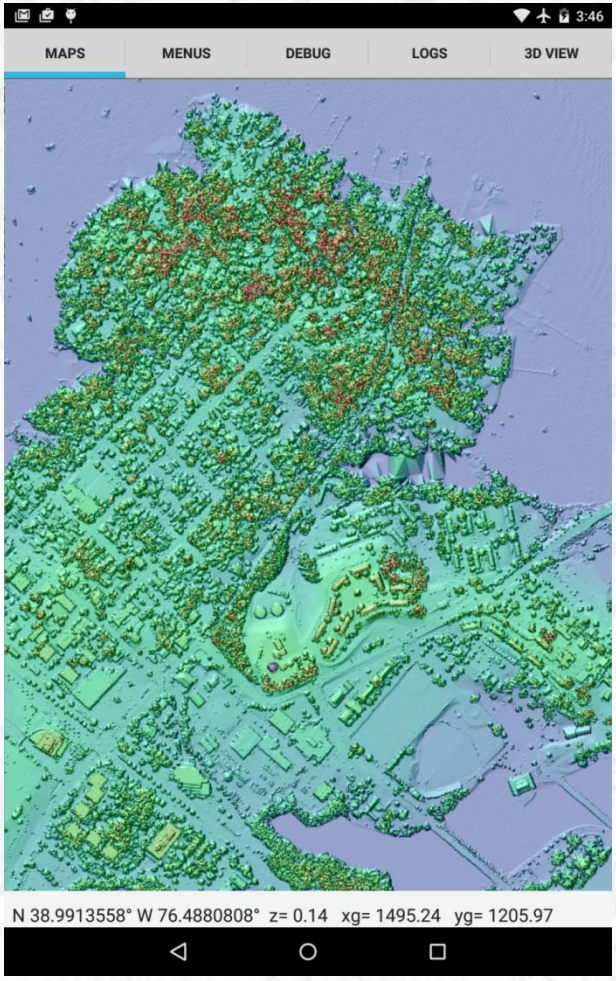
- Data entry
- Dip/strike measurement

Add new capabilities over time—full core of the GIS runs in native code on handheld

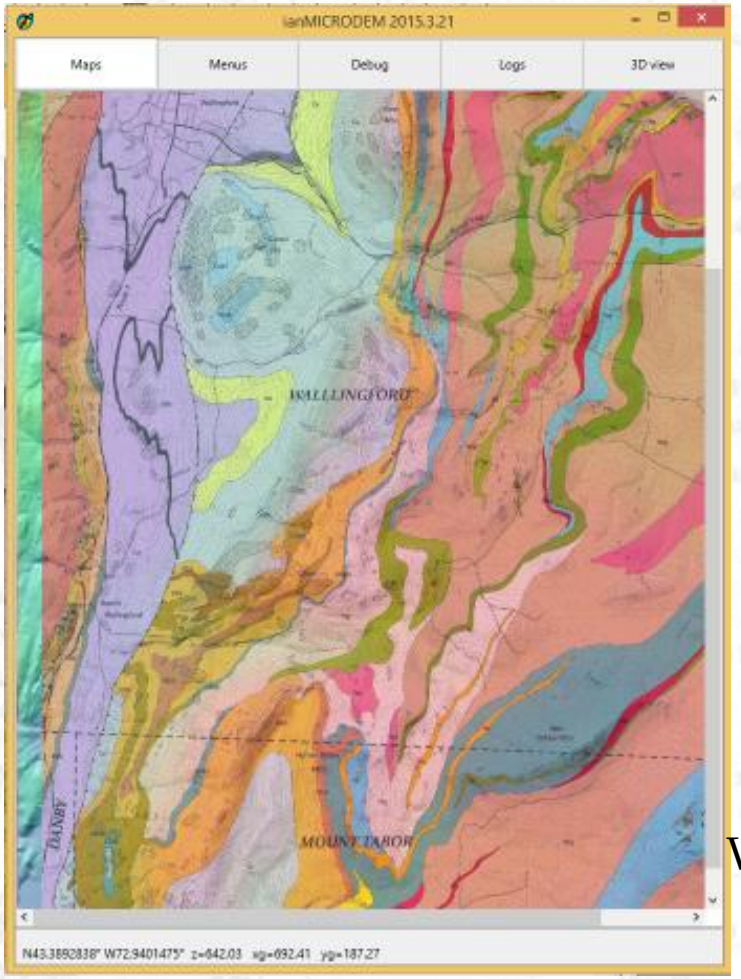
Multiplatform

Windows and Android working

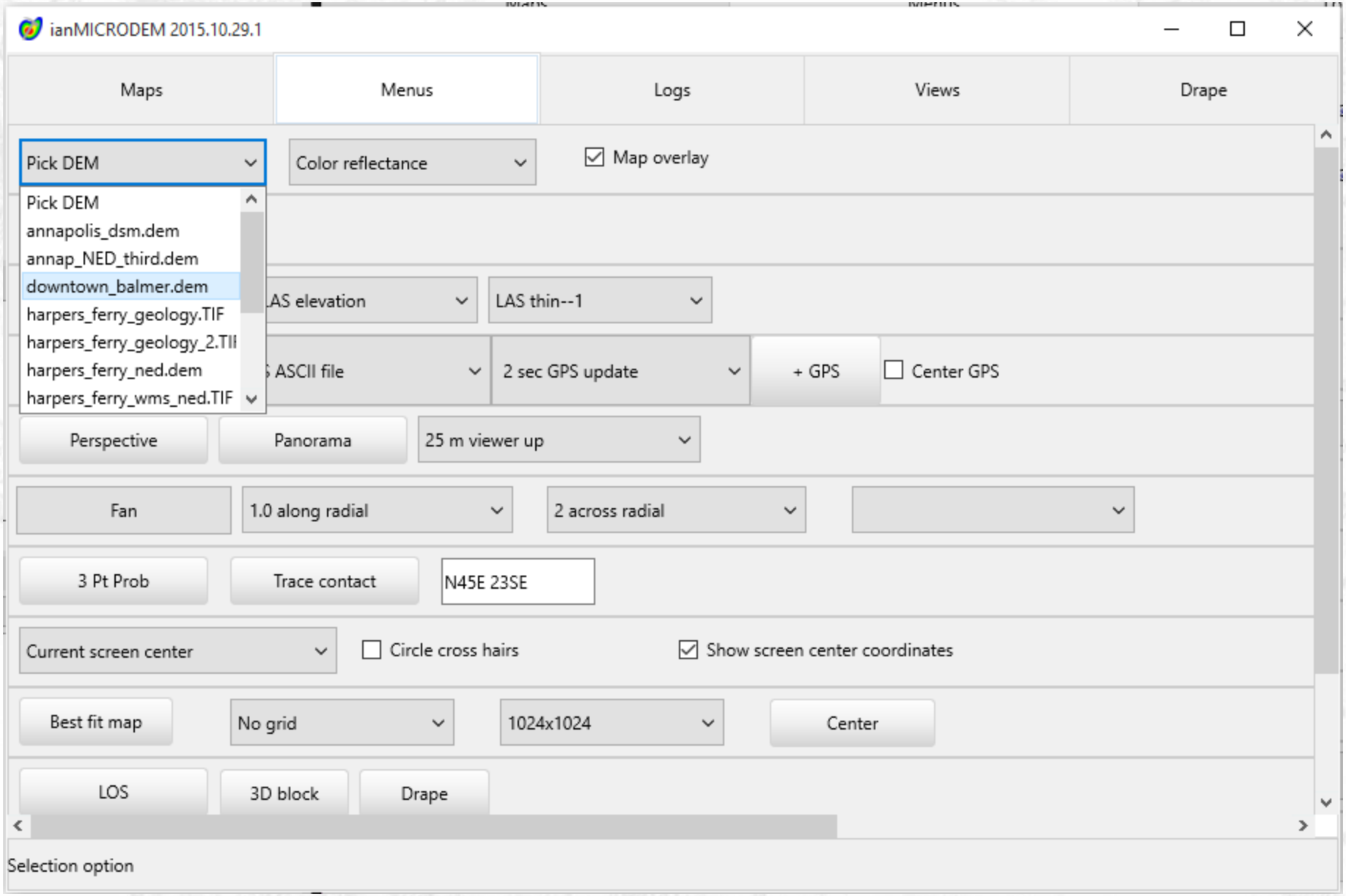
iOS and Mac OS can use same code



Android



Windows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Menus
Logs
Views
Drape
Pick DEM
Color reflectance
Map overlay
Pick DEM
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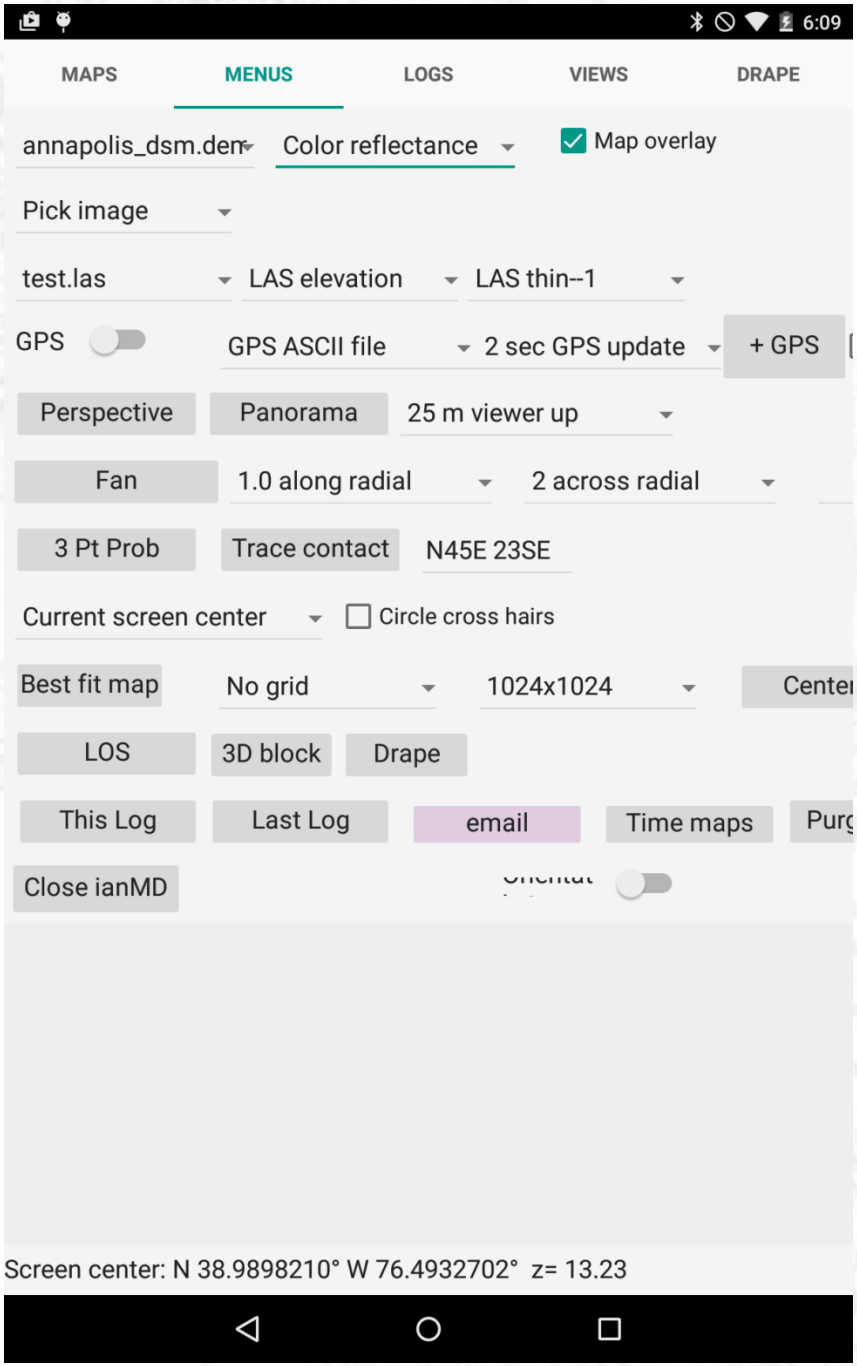
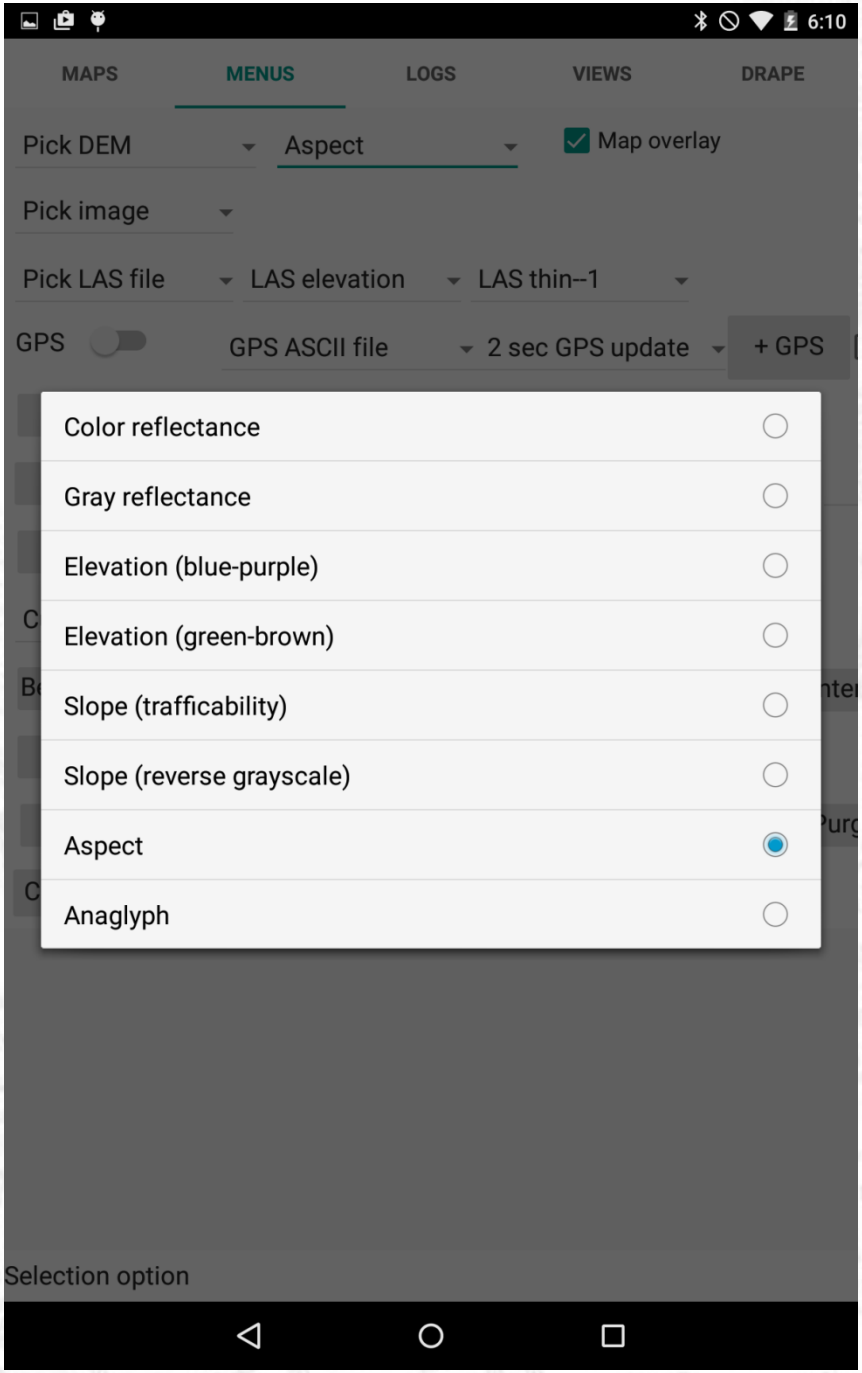
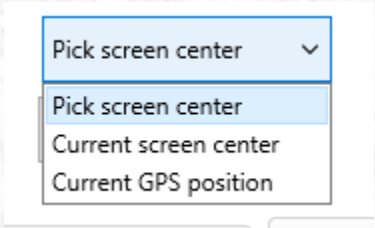
annap_NED_third.dem
downtown_balmer.dem
harpers_ferry_geology.TIF
harpers_ferry_geology_2.TIF
harpers_ferry_ned.dem
harpers_ferry_wms_ned.TIF
LAS elevation
LAS thin--1
ASCII file
2 sec GPS update
+ GPS
Center GPS
Perspective
Panorama
25 m viewer up
Fan
1.0 along radial
2 across radial
3 Pt Prob
Trace contact
N45E 23SE
Current screen center
Circle cross hairs
Show screen center coordinates
Best fit map
No grid
1024x1024
Center
LOS
3D block
Drape
Selection option


6:09
MAPS
MENUS
LOGS
VIEWS
DRAPE
annapolis_dsm.dem
Color reflectance
Map overlay
Pick image
test.las
LAS elevation
LAS thin--1
GPS
GPS ASCII file
2 sec GPS update
+ GPS
Perspective
Panorama
25 m viewer up
Fan
1.0 along radial
2 across radial
3 Pt Prob
Trace contact
N45E 23SE
Current screen center
Circle cross hairs
Best fit map
No grid
1024x1024
LOS
3D block
Drape
This Log
Last Log
email
Time maps
Close ianMD
Screen center: N 38.9898210° W 76.4932702° z= 13.23


6:10
MAPS
MENUS
LOGS
VIEWS
DRAPE
Pick DEM
Aspect
Map overlay
Pick image
Pick LAS file
LAS elevation
LAS thin--1
GPS
GPS ASCII file
2 sec GPS update
+ GPS
Color reflectance
Gray reflectance
Elevation (blue-purple)
Elevation (green-brown)
Slope (trafficability)
Slope (reverse grayscale)
Aspect
Anaglyph
Selection option

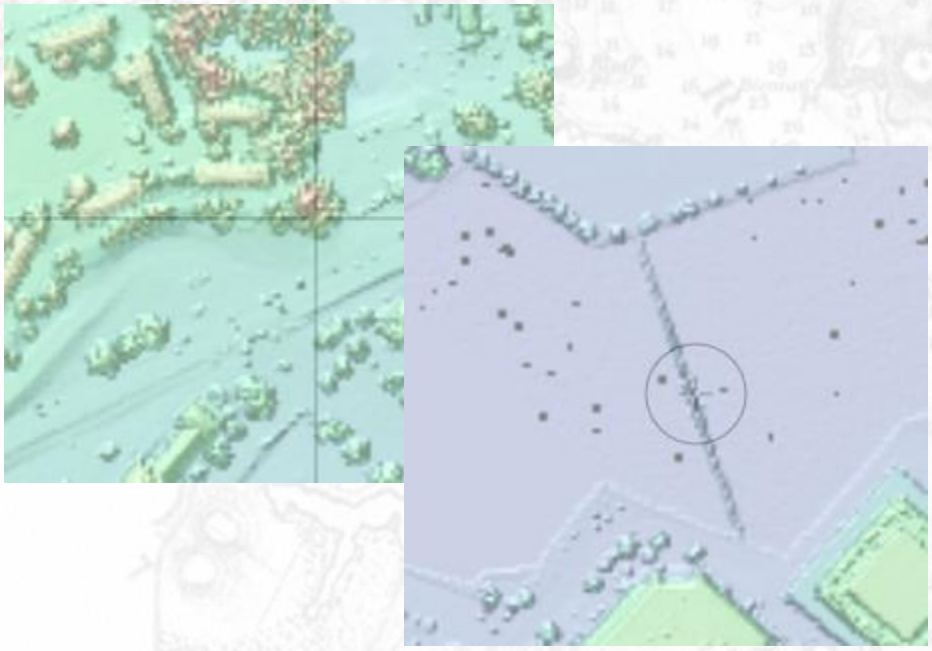
Point Selection

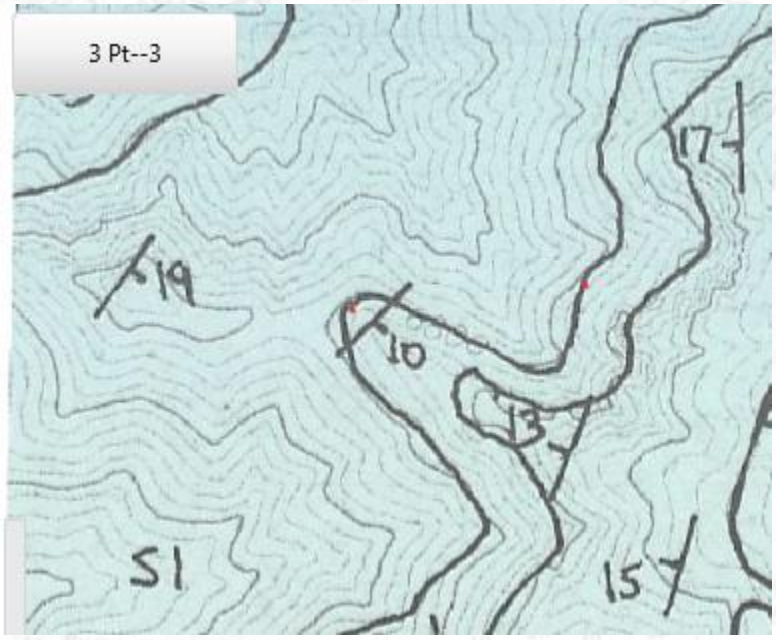


Current GPS Position

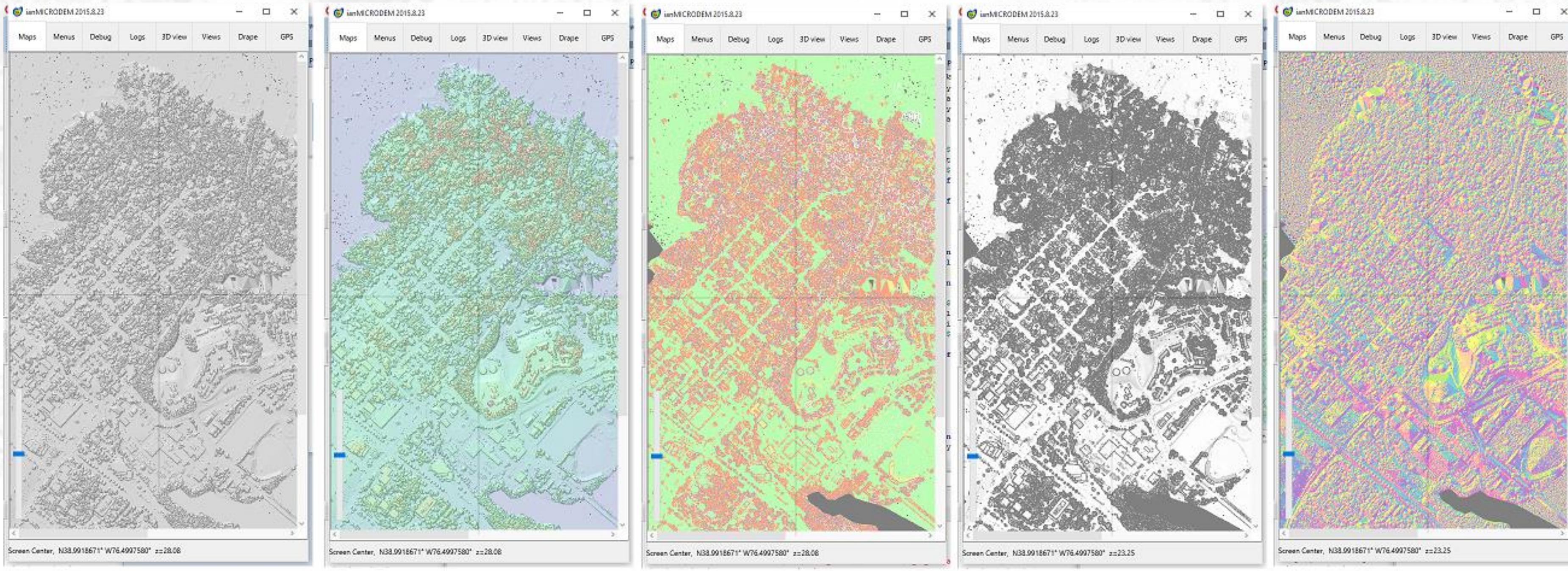
Current Screen Center (finger ≠ mouse), drag map to position

Confirm with button

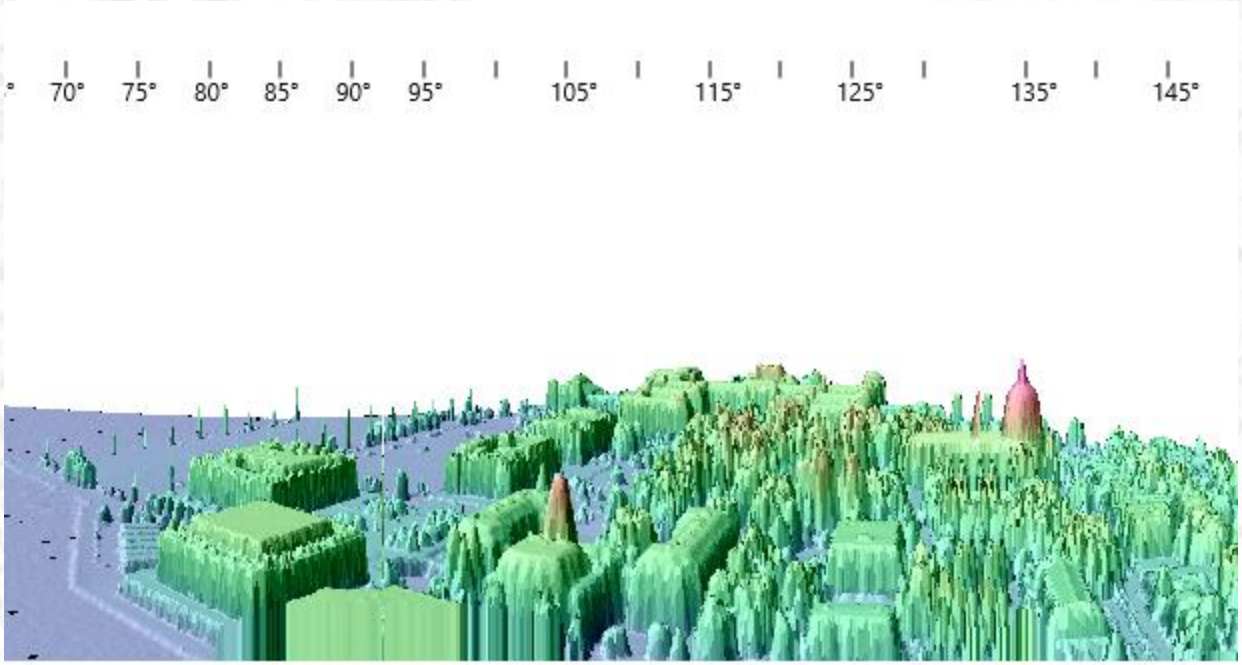


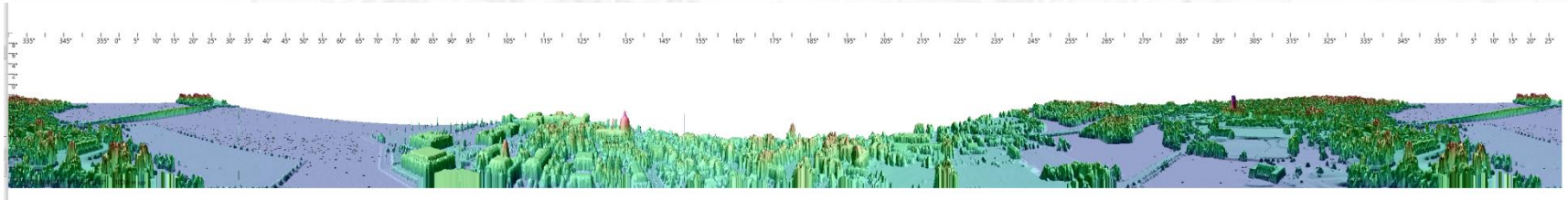


DEM Base Maps



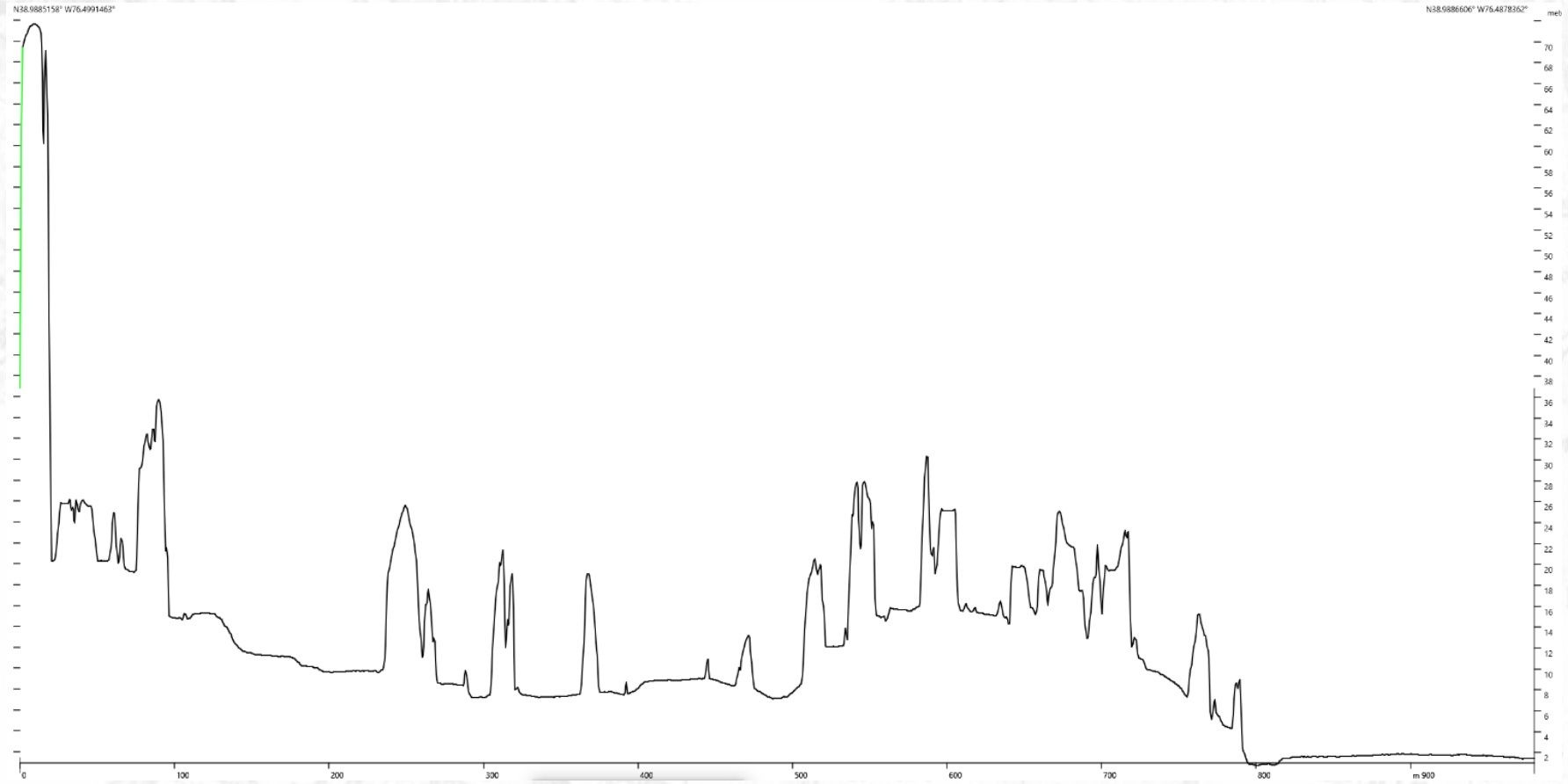
3D Panoramas



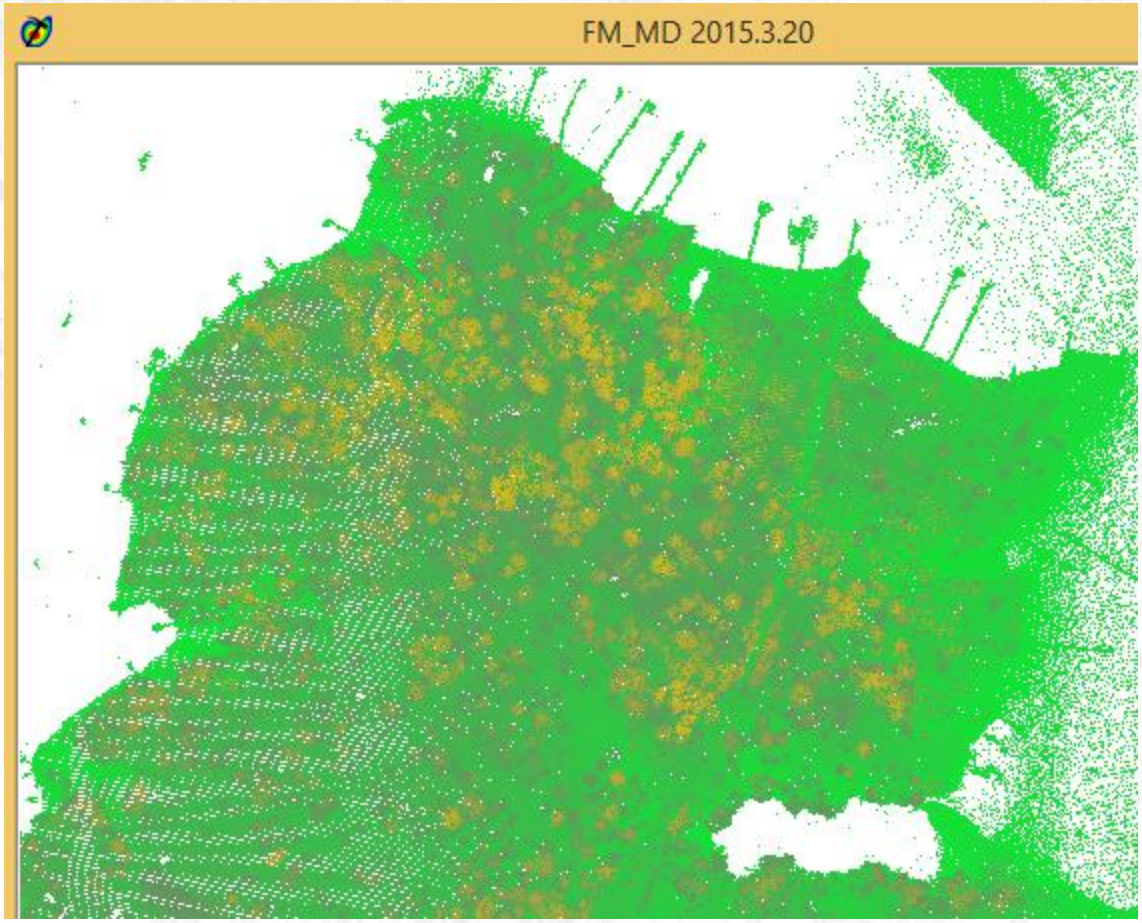


Match photo, view, get coordinates from screen

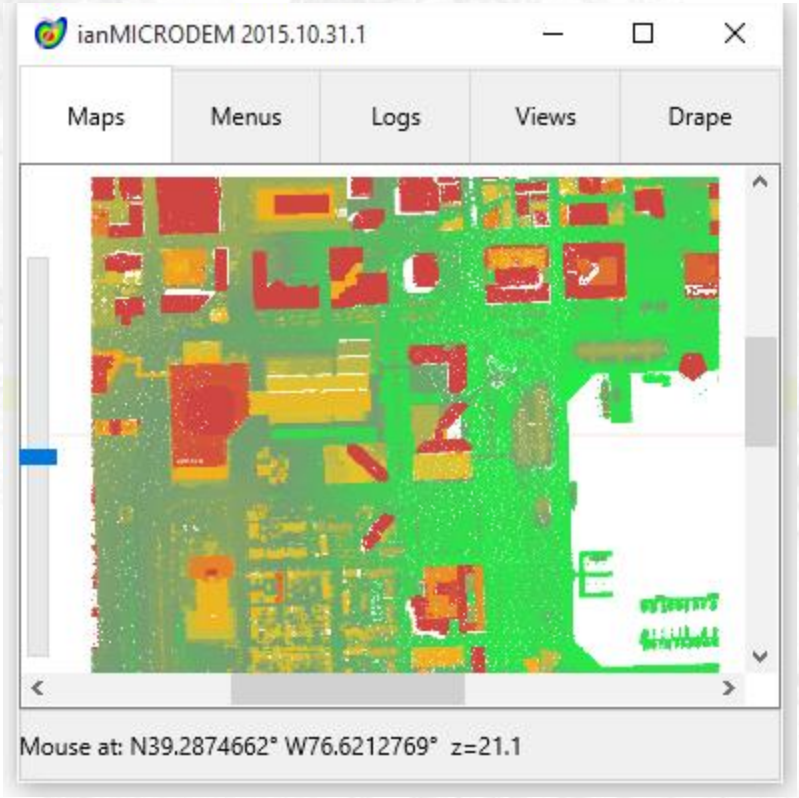
Line of Sight/Topographic Profiles



LIDAR (LAS point cloud)



Lidar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Maps
Menus
Logs
Views
Drape
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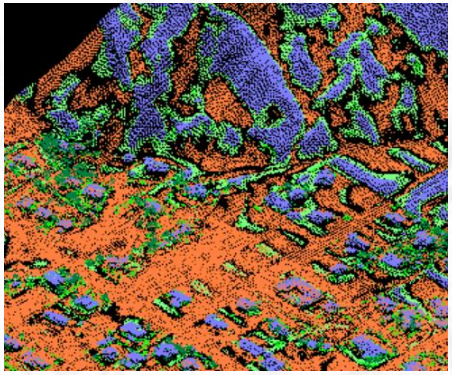
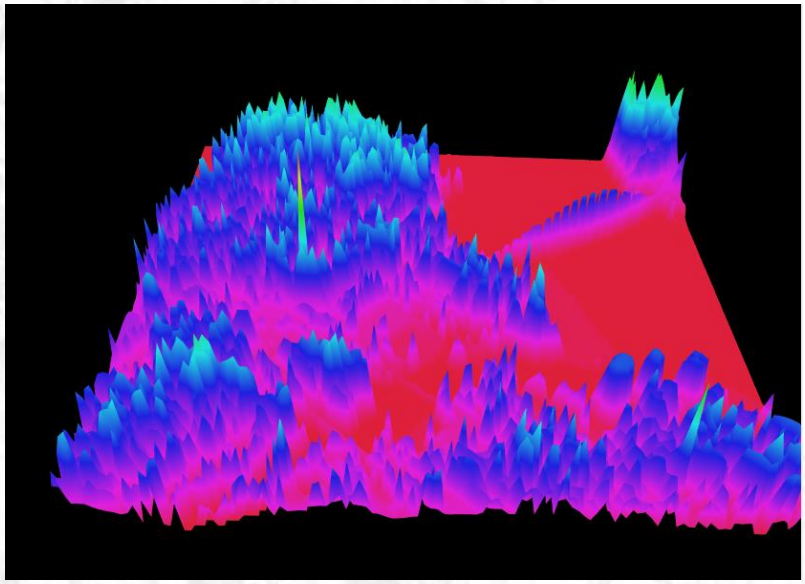
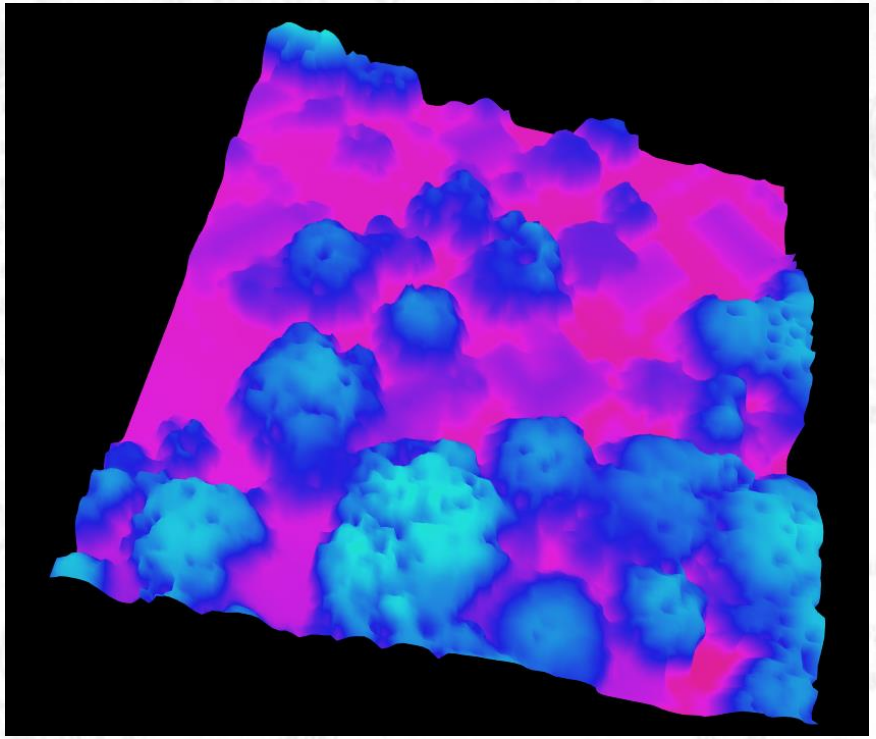
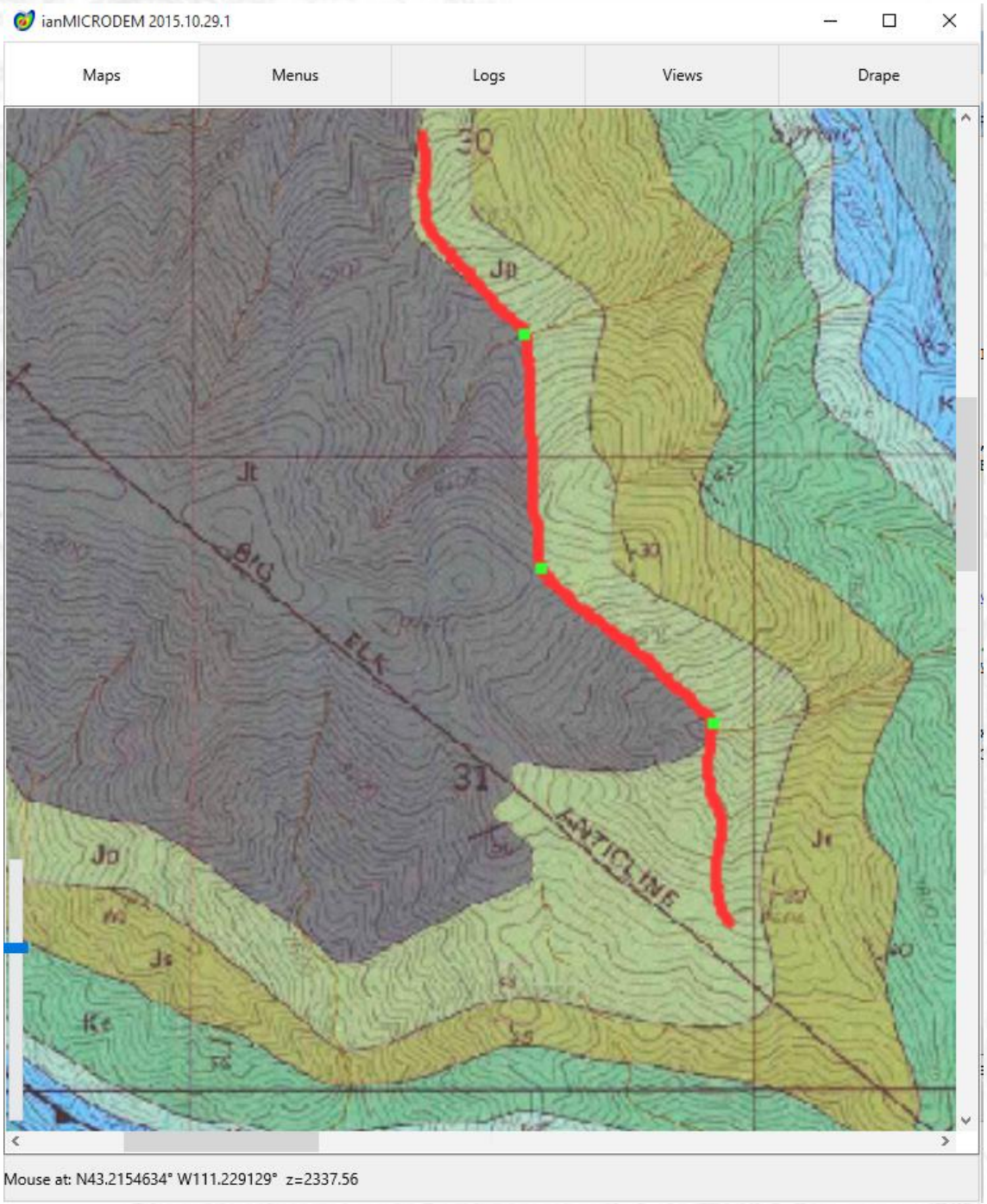


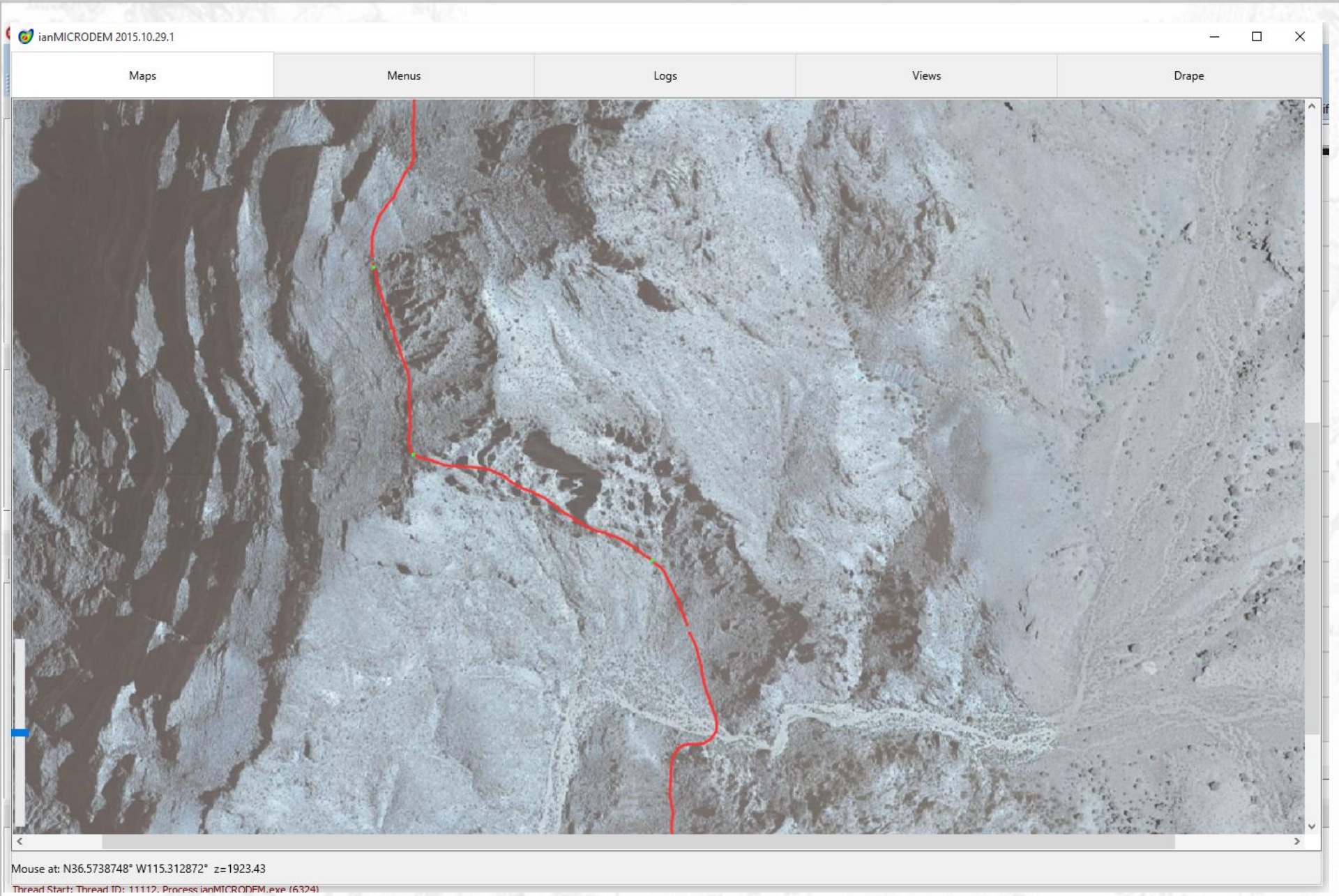
Mesh Diagrams







3 Point Problem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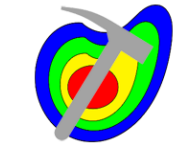
Maps
Menus
Logs
Views
Drape
Mouse at: N36.5738748° W115.312872° z=1923.43
Thread Start: Thread ID: 11112, Process ianMICRODEM.exe (6324)

MICRODEM

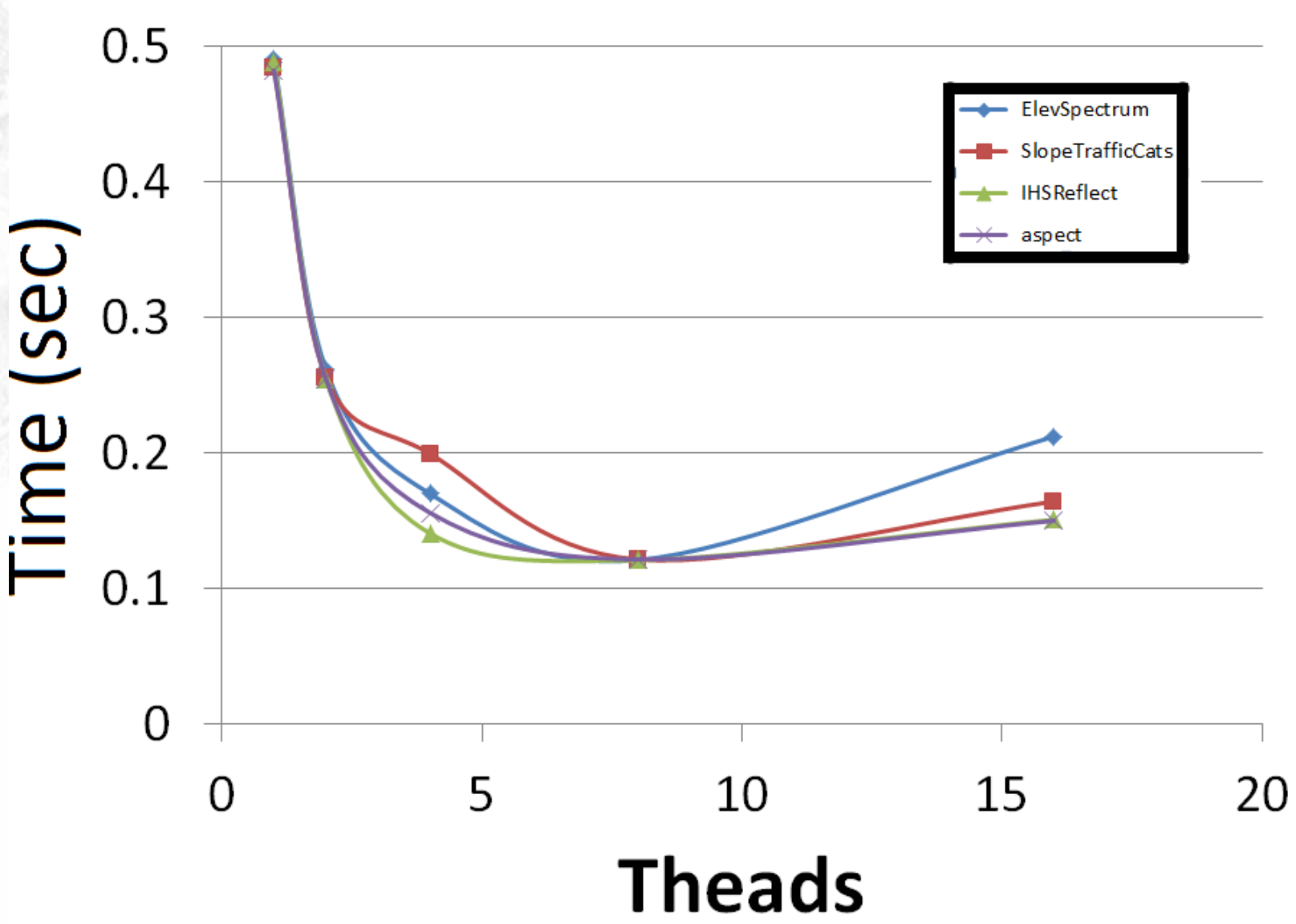
- Freeware
- Windows only, 32 and 64 bit
- Delphi DX Seattle Professional ($1081)
- ~230 forms
- ~350,000 lines of code
- Full GIS, focus geology/geomorphometry



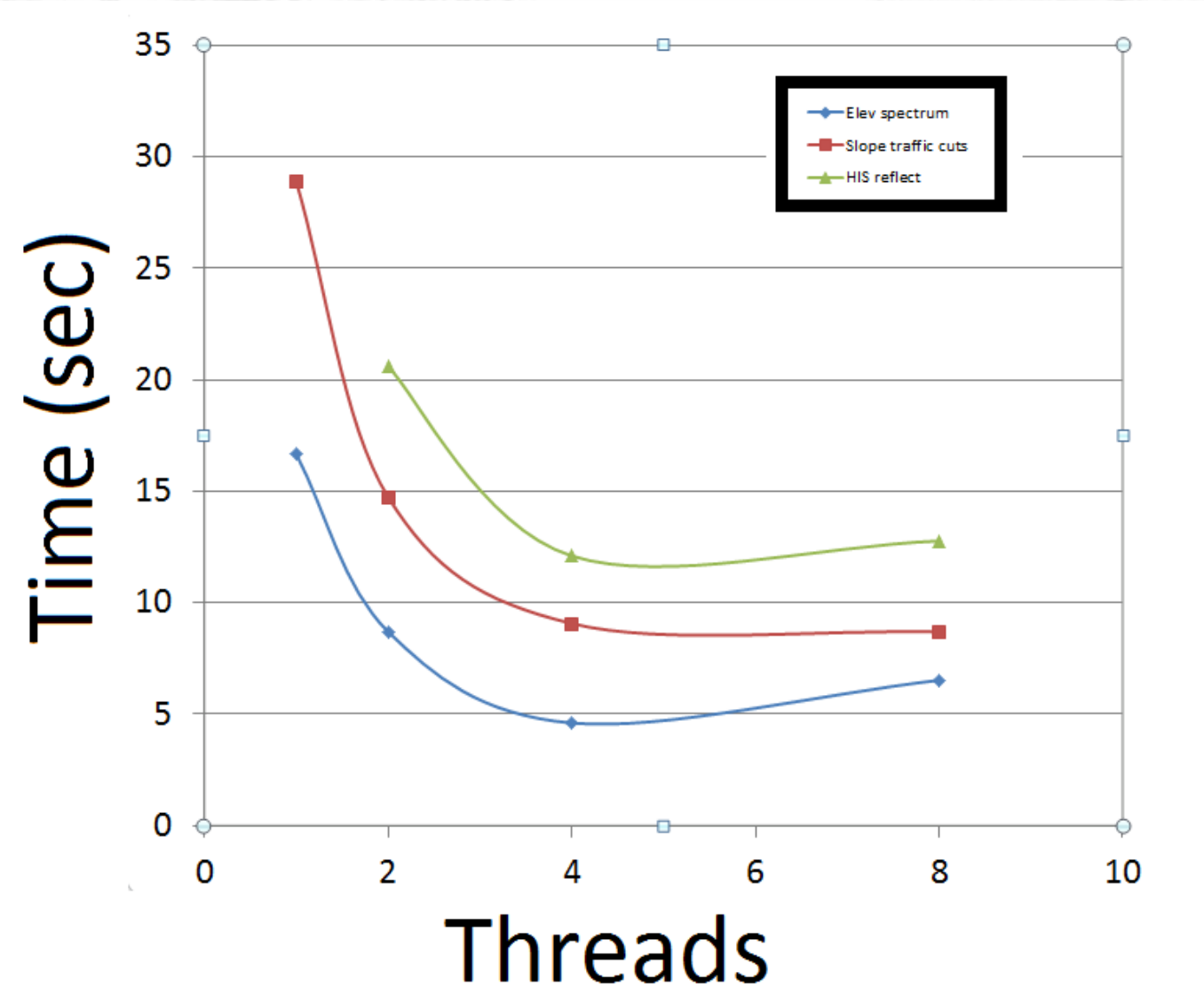
ianMICRODEM

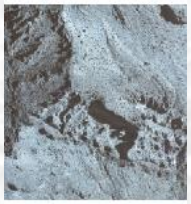
- Open source
- Windows and Android working
- iOS and Mac OS possible
- Delphi DX Seattle Professional ($1081 + $540)
- Subset of MICRODEM useful in field
- Same base code, complete new UI
- ~70,000 lines of code
- Contact me for details

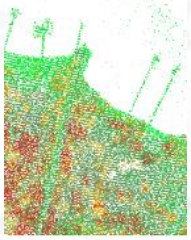
Map Drawing: Windows 10, 8 cores

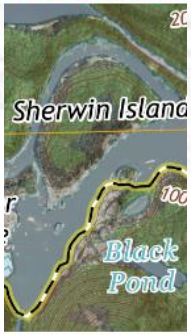


Nexus 7 (4 cores)









Data Sets Currently Supported

DEMs: MICRODEM format, GeoTiff

Imagery: untiled Geotiff

Lidar: LAS format

Topo quads: Geotiff (from GeoPDF very slow in GDAL, huge files)

National Geologic Map Database: Geotiff (from KMZ, their "Geotiff" via ESRI)

One Datum: WGS84/NAD83

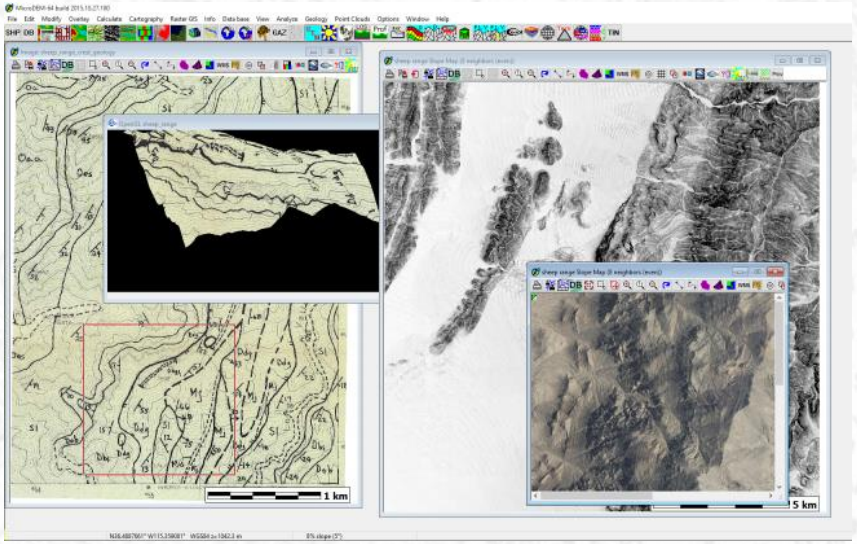
Integrate with Desktop MICRODEM (or QGIS or Arc or ….)

Reformat data, with GDAL

Get USGS WMS imagery and save as Geotiff

Convert KMZ geologic maps to Geotiff

Pre and post analysis in full GIS



Next Steps

Download program and data provide feedback

- http://www.usna.edu/Users/oceano/pguth/ianMD/
- Windows and Android

Code for iOS, Mac OS if you want those platforms

- Open source

Code for Android phones, Google Glass ……

- Open source

Cell Phones/Tablets Can do Geologic GIS

Native code

Little slower than desktop

In the field

Vest or shirt pocket

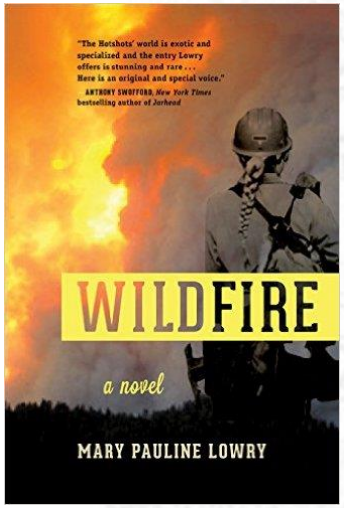
Smart interface

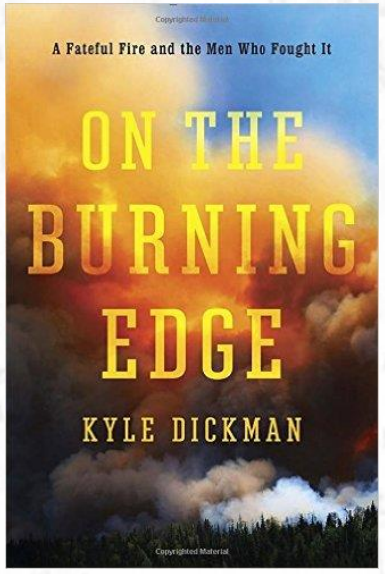
Demos near posters, #3
12:00 noon
4:00 PM

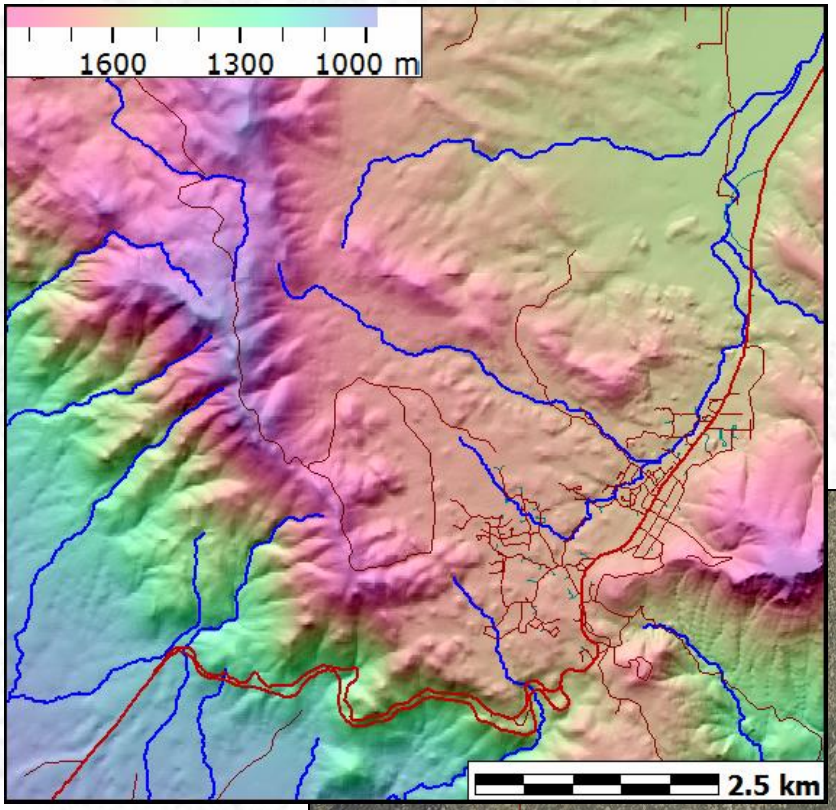
- http://www.usna.edu/Users/oceano/pguth/ianMD/

Situational Awareness

Figure 4. Photo taken by a GMIHC Crew member on two-track road on June 30, 2013.



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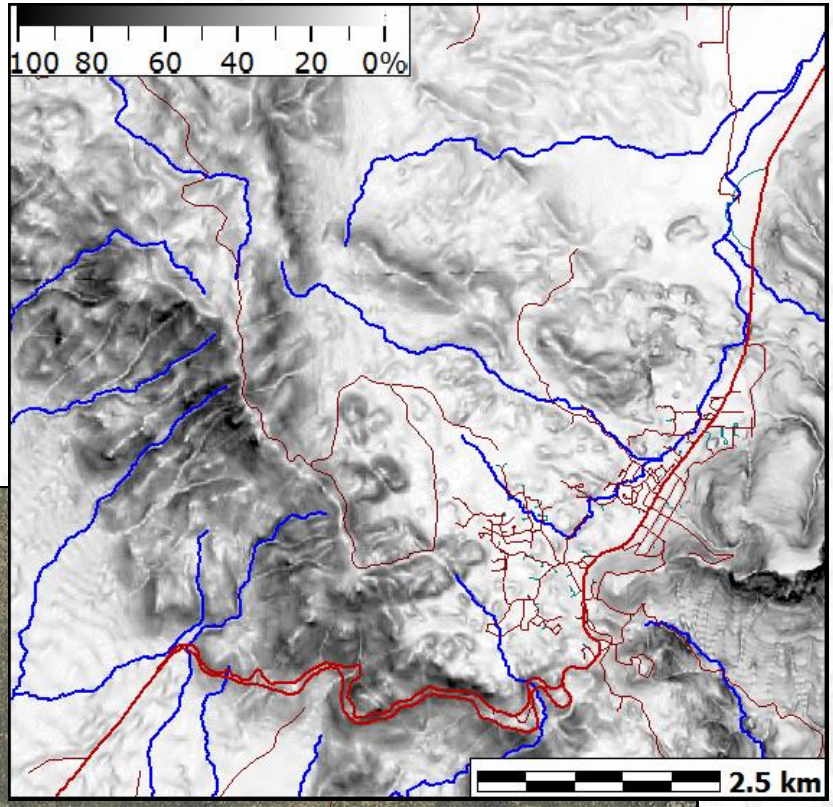
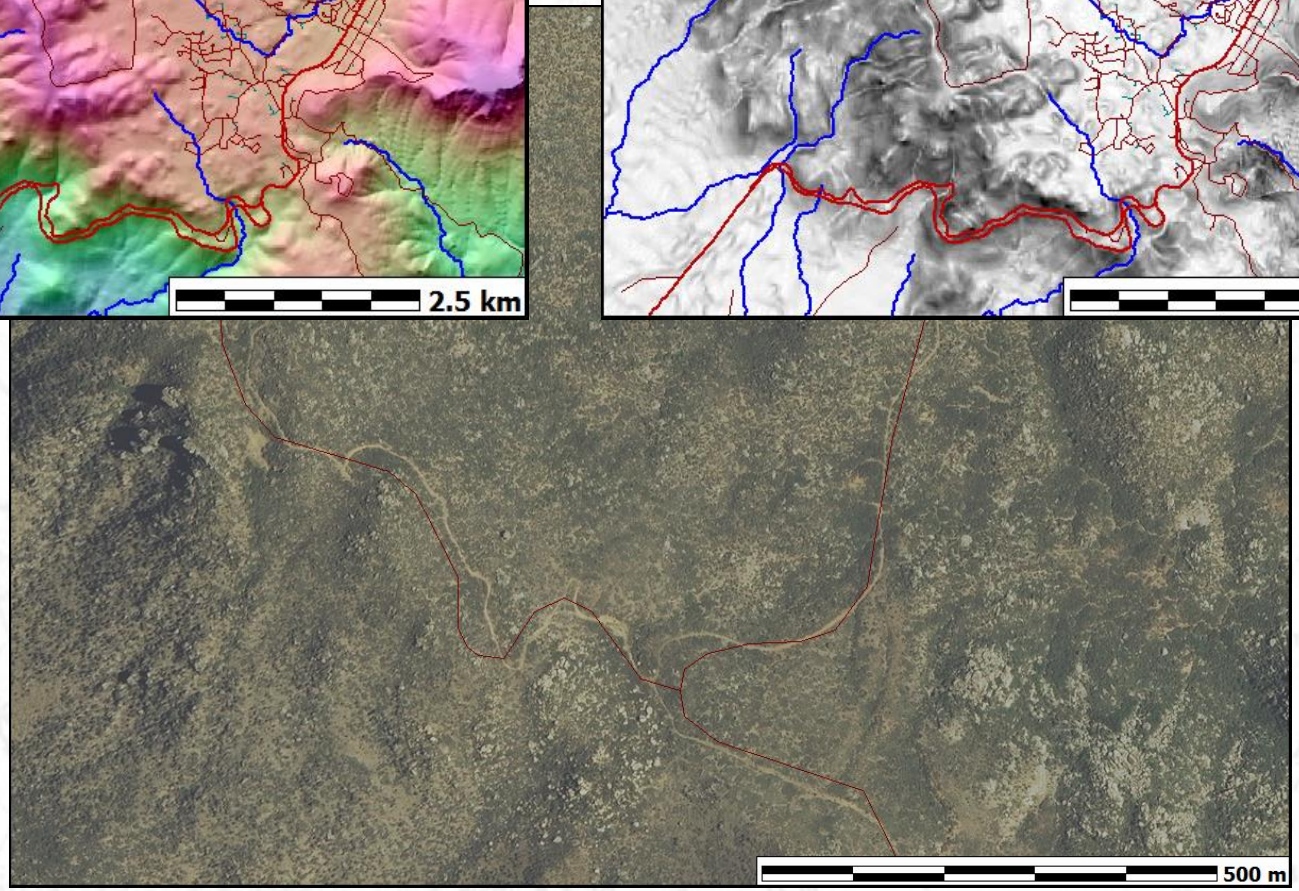
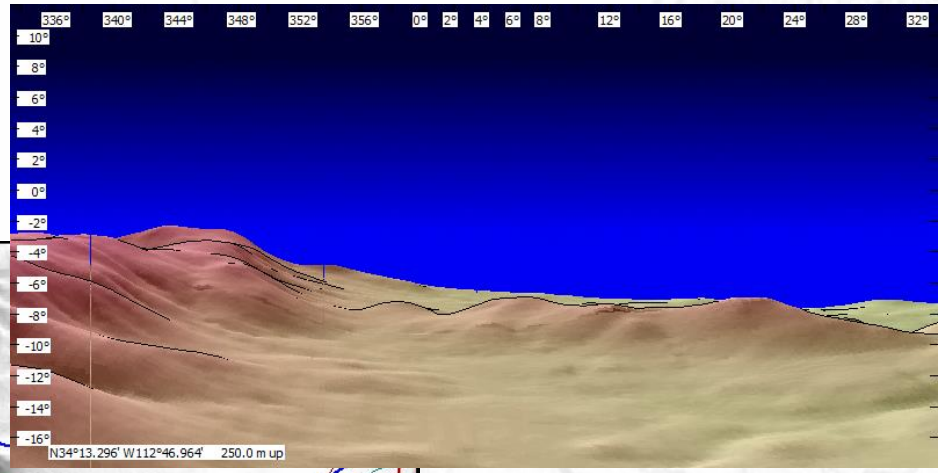
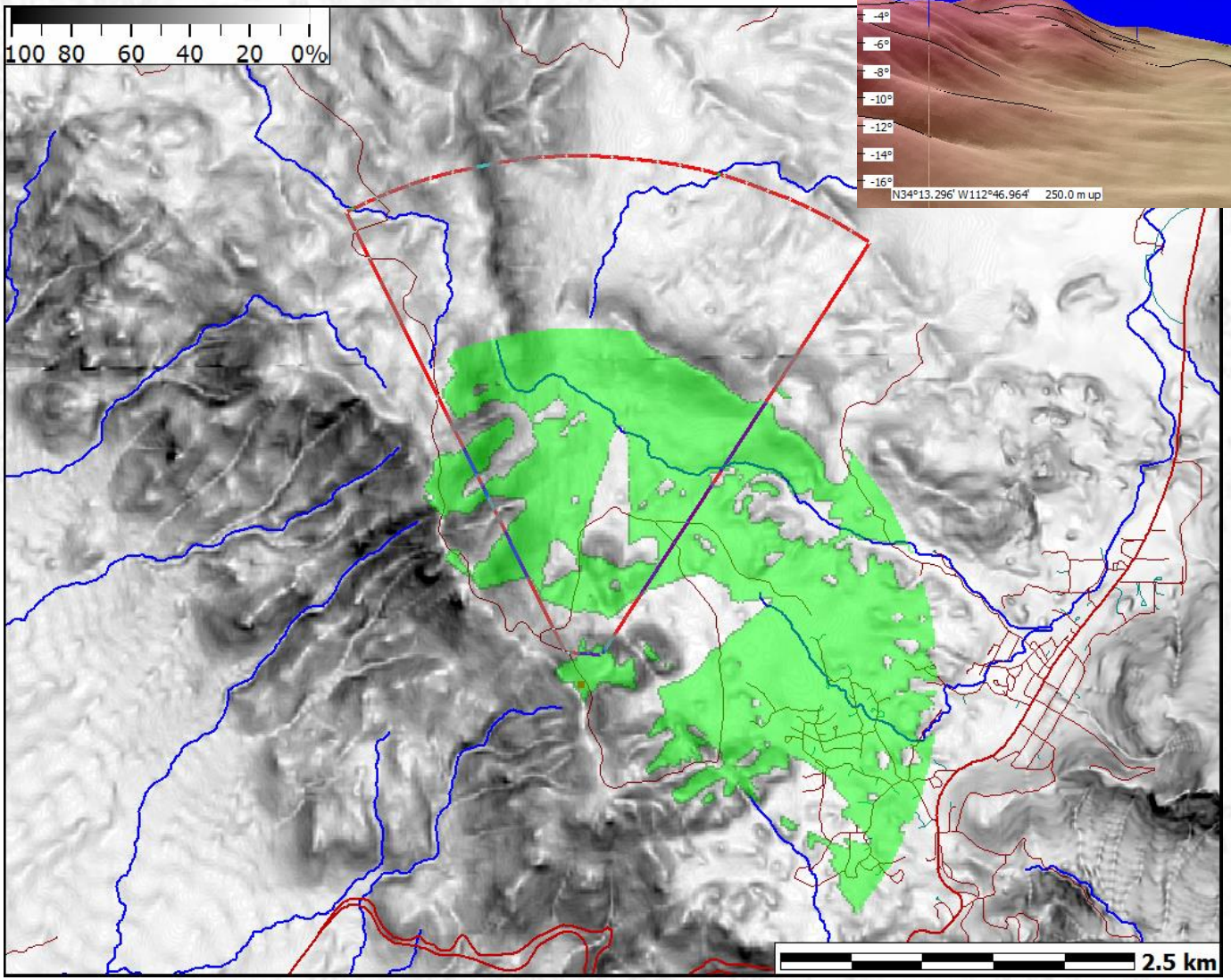
2.5 km


100 80 60 40 20 0%
2.5 km


500 m





1/3” NED

Add vegetation, land cover

GPS & compass

Cell Phones/Tablets Can do Geologic GIS

Native code

Slower than desktop

In the field

Vest or shirt pocket

Smart interface

Demos near posters, #3
12:00 noon
4:00 PM

- http://www.usna.edu/Users/oceano/pguth/ianMD/