Flood Risk Mapping using LIDAR, SE NB Climate Change Action Fund

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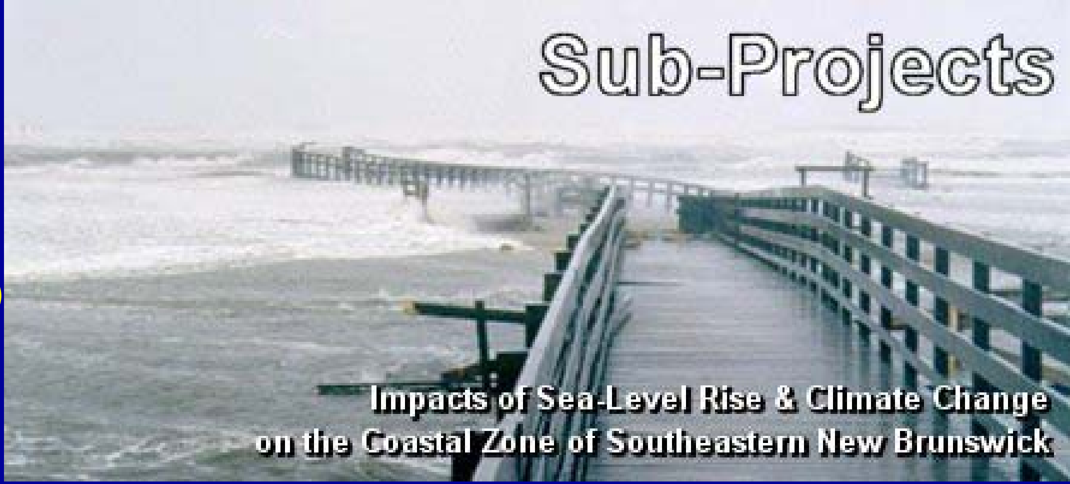
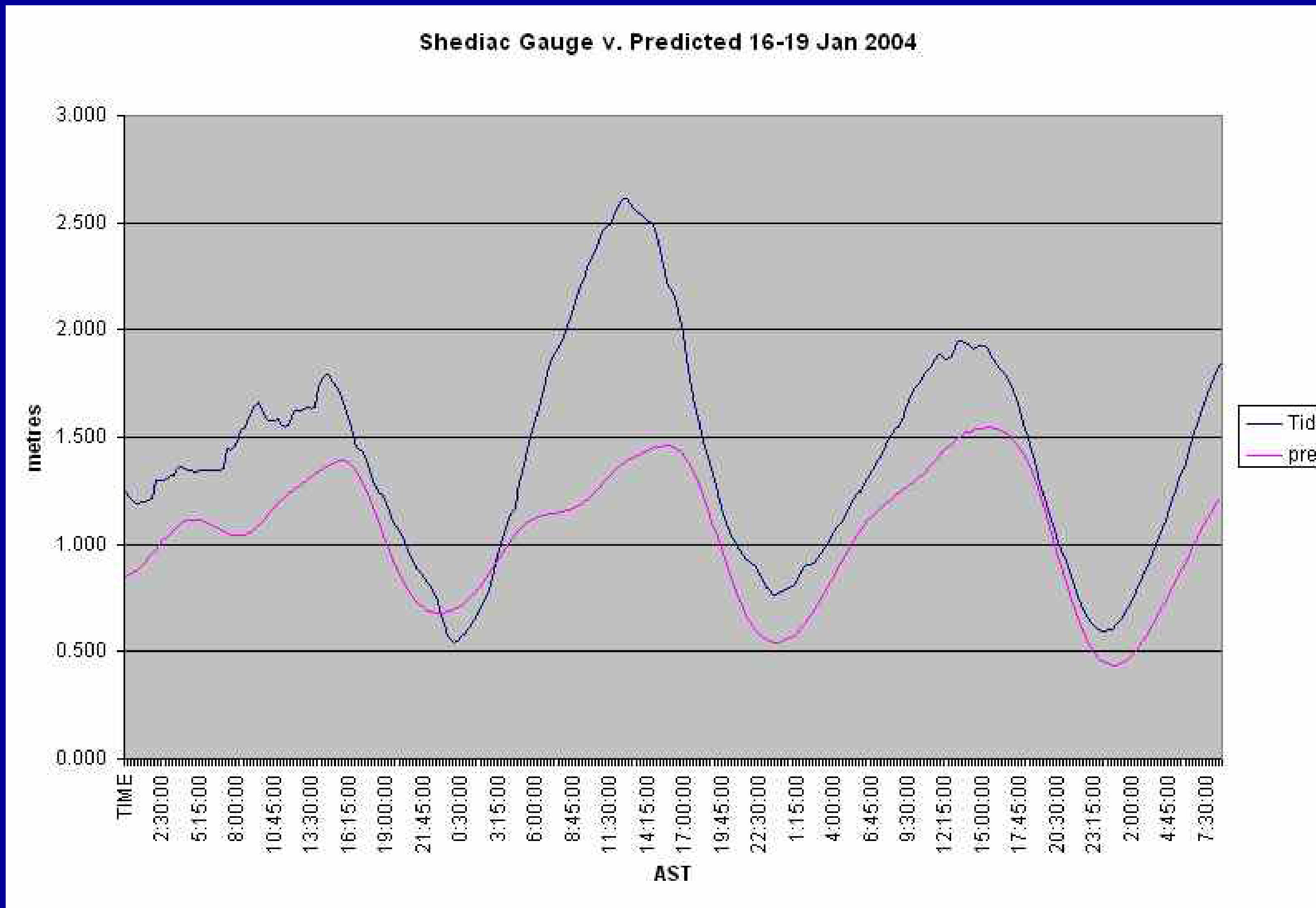
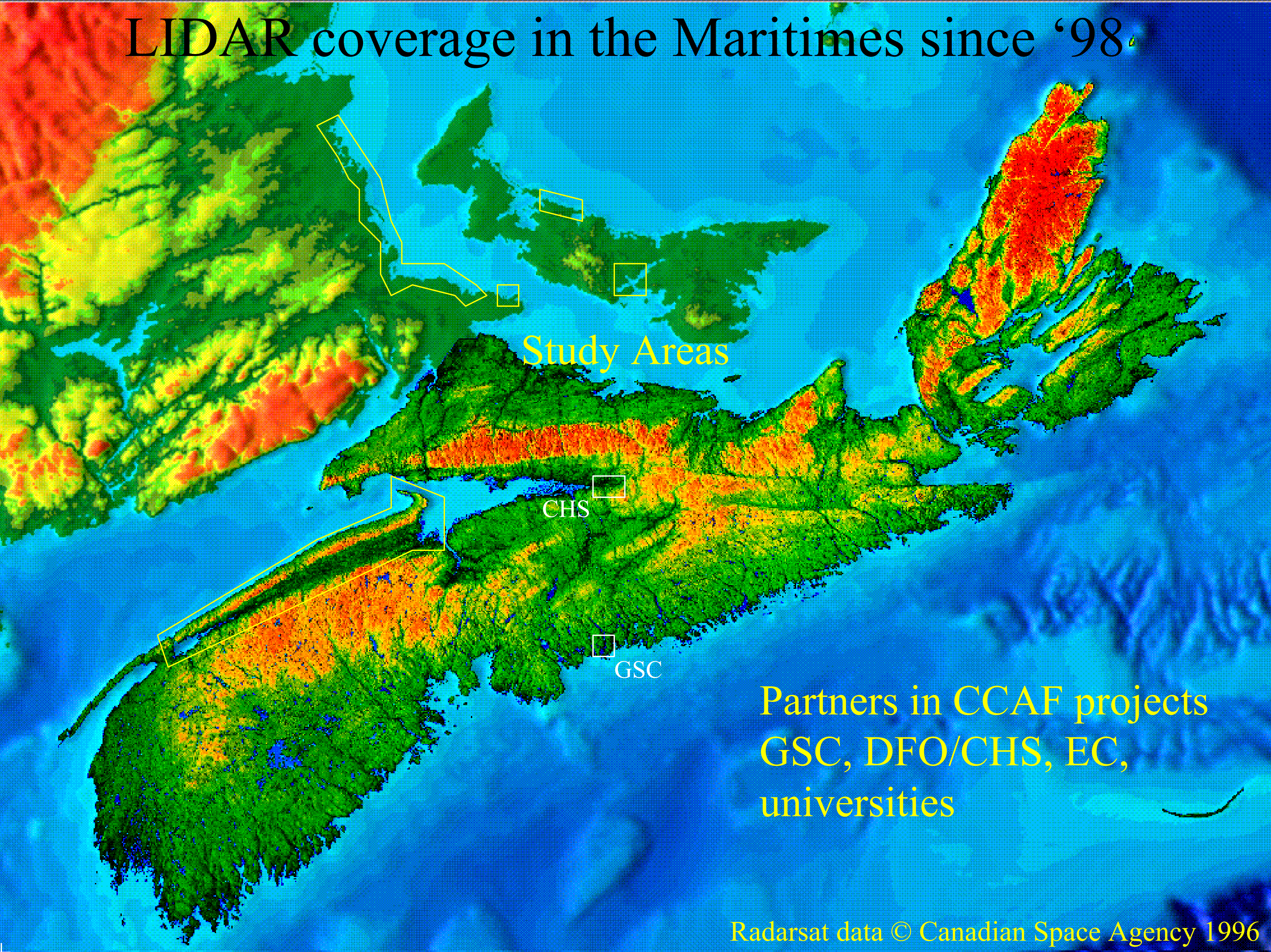


- **Project Team**
- Université de Moncton
- University of New Brunswick
- Mount Allison University
- Centre of Geographic Sciences (AGRG)
- Dalhousie University
- La Dune de Bouctouche
- Province of New Brunswick
- Environment Canada
- Natural Resources Canada
- Parks Canada
- Department of Fisheries and Oceans
- Public Safety and Emergency Preparedness Canada
- Government of Canada's Climate Change Impacts and Adaptation Program
- Beaubassin Planning Commission
- Kent Planning Commission

http://atlantic-web1.ns.ec.gc.ca/slr/

Storm Surge + Sea Level Rise

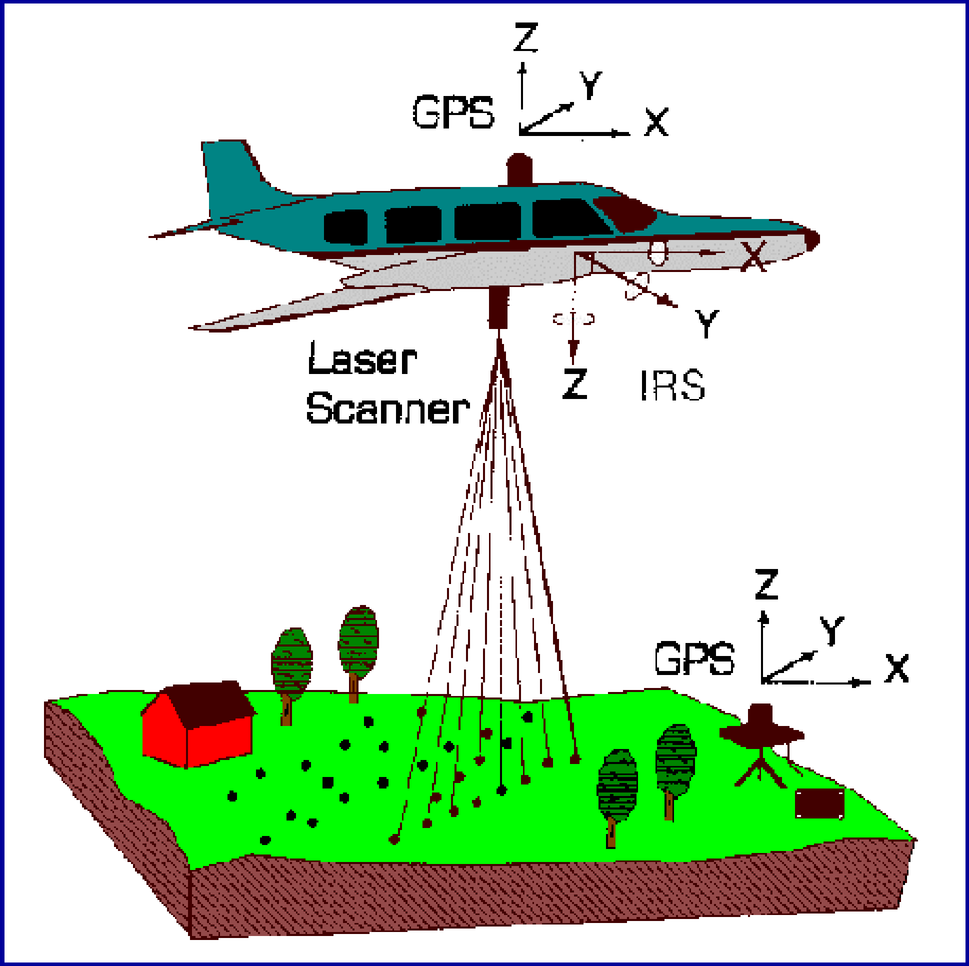



LIDAR coverage in the Maritimes since '98
Study Areas
CHS
GSC
Partners in CCAF projects
GSC, DFO/CHS, EC,
universities
Radarsat data © Canadian Space Agency 1996

LIDAR Unit

LIDAR uses laser pulses, fired from an airborne platform, to determine and record the elevation of the ground integrated through the Time Interval Meter (TIM)

- GPS P-code is used to position the aircraft
- Inertial Reference System (IRS or IMU) is used to measure the attitude of the aircraft (pitch, yaw, roll).
- TIM used to record pulse 2 way time and scan angle (point spacing controlled by pulse rate, scan rate and forward speed).
- Target position latitude, longitude, ellipsoidal height (WGS84)



LIDAR Post Processing

- Differential processing of carrier phase GPS data from the ground and airborne units. Aircraft track plot can be generated at this time.
- Laser point coordinate determination from the eight data elements (aircraft XYZ and attitude from the IMU output, scanner angle and range from the TIM). The points are transformed into WGS-84 latitude and longitude or UTM.
- Point analysis is performed, classifying them into terrain or other objects.
- Accuracy analysis. Determination of systematic positioning errors in the points. Use overlap areas and GCPs as reference.

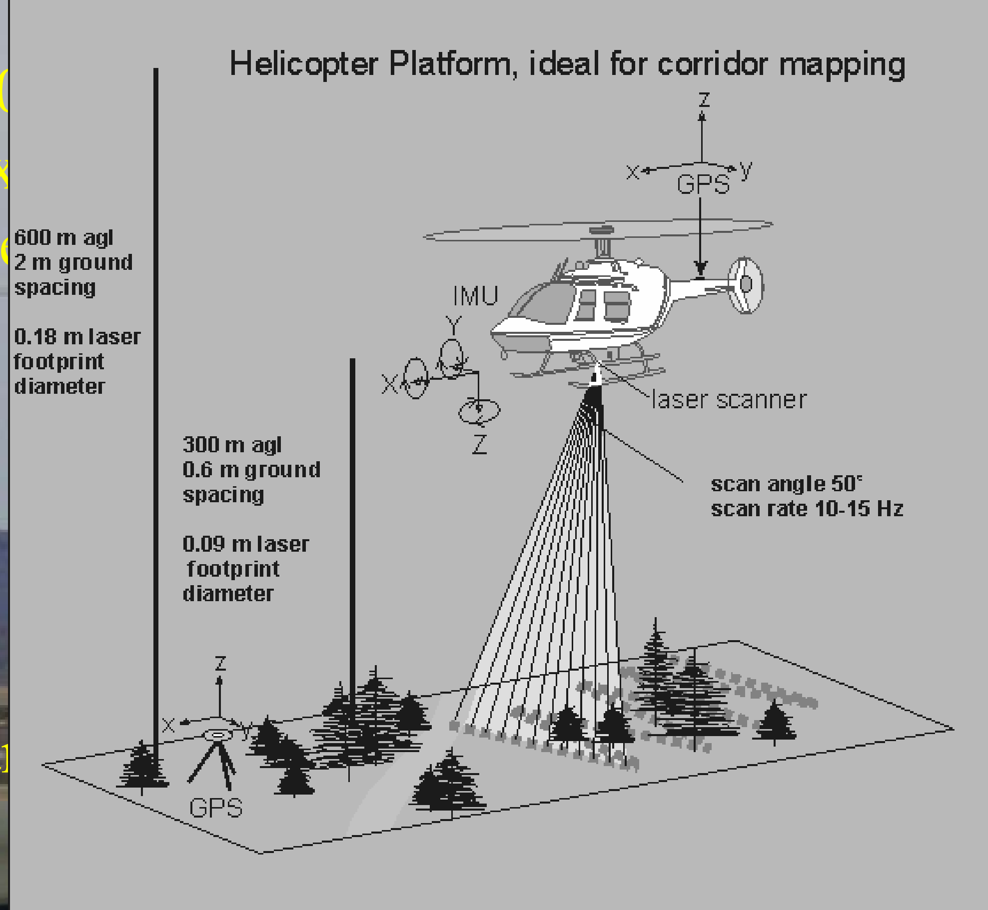
LIDAR – practical consideration

- Narrow non-divergent beam (18-25 cm footprint)
- NIR wavelength – less sensitive to aerosols
- Reflectors: good-vegetation, poor-water/wet snow
- Measure different returns: first, last, both, intensity
- Active sensor so less requirement for fair weather
- Higher probability of reaching ground in leaf-off conditions (especially first return sensors)
- Dense vegetation or smooth surface (mudflats) increase overlap between flight lines for good coverage (shadow and specular reflection)

Changes 2000 to 20 … nsing, 2003

Improved Applanix

Collimator (laser be

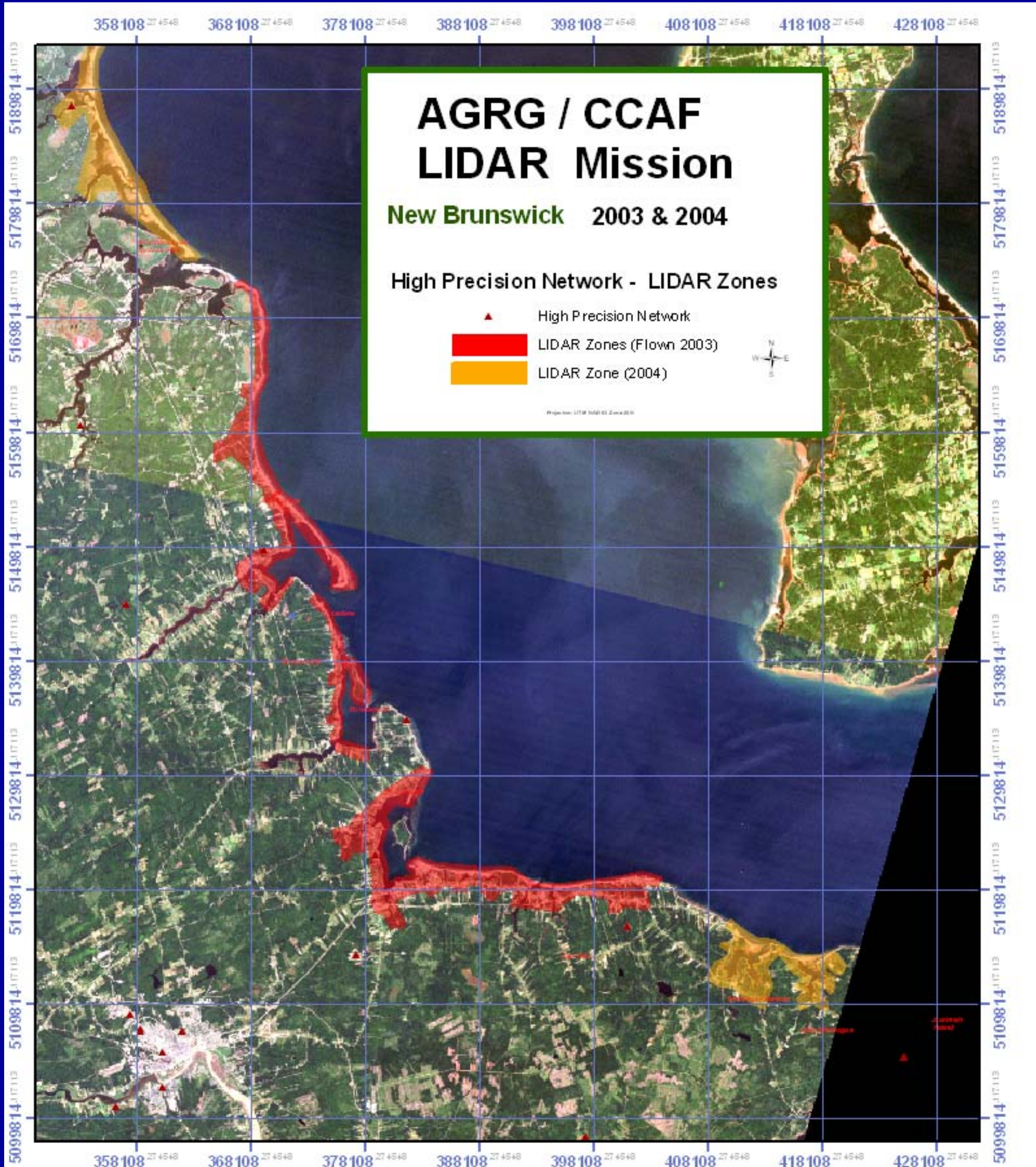


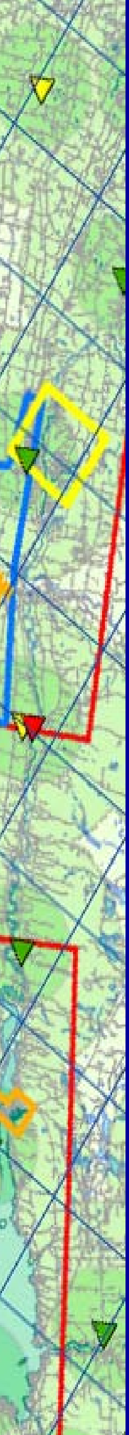
Pod with LIDAR a … IMU, computers


Kouchibouguac National Park
Cap-Lumiere
Ladune
Bouctouche
Cormierville
Cap Pele
Shemogue Harbour
Cape Jourimain
Little Shemogue
LIDAR Zones
New Brunswick
May 2003
Legend
HPN - High Precision Network
roads
Lidar Coverage Zone
N
W
E
S
0 3.75 7.5 15 22.5 30
Kilometers

Project Chronology: LIDAR Acquisition

- Nov. 2002 mission cancelled poor weather, snow
- May 2003 LIDAR coverage prior to leaf emergence
- Fall 2003 mission with new LIDAR system cancelled technical problems
- Spring 2004 remaining areas acquired prior to leaf emergence with new multi-return system





Validation

"Z must be within an average 30 cm of measured points"

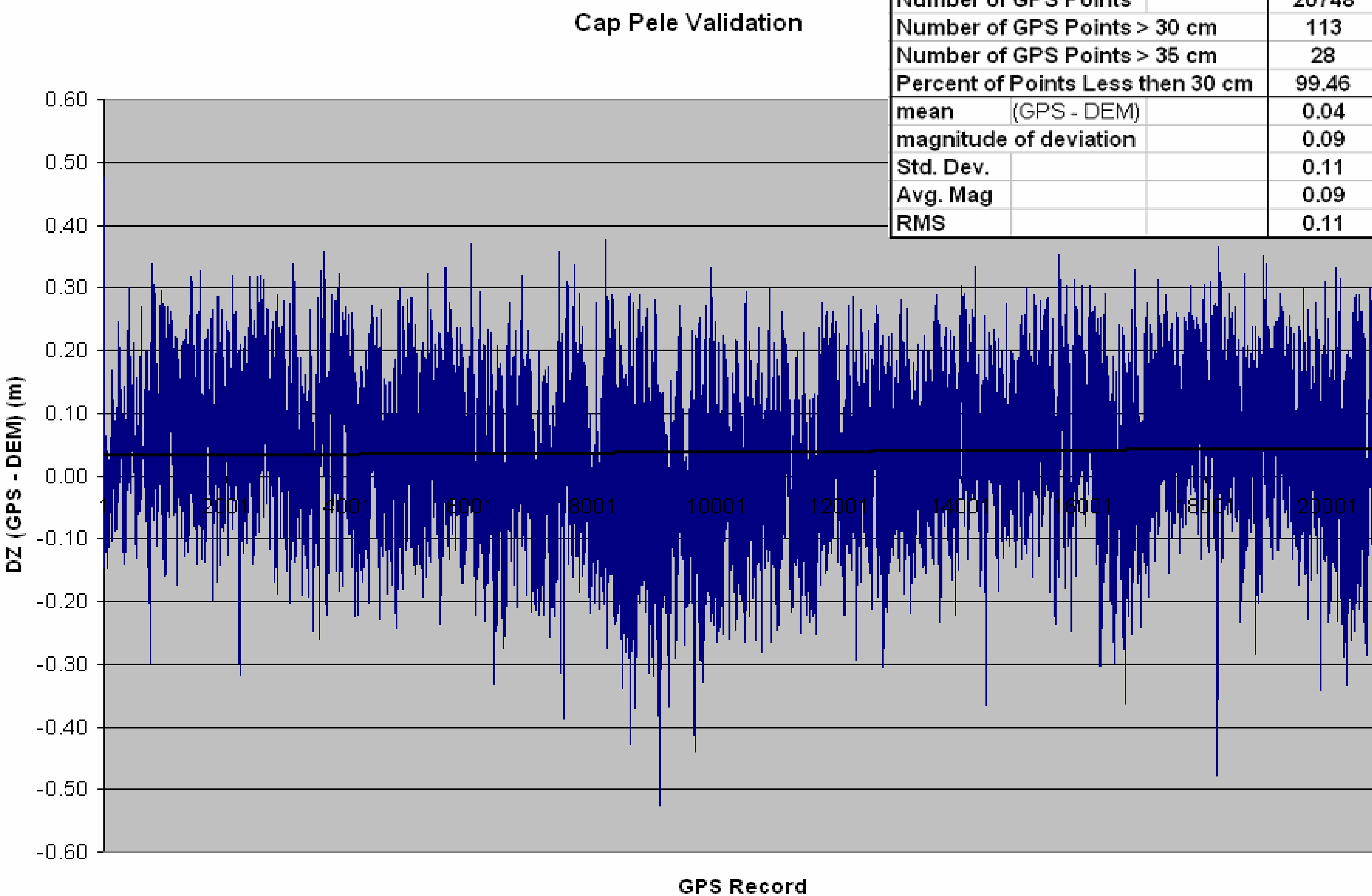
- Guaranteed only on flat hard open surface = road
- GPS points (ellipsoid and orthometric heights)
- Overlay GPS with LIDAR ground points (radius)
- Overlay GPS with LIDAR ground surface
- Compare Z value from GPS and LIDAR

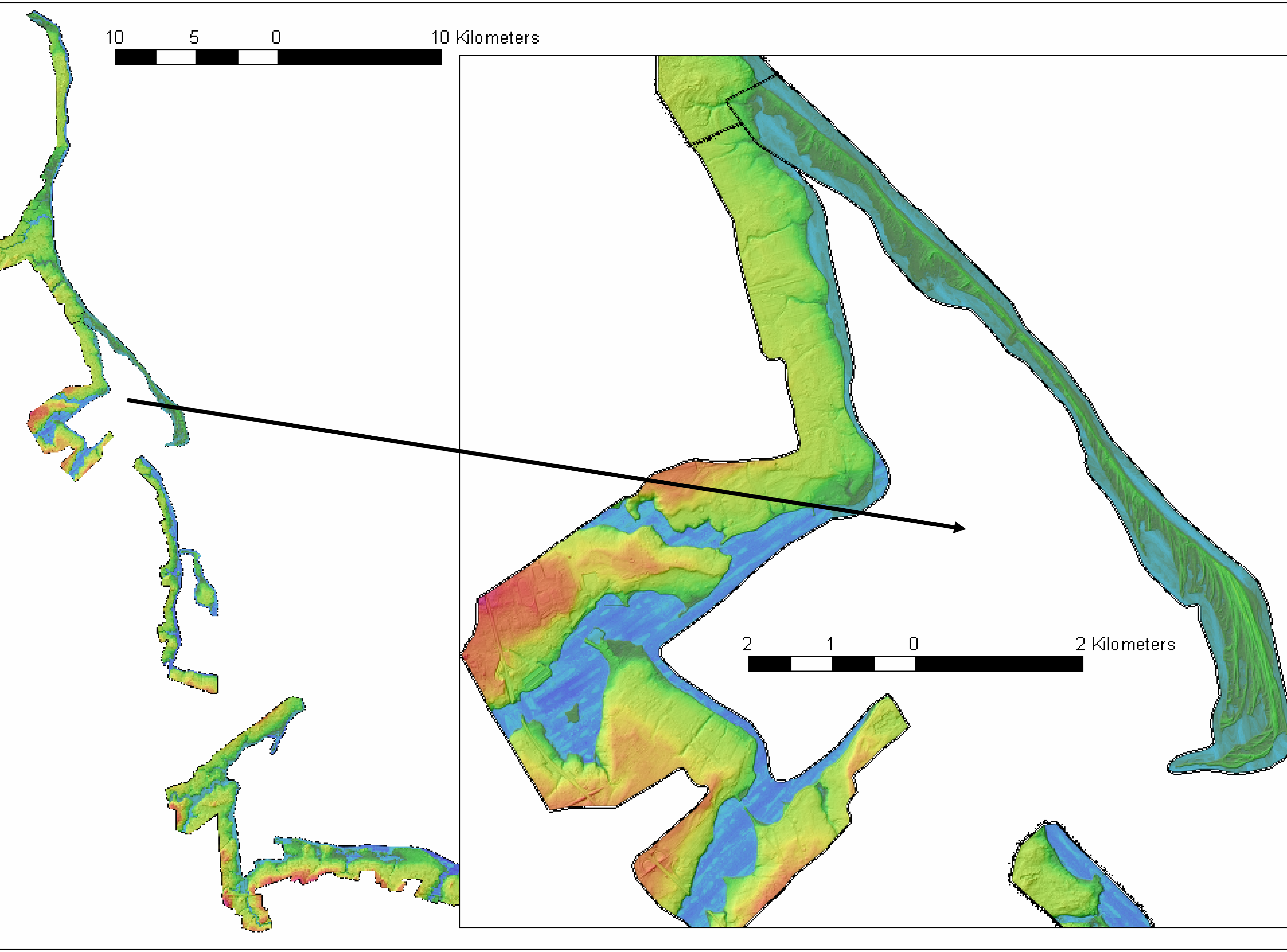
Ground Validation Equipment

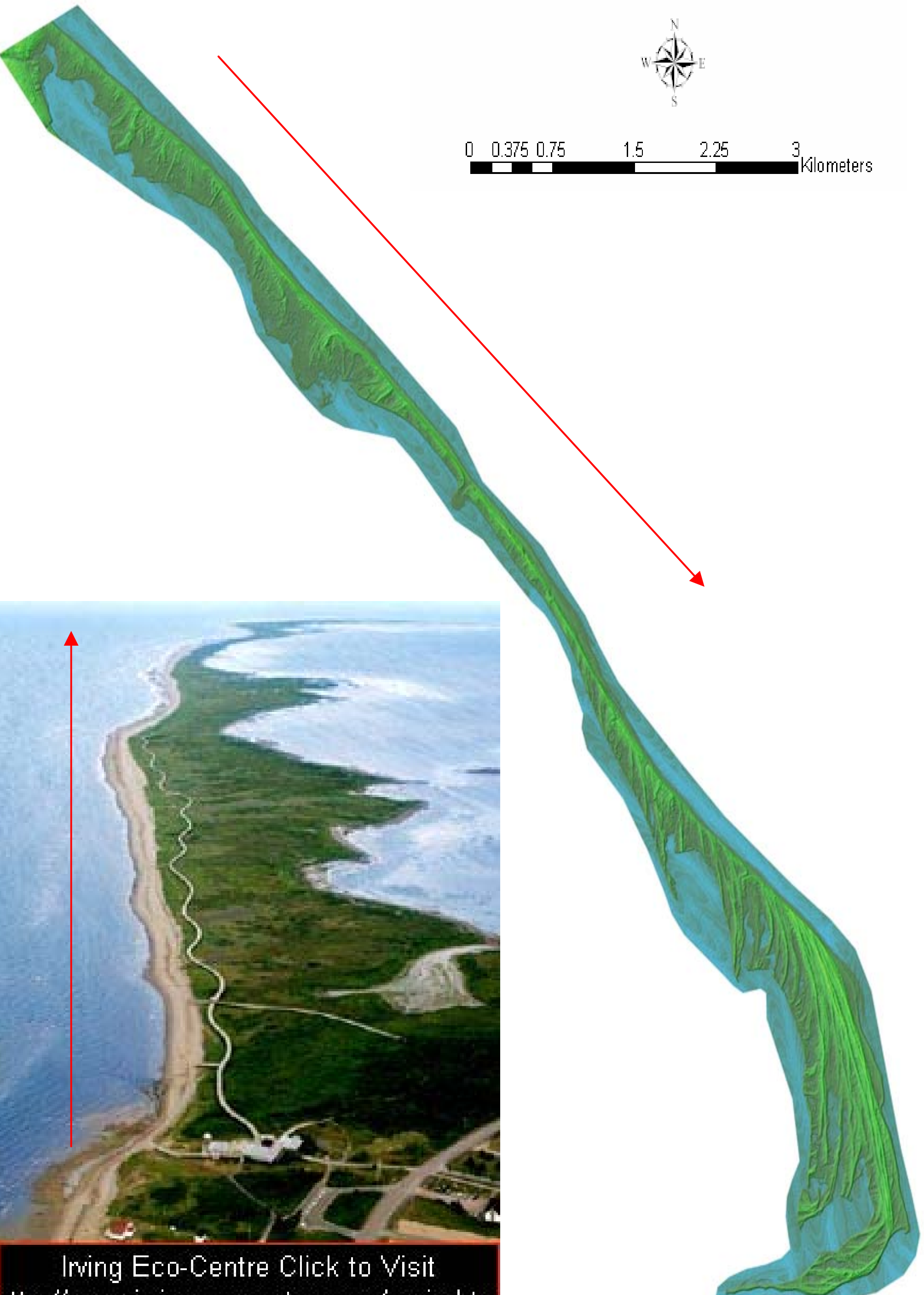
- Base and rover RTK system, 10 km range; Total station for under the canopy surveying
- Setup Base over HPN monument, RTK on Pole & vehicle mount

Cap Pele Block Validation Results

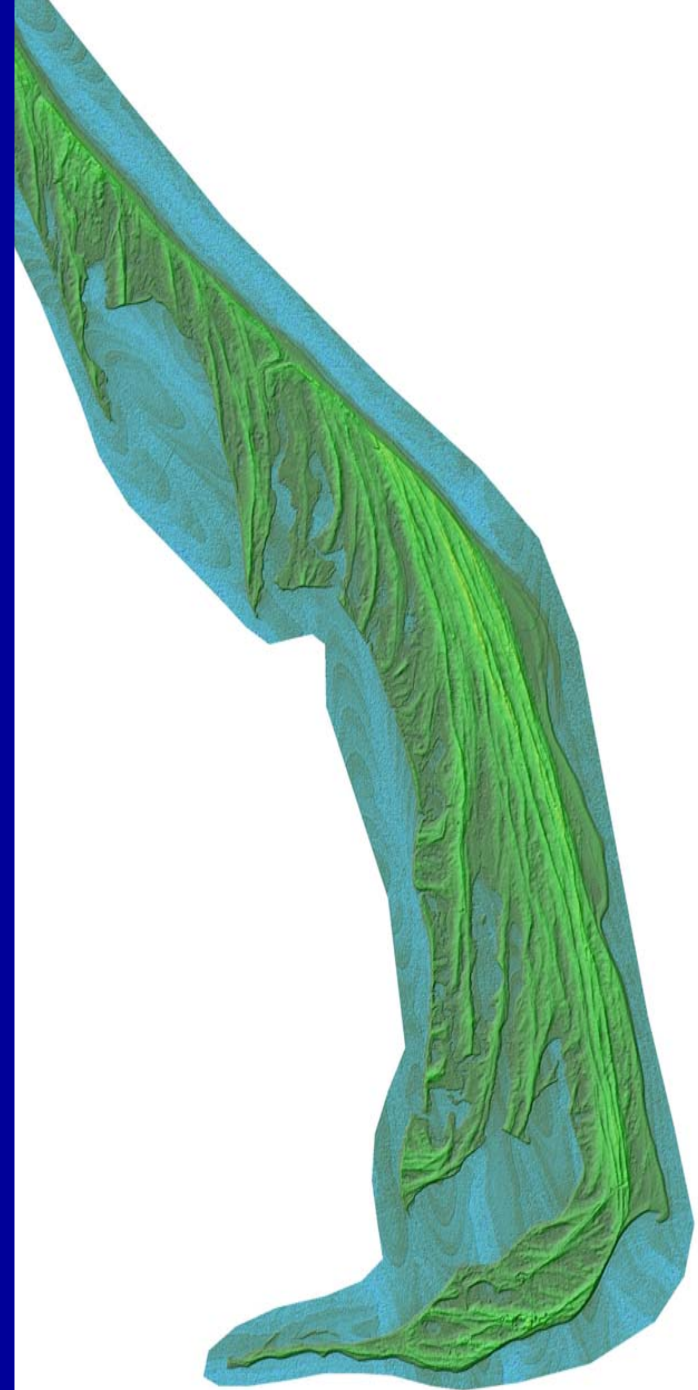
Number of GPS Points			20748
Number of GPS Points > 30 cm			113
Number of GPS Points > 35 cm			28
Percent of Points Less then 30 cm			99.46
mean	(GPS - DEM)		0.04
magnitude of deviation			0.09
Std. Dev.			0.11
Avg. Mag			0.09
RMS			0.11



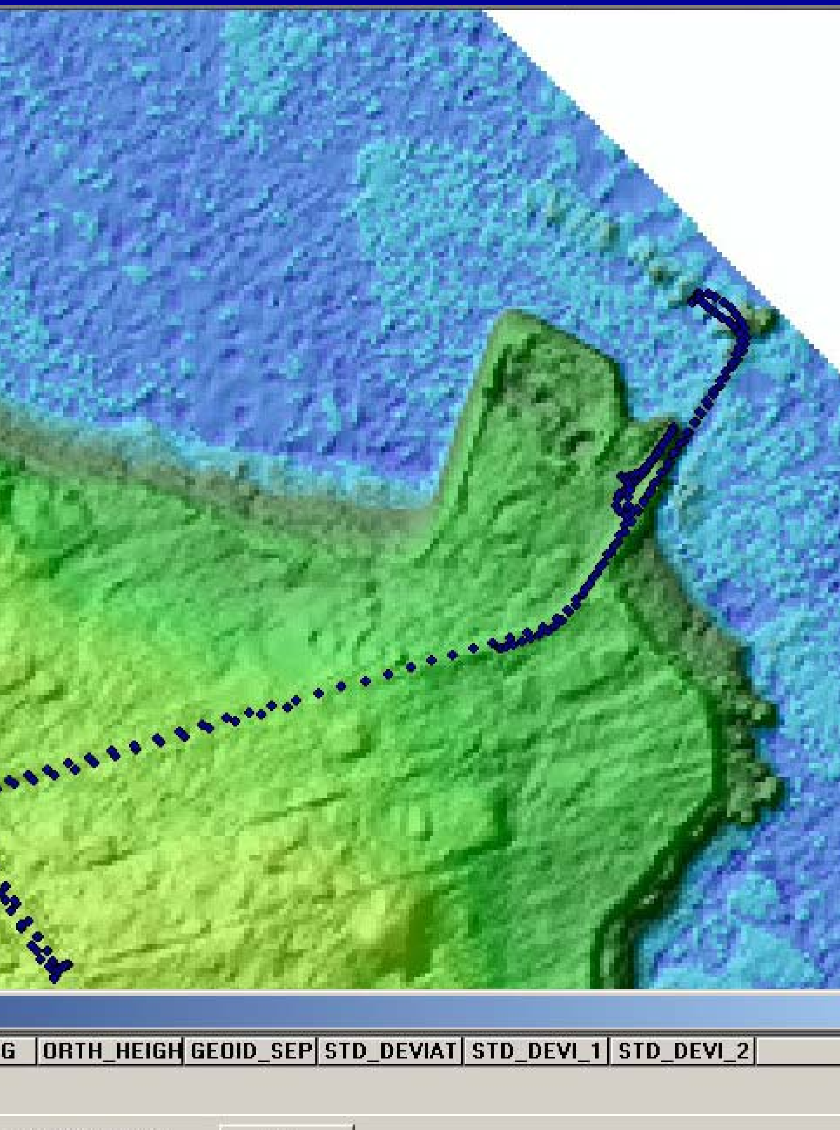

10 5 0 10 Kilometers
2 1 0 2 Kilometers

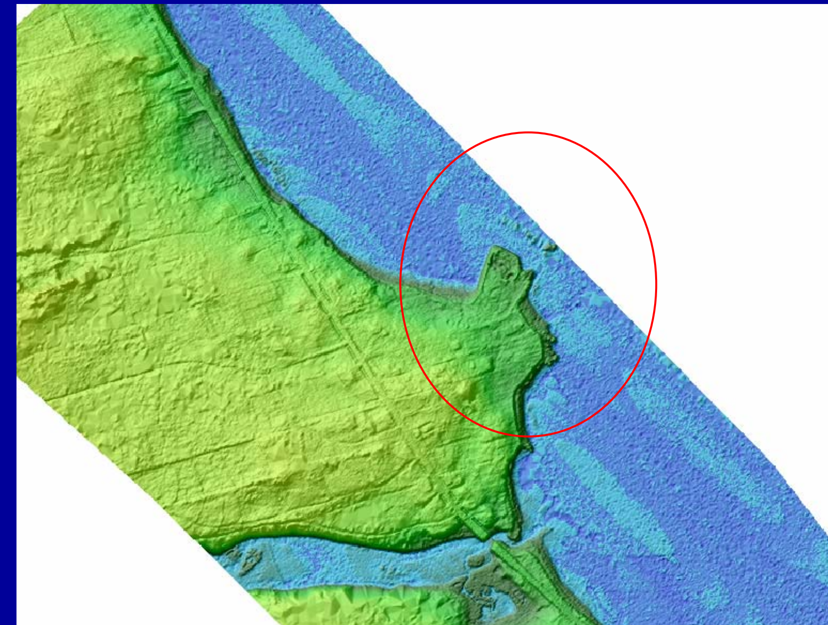


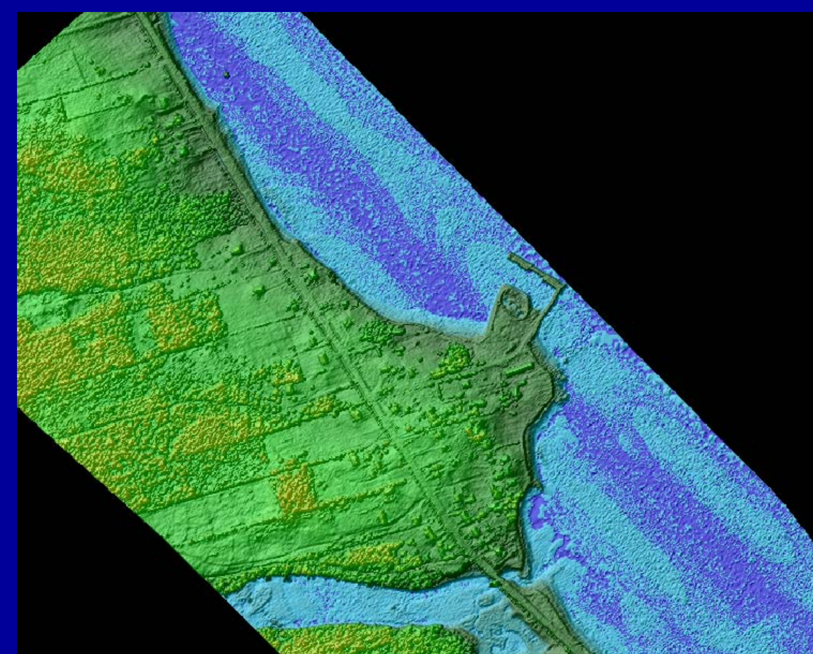
Irving Eco-Centre Click to Visit
http://www.irvingecocenter.com/main.htm

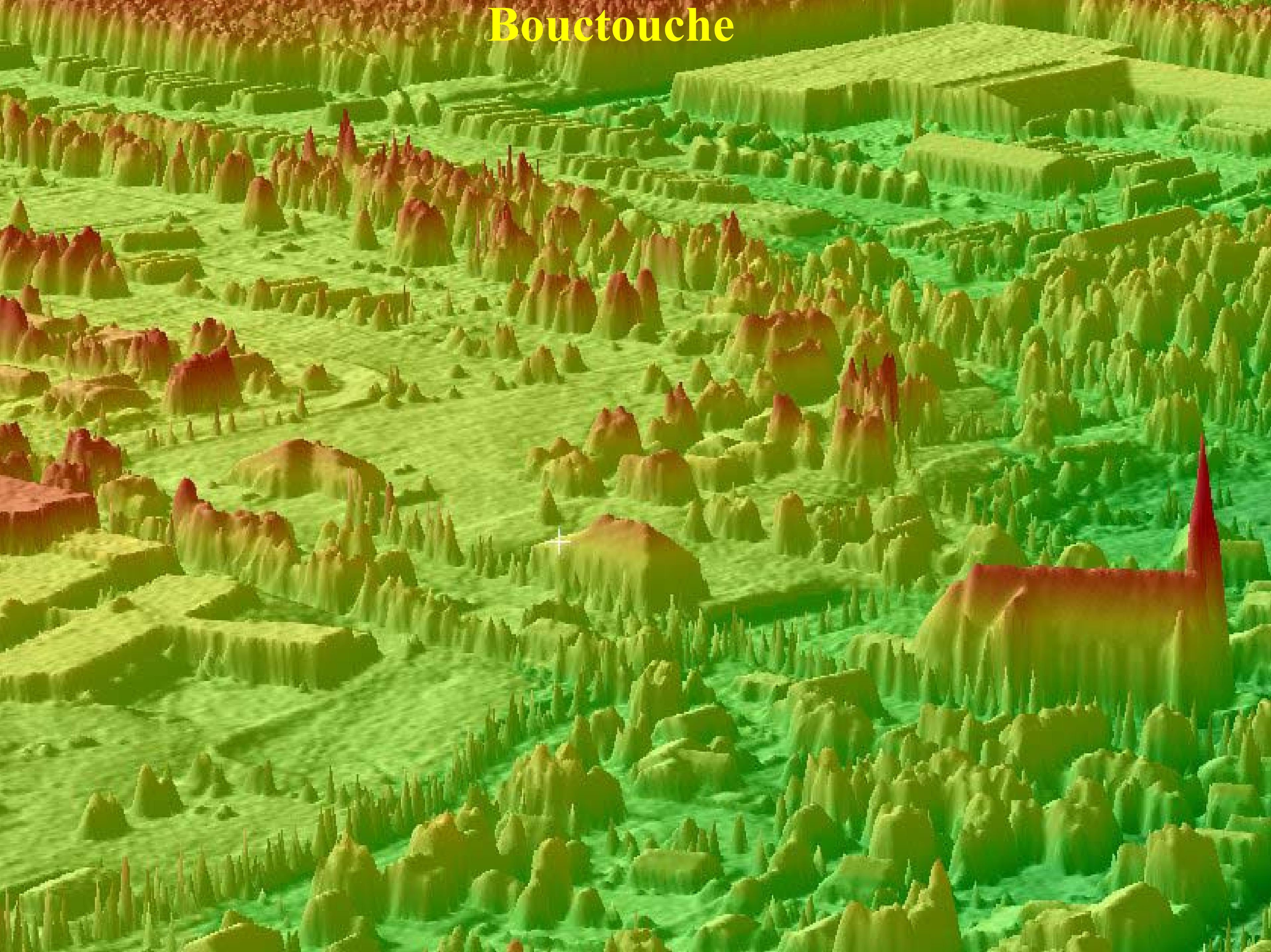


Cormierville: addition of waterfront structures in the ground DEM

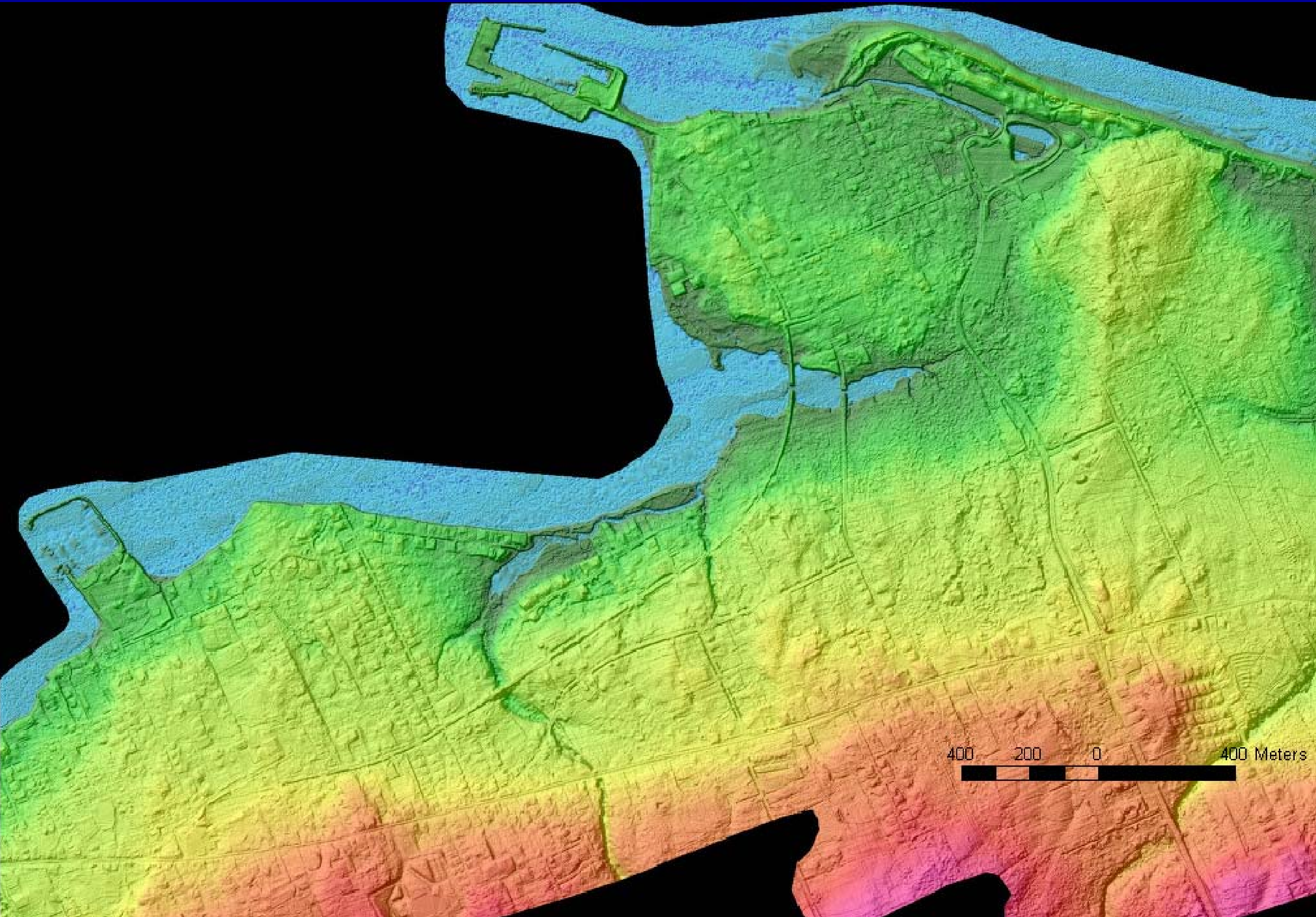






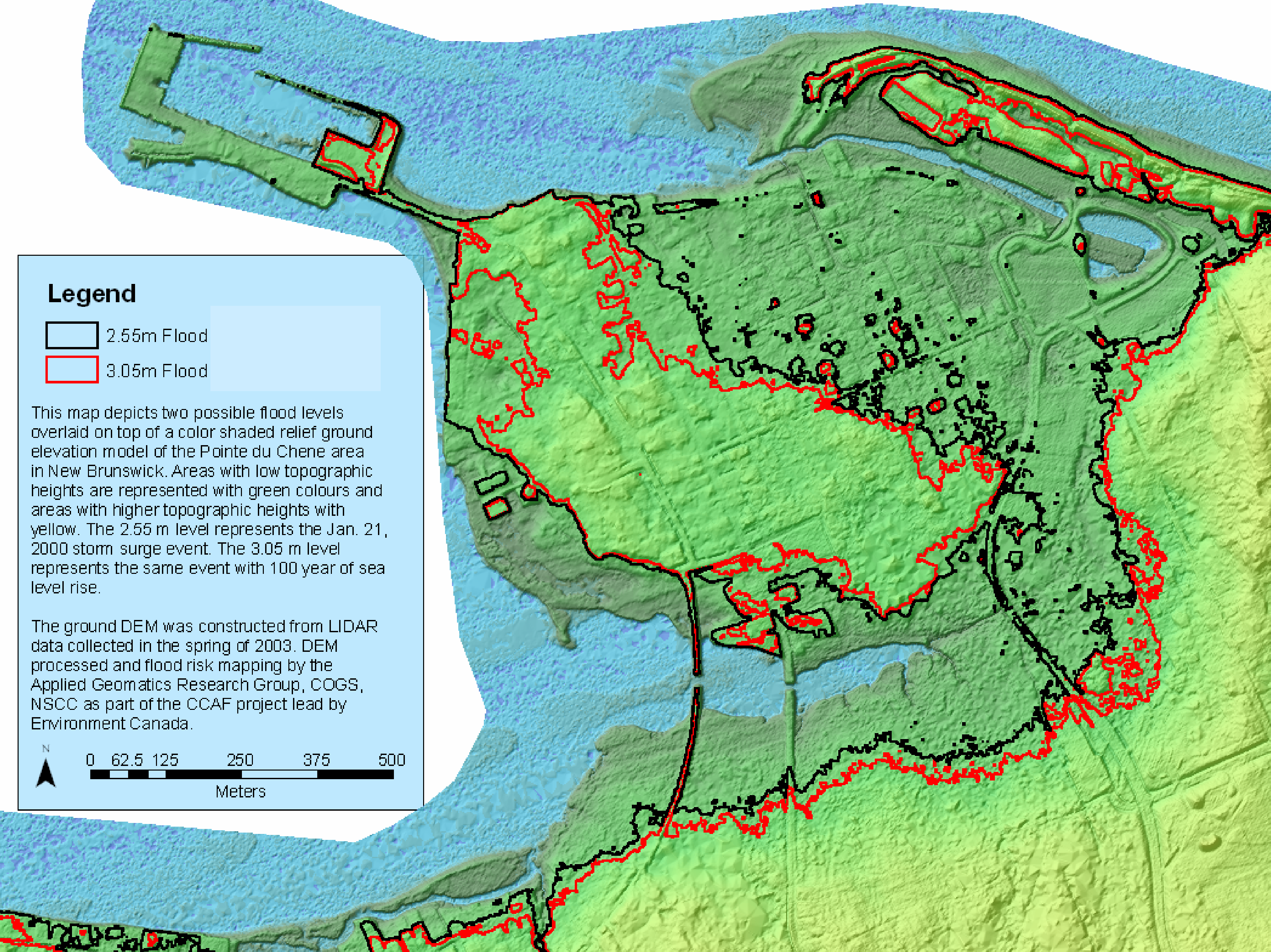

Bouctouche

Shediac – Pointe du Chene Wharf

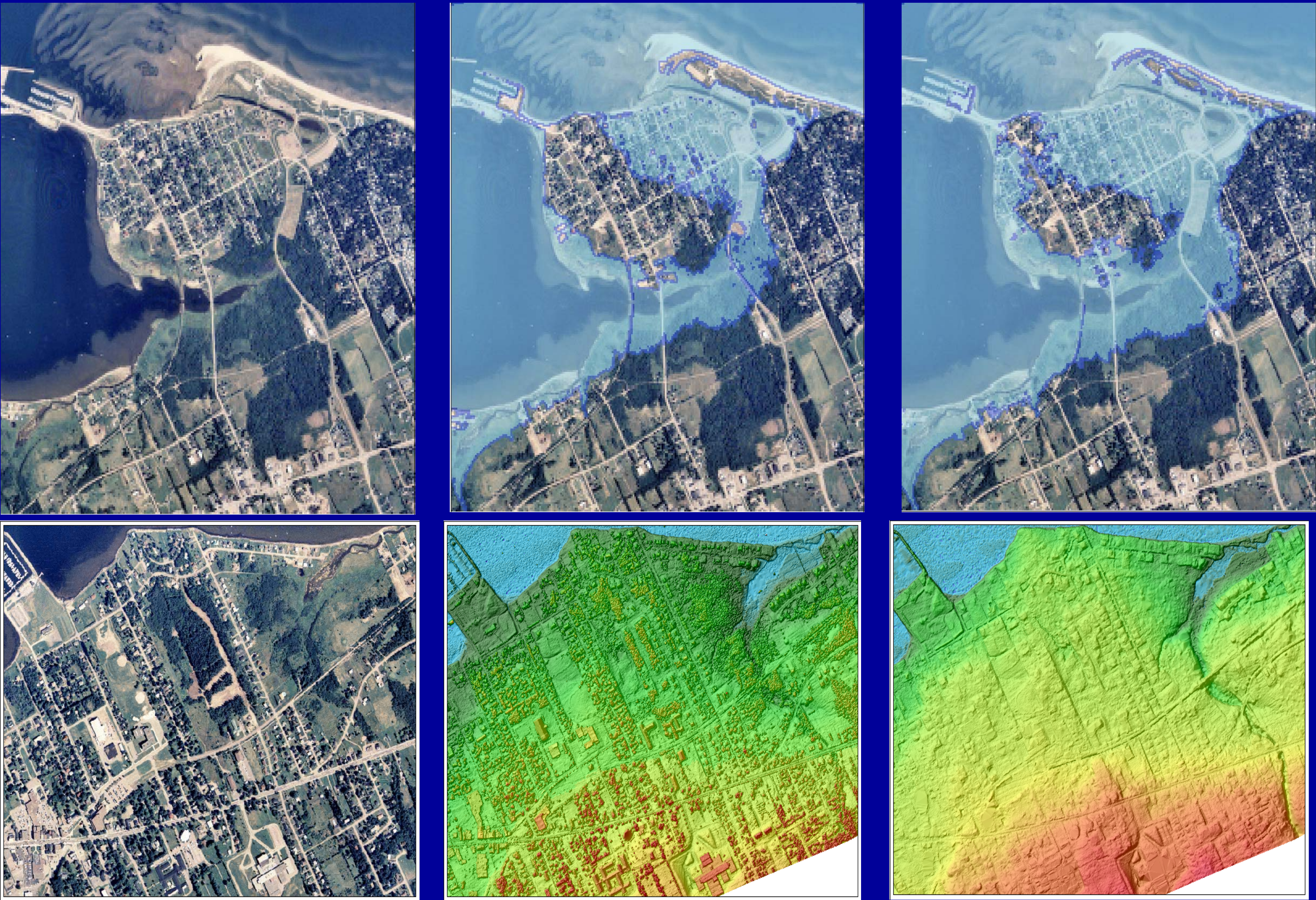


Ground DEM – Flood Risk Maps

- Ground DEM used to generate flood risk maps
- Water levels based on historic storm surge events (Jan. 2000) and future sea level rise
- SLR Worse case: 70 cm/100 yr (50 global + 20 subsidence)
- SLR moderate: 50 cm/100 yr (30 global + 20 subsidence)
- Resolve vertical datum issues (chart vs geoid MSL)
- DEM flooded from the ocean
- Low lying Inland areas must have free connection with ocean
- 3 flood levels generated plus other products


Legend
2.55m Flood
3.05m Flood
This map depicts two possible flood levels overlaid on top of a color shaded relief ground elevation model of the Pointe du Chene area in New Brunswick. Areas with low topographic heights are represented with green colours and areas with higher topographic heights with yellow. The 2.55 m level represents the Jan. 21, 2000 storm surge event. The 3.05 m level represents the same event with 100 year of sea level rise.
The ground DEM was constructed from LIDAR data collected in the spring of 2003. DEM processed and flood risk mapping by the Applied Geomatics Research Group, COGS, NSCC as part of the CCAF project lead by Environment Canada.
N
0
62.5
125
250
375
500
Meters

Service NB digital ortho series



Jan. 2000 storm surge 2.55 m above MSL

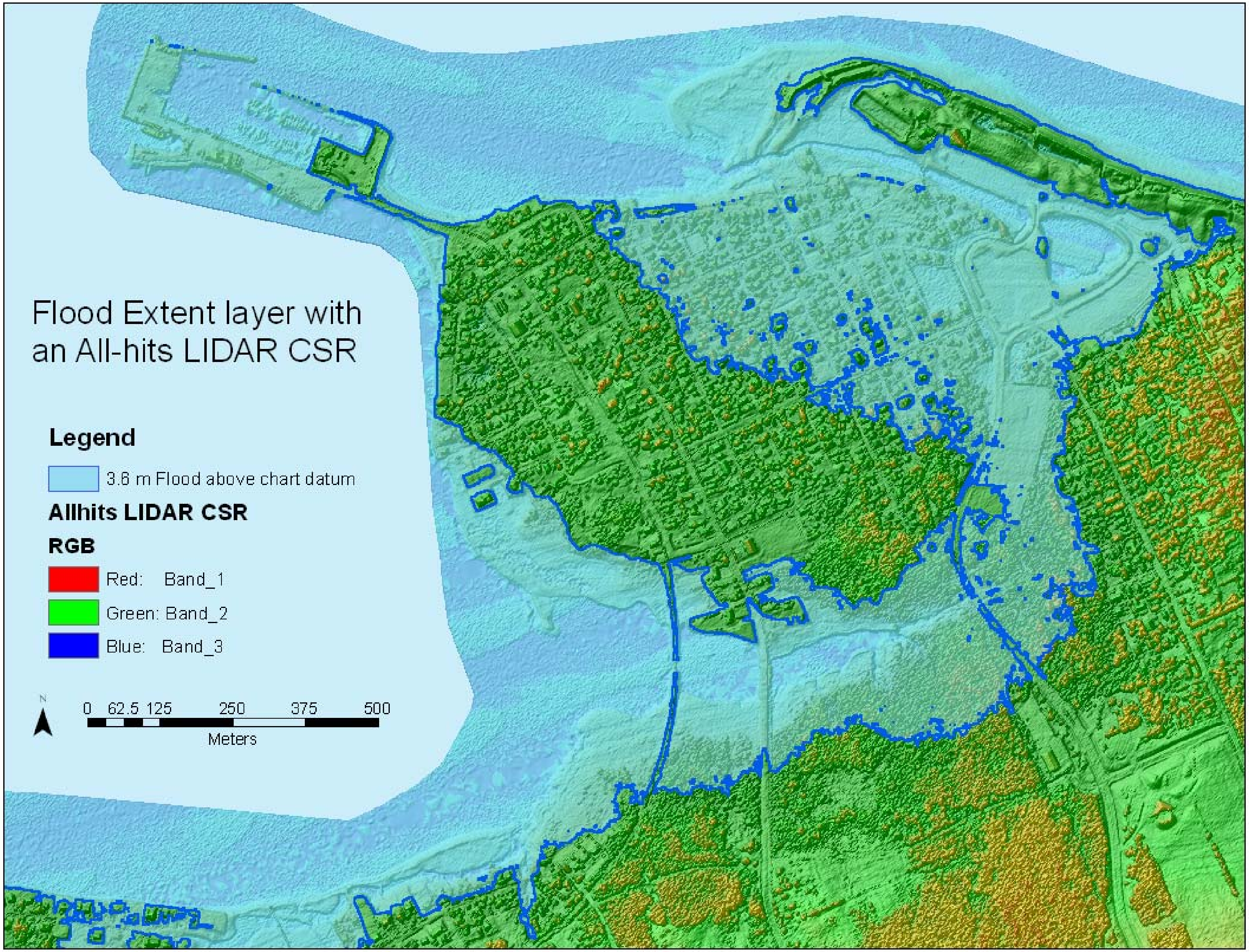
Jan. 2000 storm surge + 100 years sea level rise (0.5m/100 yrs estimate)

Jan. 2000 storm surge + 100 years sea level rise (0.7m/100 yrs estimate)

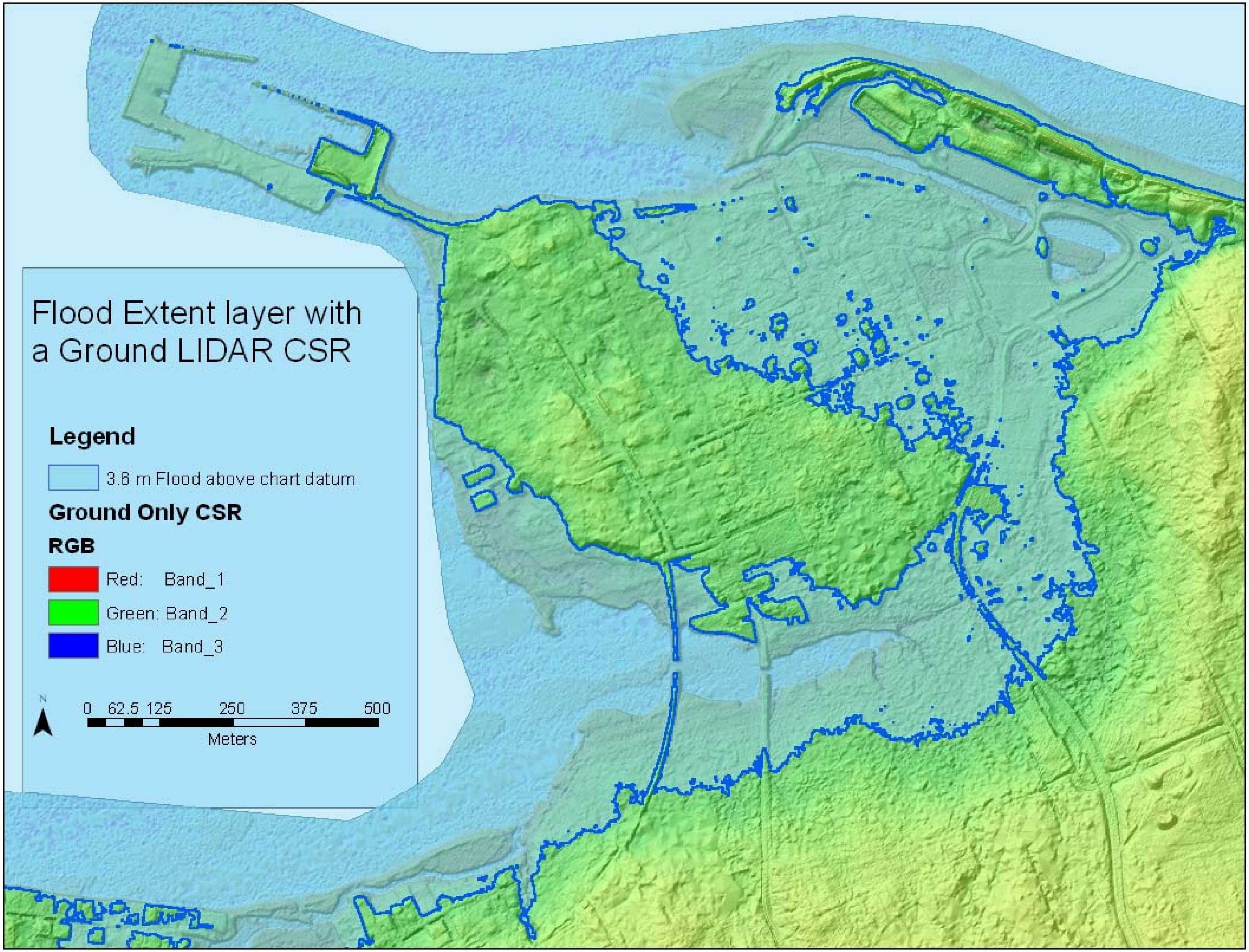
Combined flood levels

Jan. 2000 event

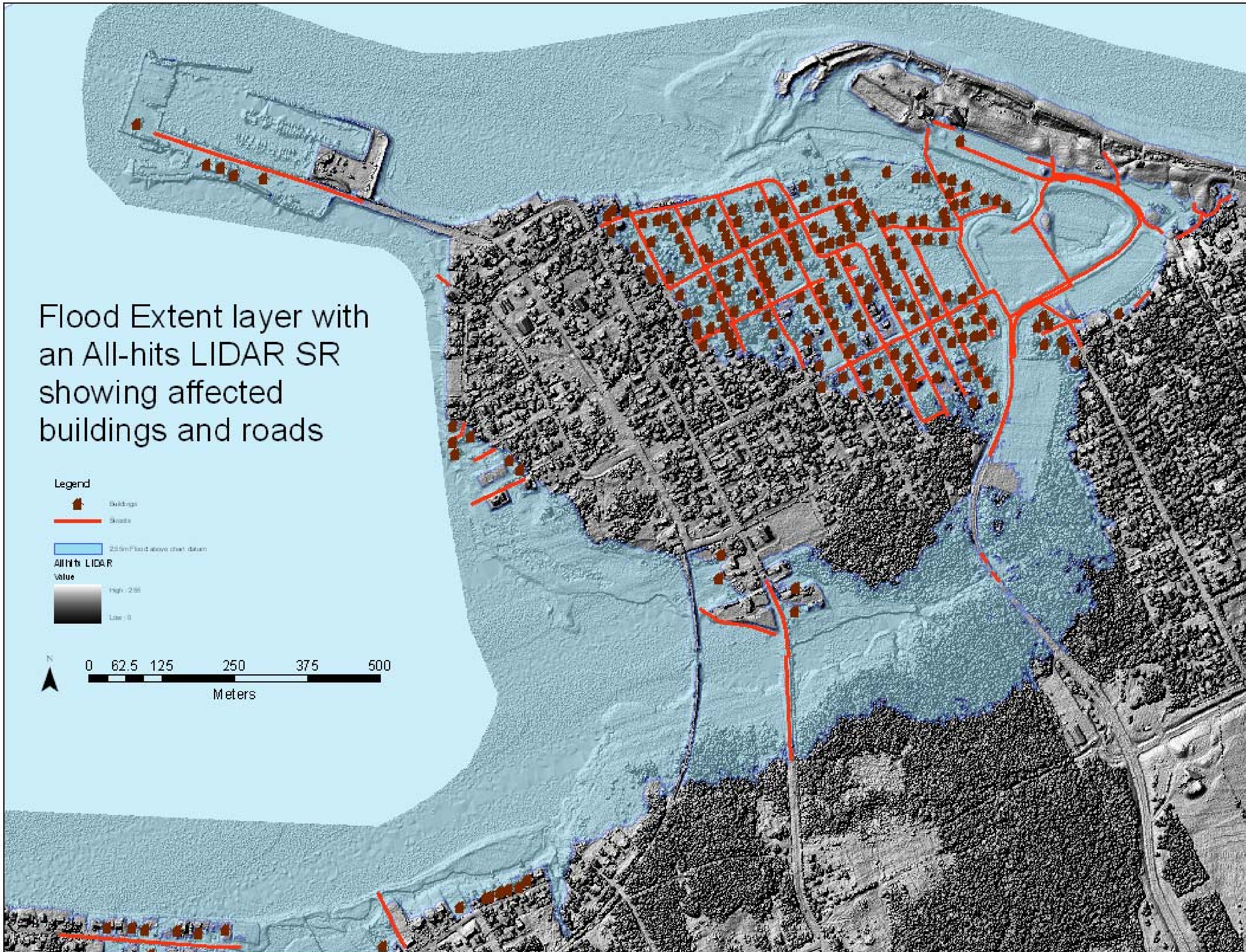
Jan. 2000 event



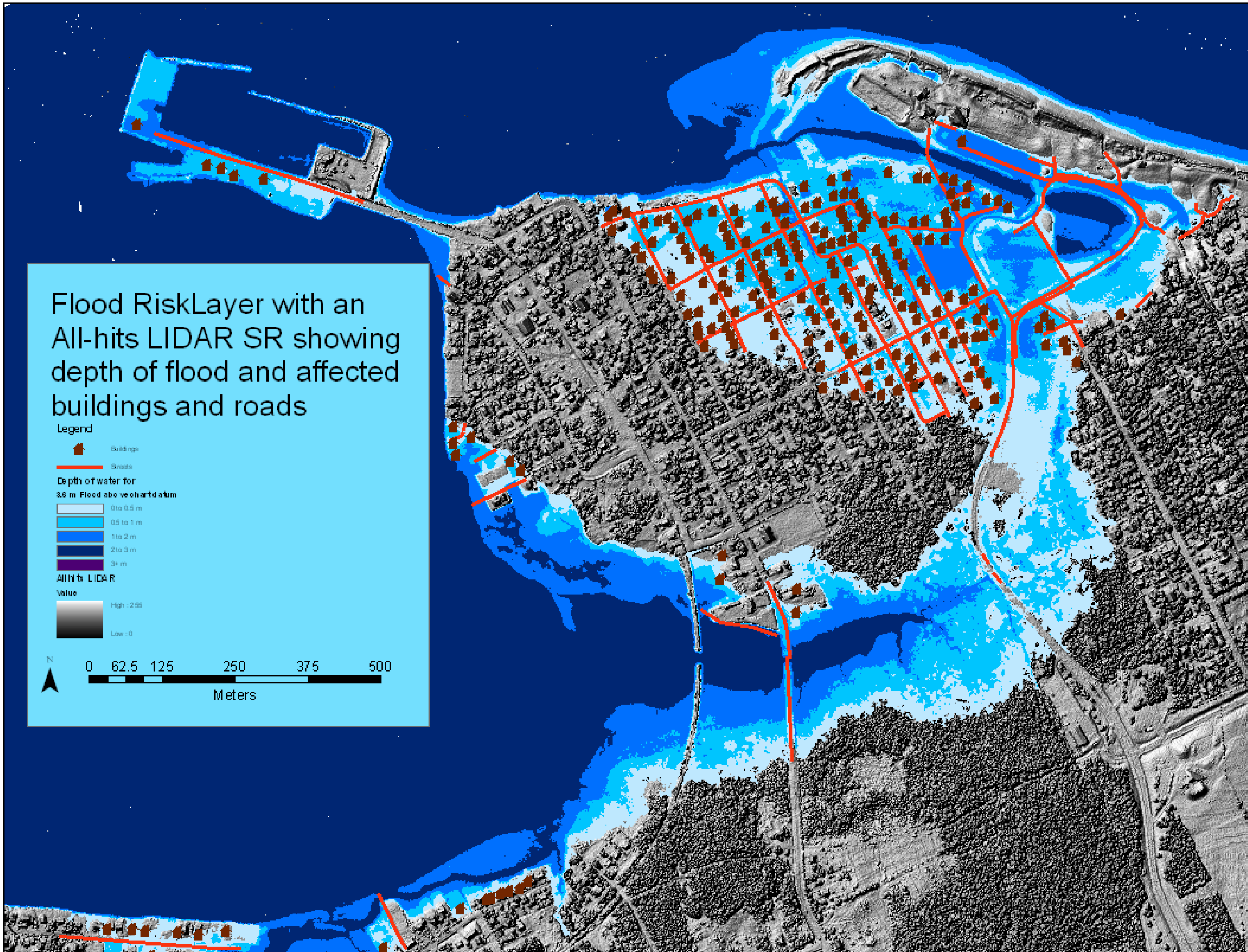
Jan. 2000 event



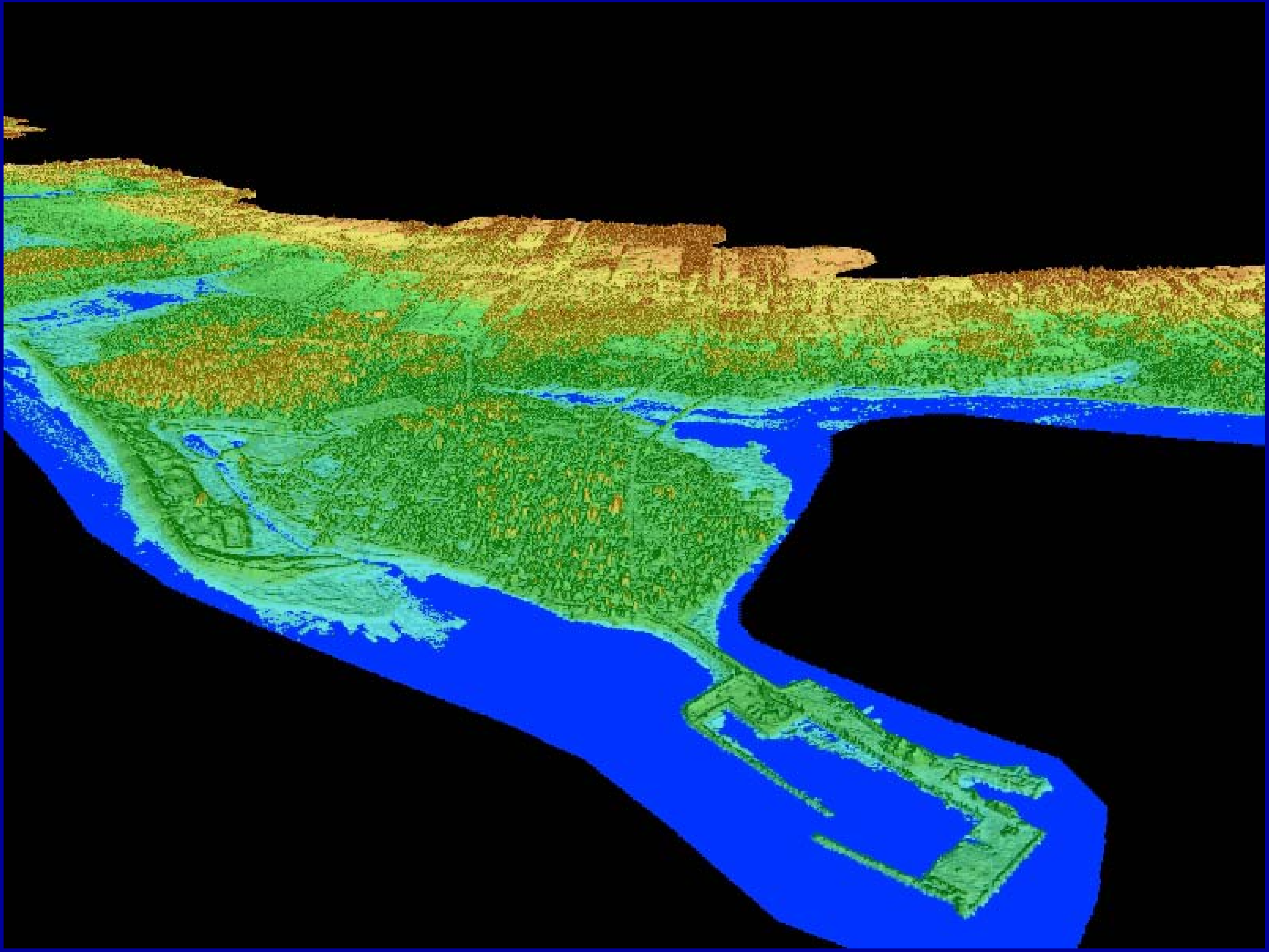
Impact to infrastructure, $$



Flood Depth Maps

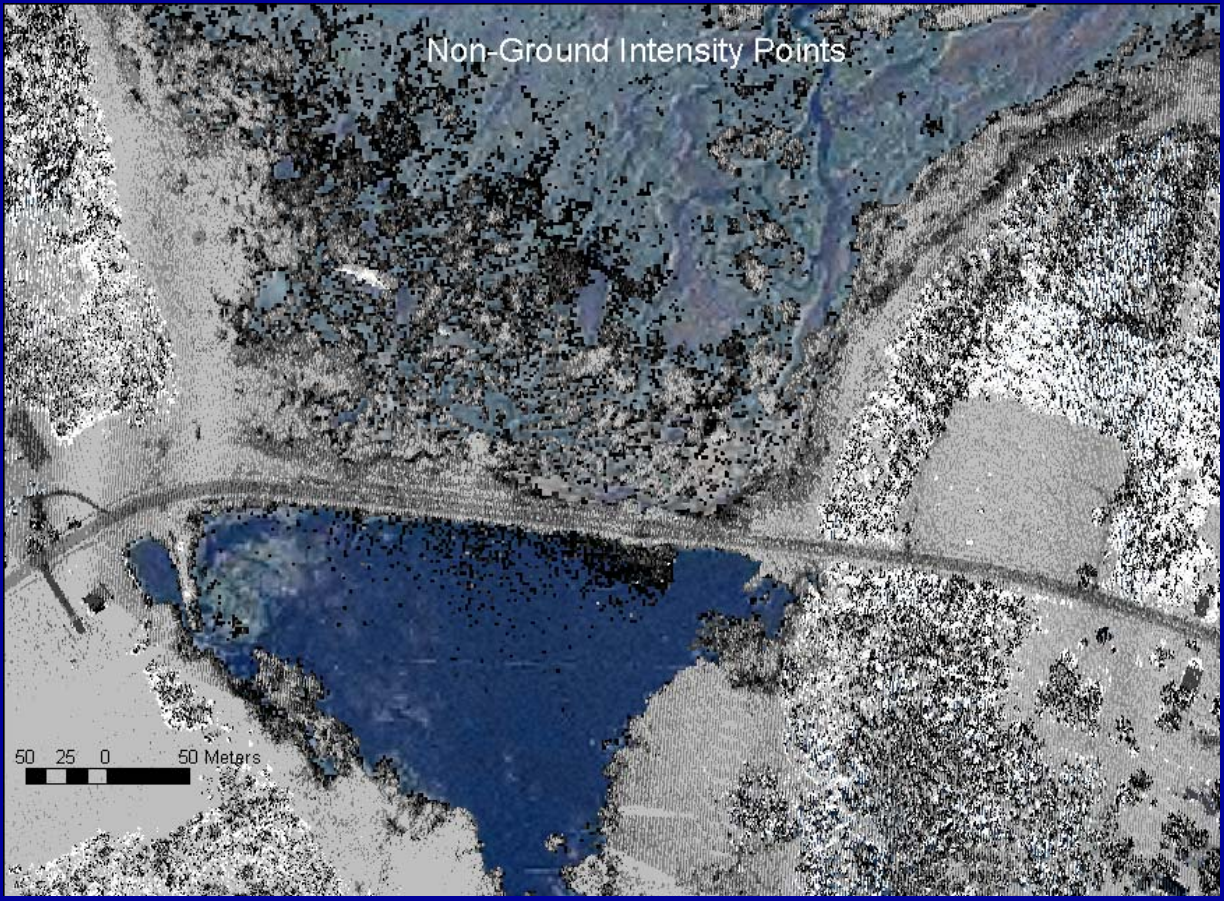


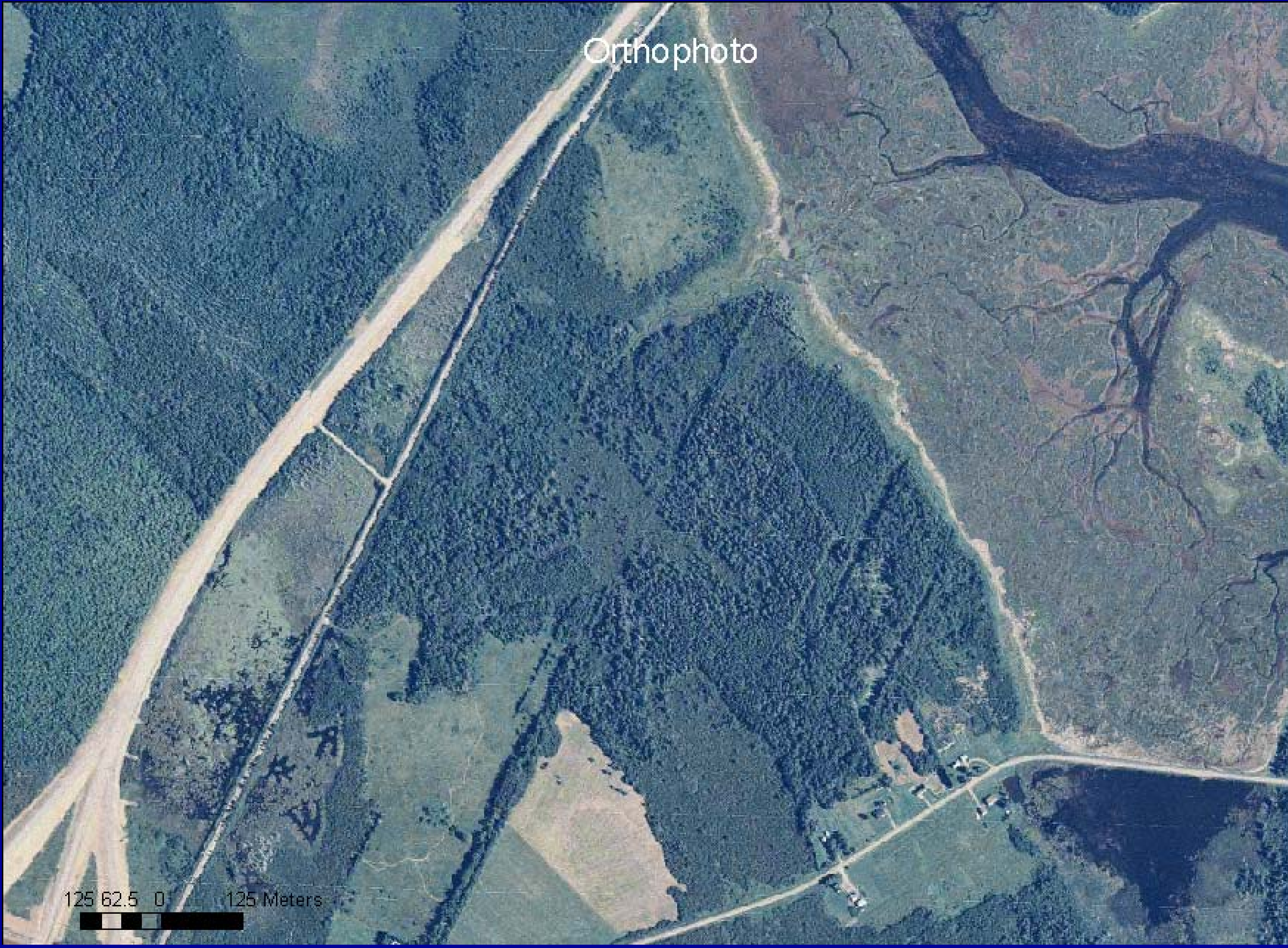
Flood Animation 5 m ASL



Spring 2004 data

- New LIDAR system for Terra RS capable of measuring 1st and last returns and Intensity on alternating returns




Orthophoto
125 62.5 0 125 Meters

Conclusions

- LIDAR requires planning, ground validation, intensive GIS processing
- Need P-code GPS in order to validate accuracy
- LIDAR ideal for modeling storm surges of 1-2 m
- NB Orthophotos compliment LIDAR DSM/DEM
- Remainder of NB polygons acquired 2004
- Terra using a new multi-return system
- Intensity of return may be a useful product
- Flood modelling complete for 2003 data
- Economic and ecosystem impact analysis to follow

Acknowledgements

- Funding CCAF, AIF, and CFI
- Fieldwork support by AGRG students
- All CCAF partners