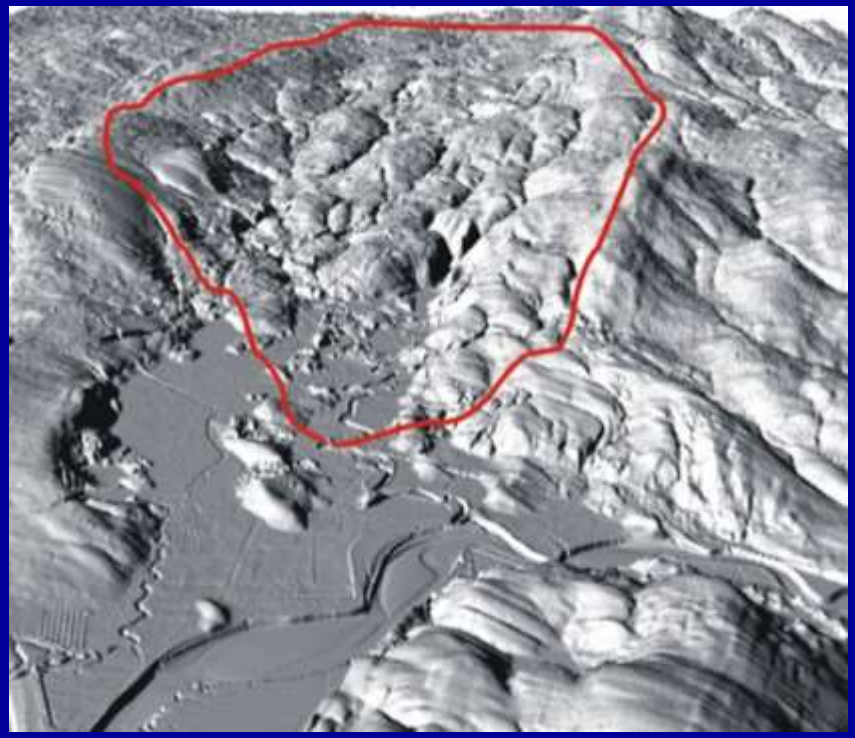
River Flood Risk of the Nappan River & River Phillip Incorporating Climate Change



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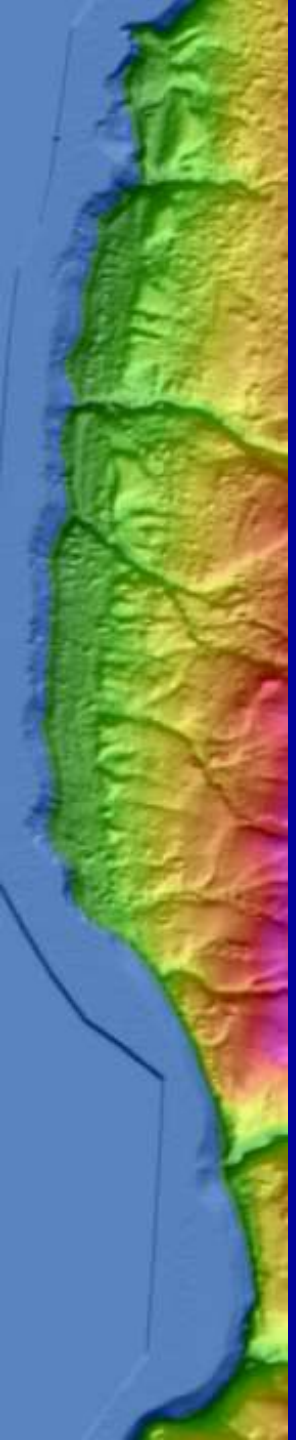
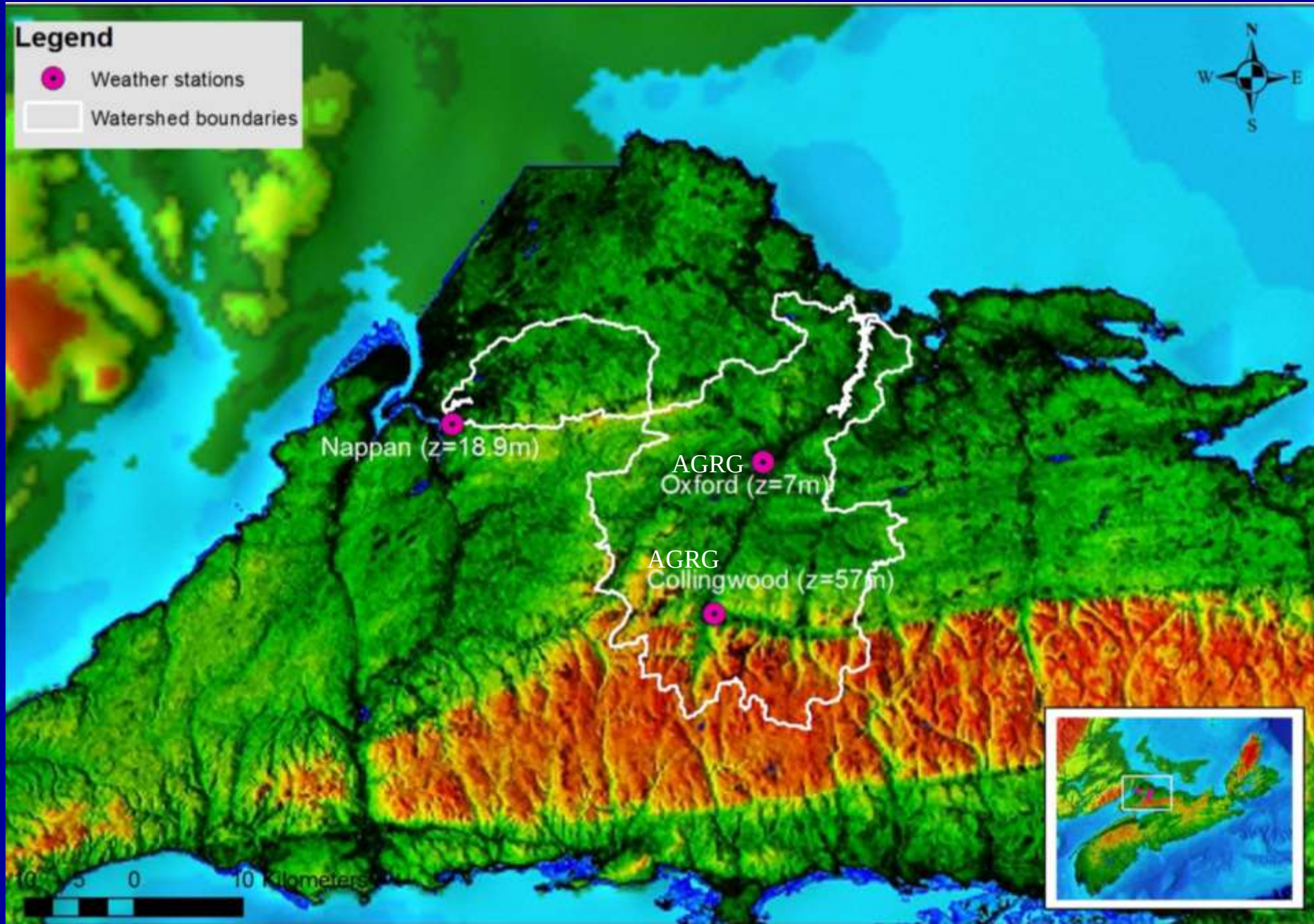
Nova Scotia Community College Middleton, NS, Canada
Timothy.webster@nscc.ca

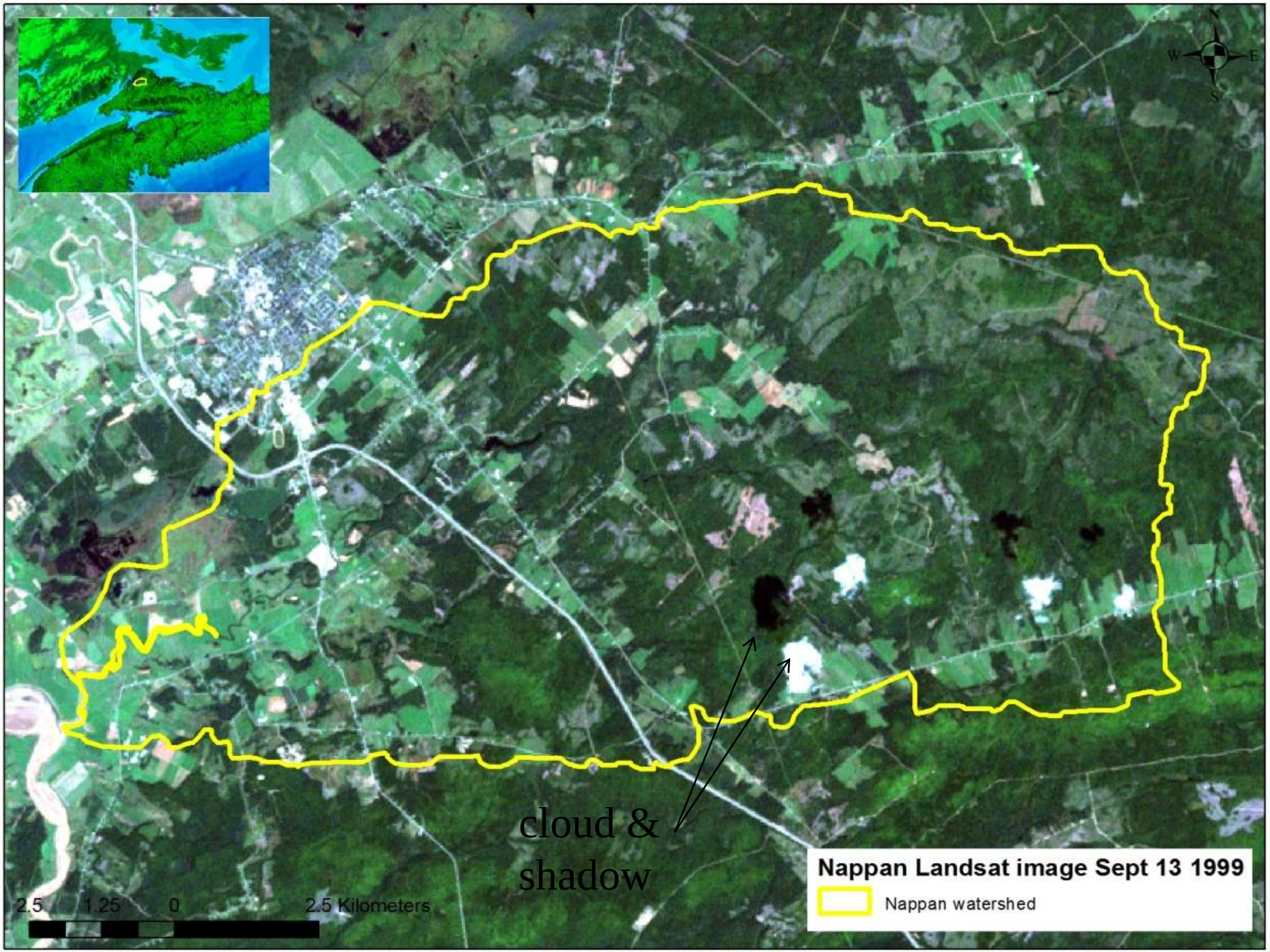


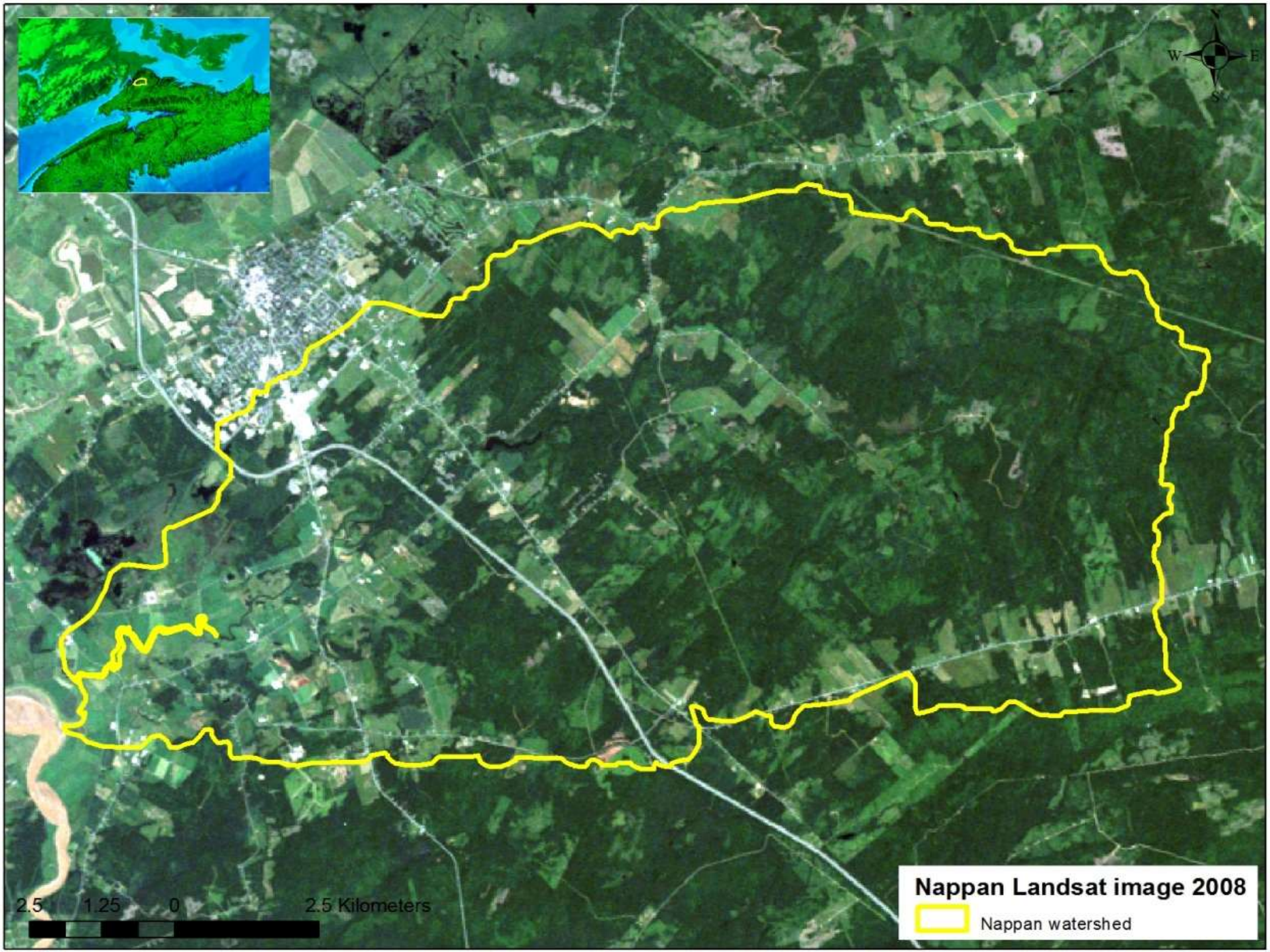
Outline

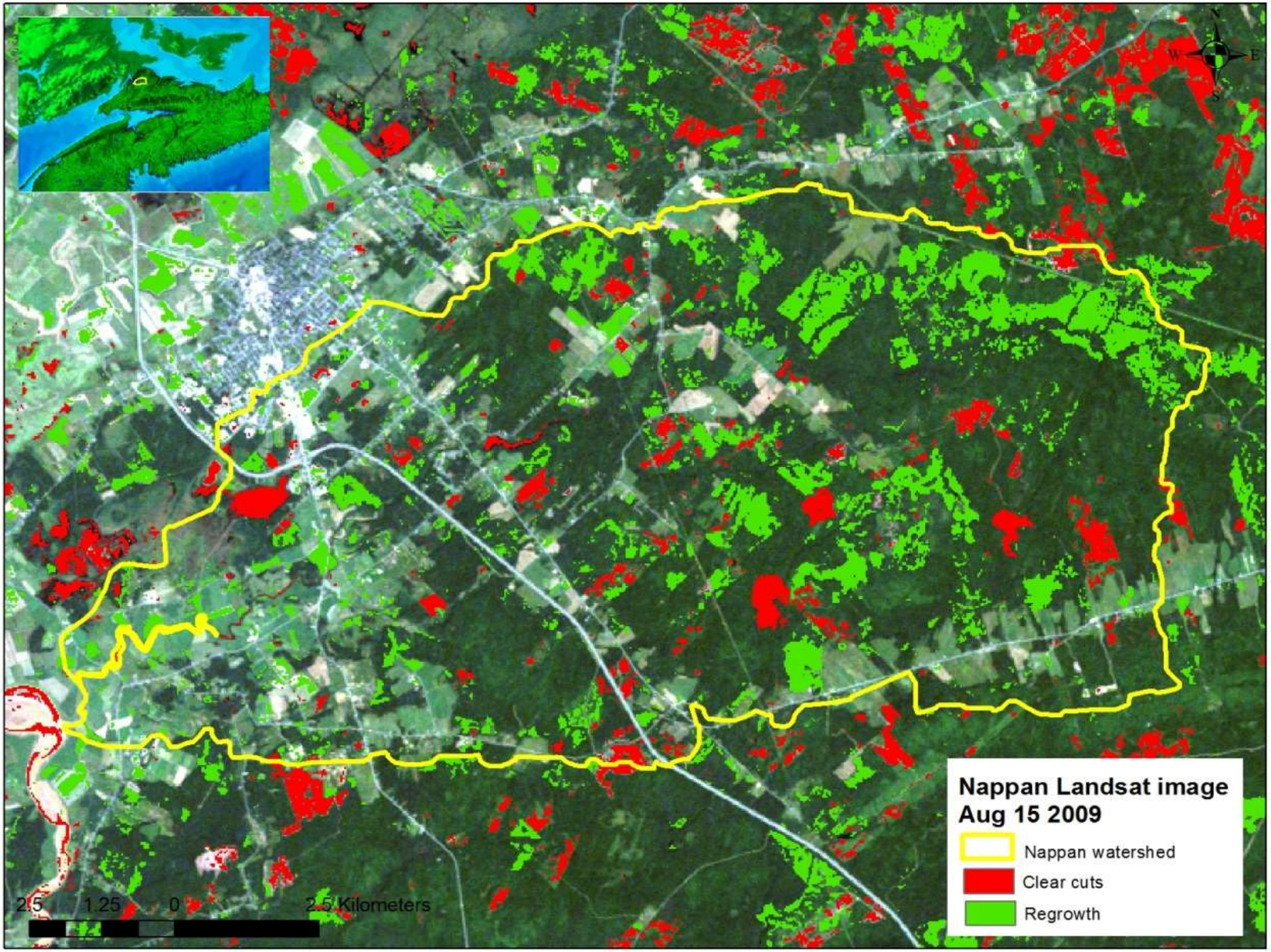
- Lidar provides detail for floodplain flooding
- No info on riverbed or estuary bathymetry
- Watershed models can use coarser DEM to calculate catchment area etc. (ca 5 m)
- Only large rivers are measured for flow EC
- Nappan River discharge controlled by an aboiteau, chronic flooding of Smith Road
- Oxford flooding said to be influenced by tide-surge on River Phillip
- Need to couple watershed runoff river models with ocean-coastal tide-surge models
- Intensity on rainfall events expected to increase

The Study Areas and weather stations




cloud &
shadow
Nappan Landsat image Sept 13 1999
Nappan watershed
2.5 1.25 0 2.5 Kilometers


W
E
S
2.5
1.25
0
2.5 Kilometers
Nappan Landsat image 2008
Nappan watershed


Nappan Landsat image
Aug 15 2009
Nappan watershed
Clear cuts
Regrowth
2.5
1.25
0
2.5 Kilometers

The problem: Nappan

Amherst Daily News

AMHERST, N.S. www.amherstdaily.com

TUESDAY, JULY 13, 2010

Spain celebrates

World Cup win gives country a break from economic and political strife.

Page 10

YOU SAID IT

"In Amherst, it's not big enough for a parade, and we're not ready yet. But we do want to say how proud and grateful we are that the town has allowed us to do this."

Susan Reid, chairwoman of the Cumberland Pride Society, at the Pride Week flag raising ceremony Monday at Amherst Town Hall. – Page 2

SYNOPSIS

Regis and Kelly hit the Island

Television stars Regis Philbin and Kelly Ripa were flanked by eight Mounties on Monday as they greeted thousands of cheering fans and brought their New York-based morning show to Charlottetown. Atlantic – Page 7

QUICK WEATHER

TODAY Variable High 26 Low 19

TOMORROW Showers

July 10'10

Upper Nappan farmer Doug Bacon is waiting for water levels to recede before about two dozen cattle can be rescued from his fields. The cows became stranded during heavy rain on Sunday that caused flooding and closed several roads. DARRELL COLE – AMHERST DAILY NEWS

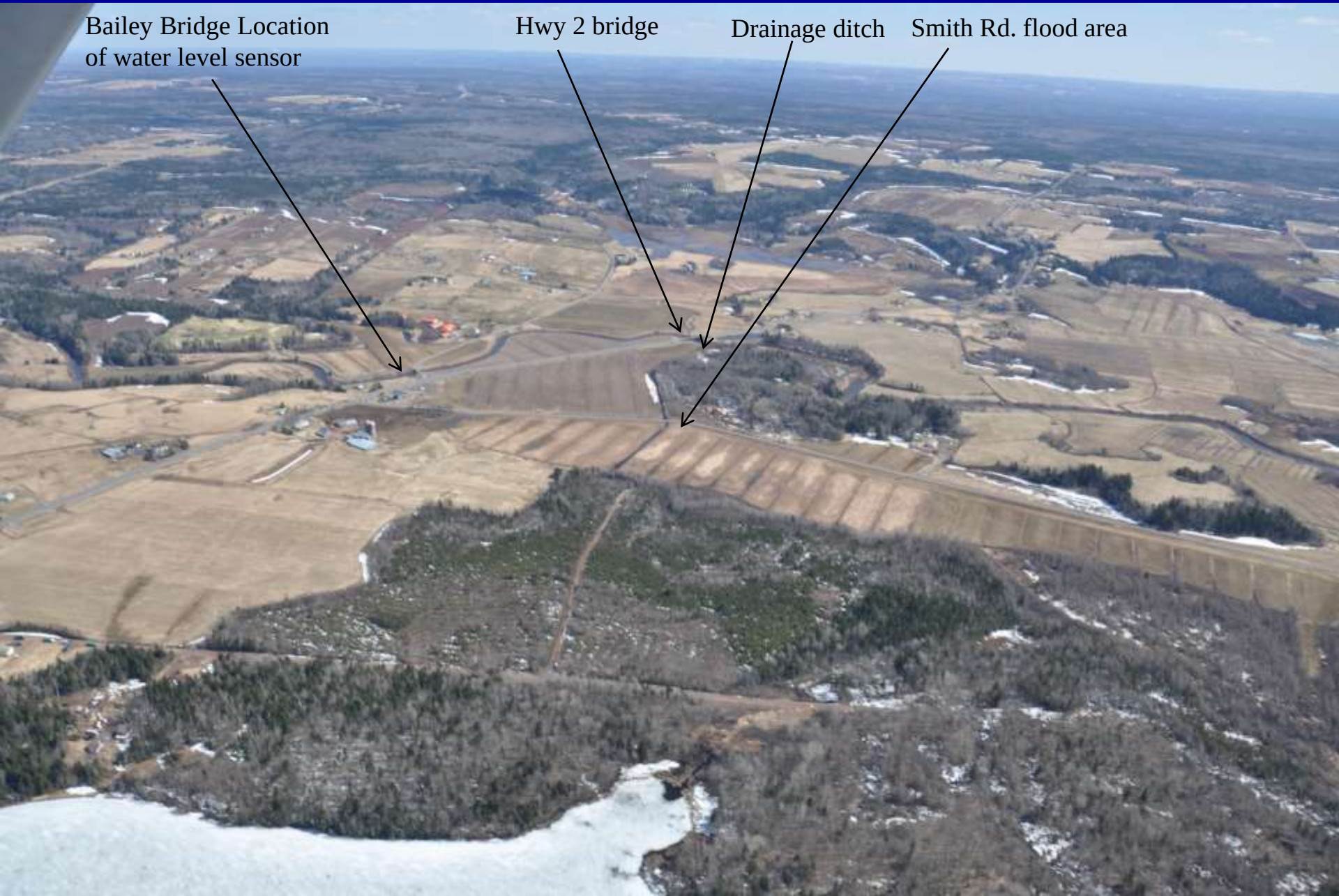
Flooding strands cattle

March 13'10

September 7'08

October 31'98

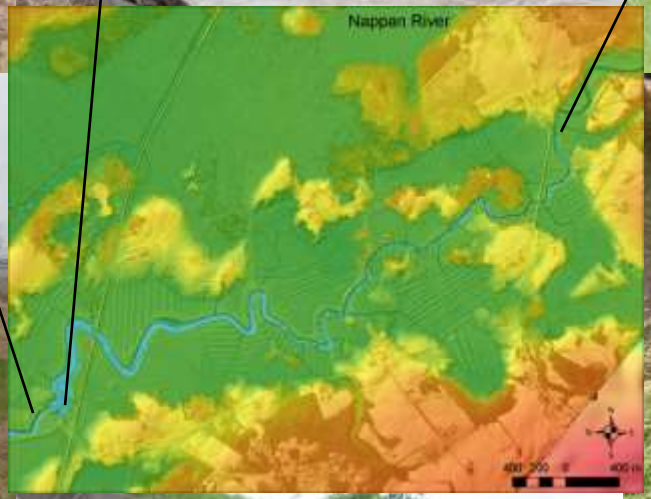
Oblique photo March 2011



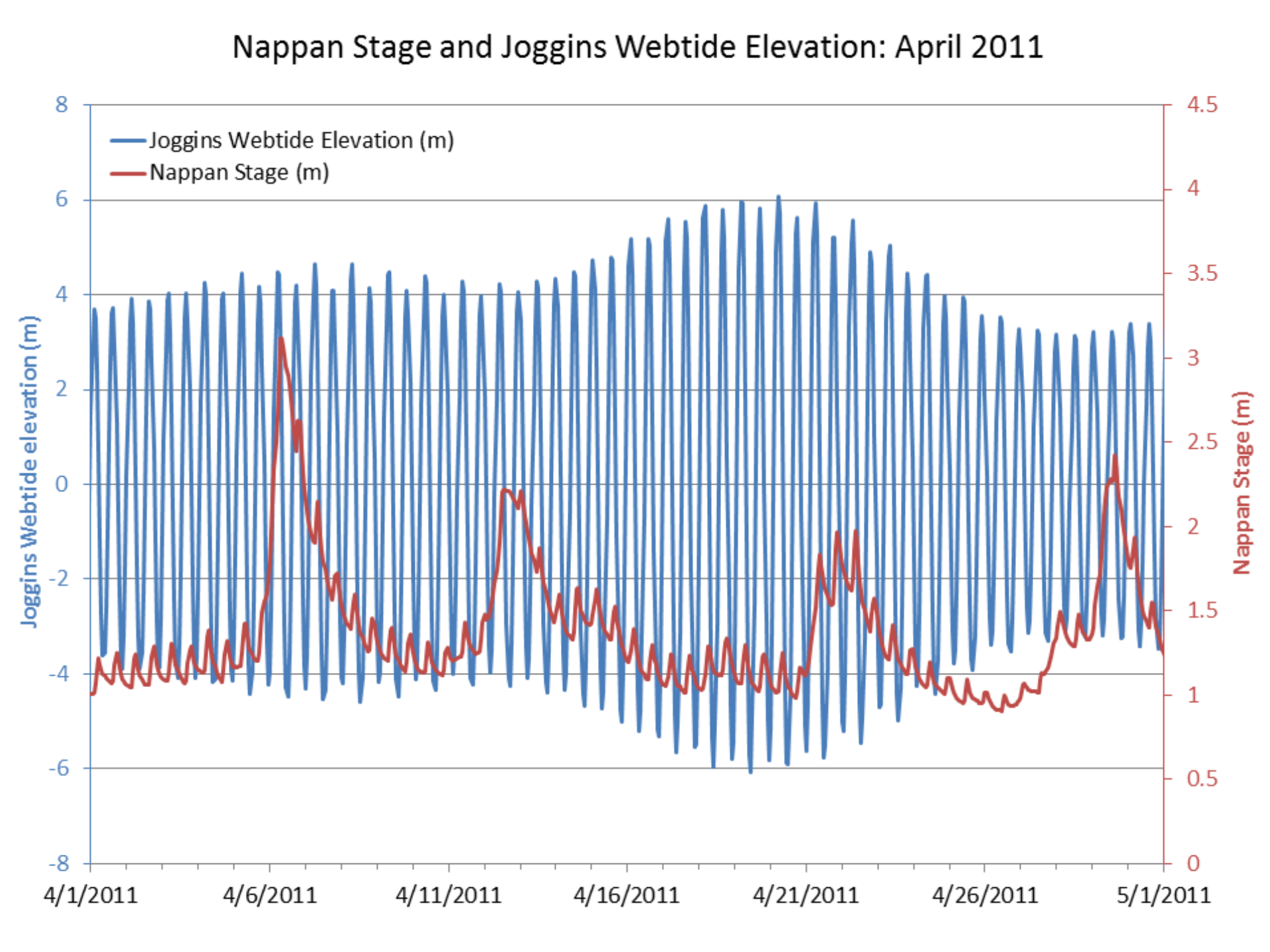
Aboiteau Downstream

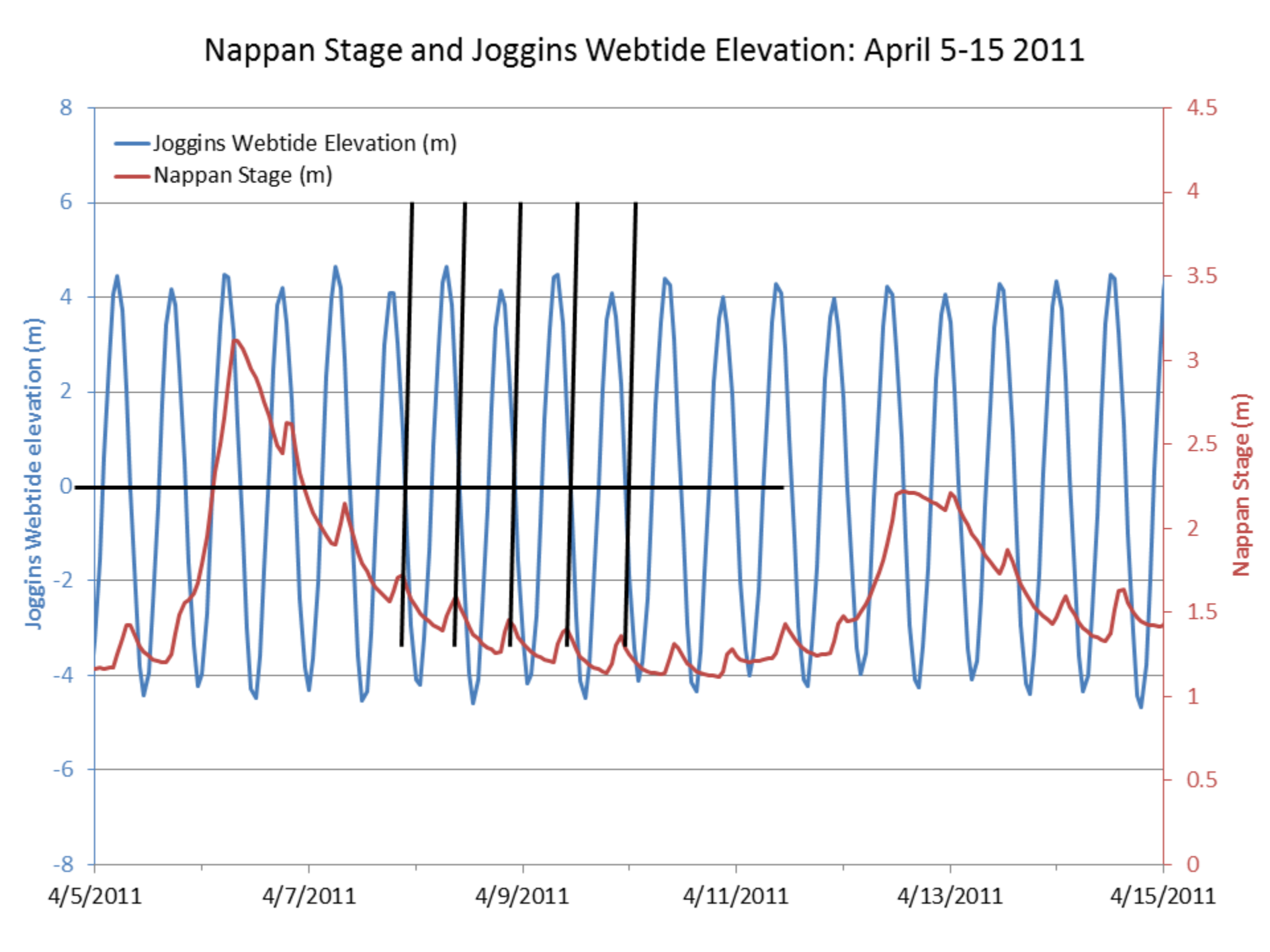
Aboiteau Upstream

Flow at Stage Sensor

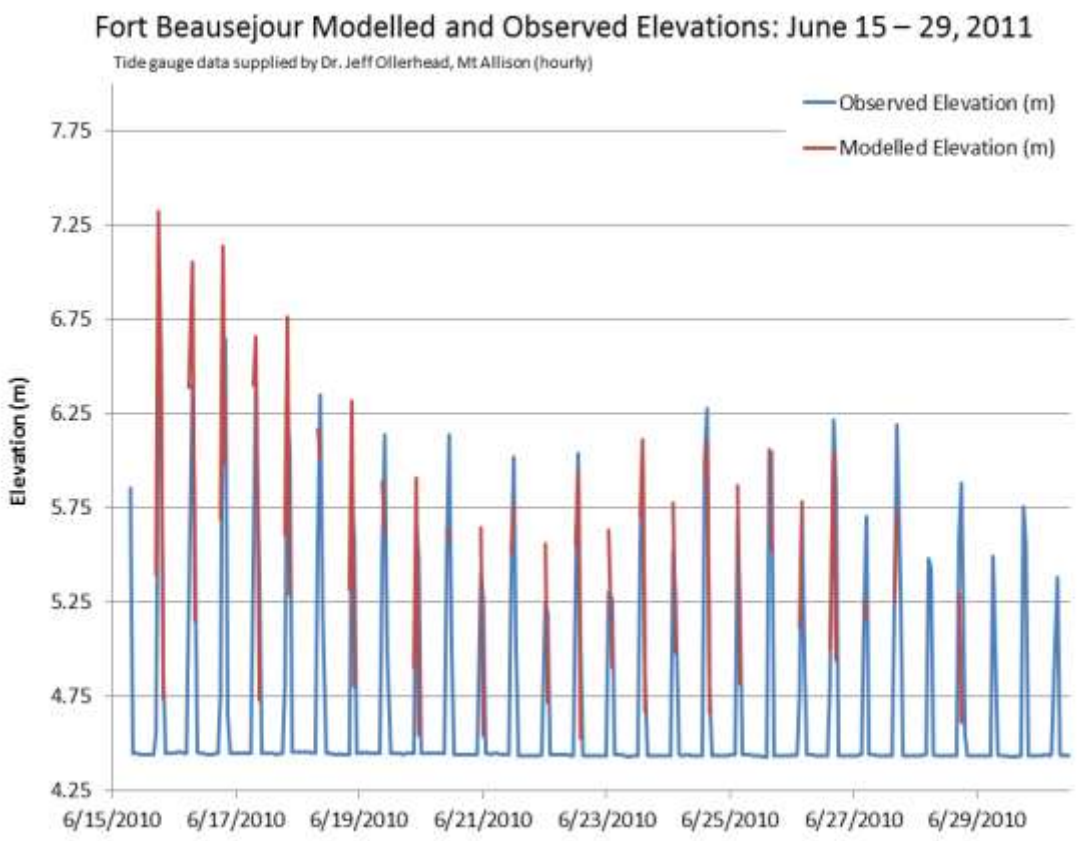


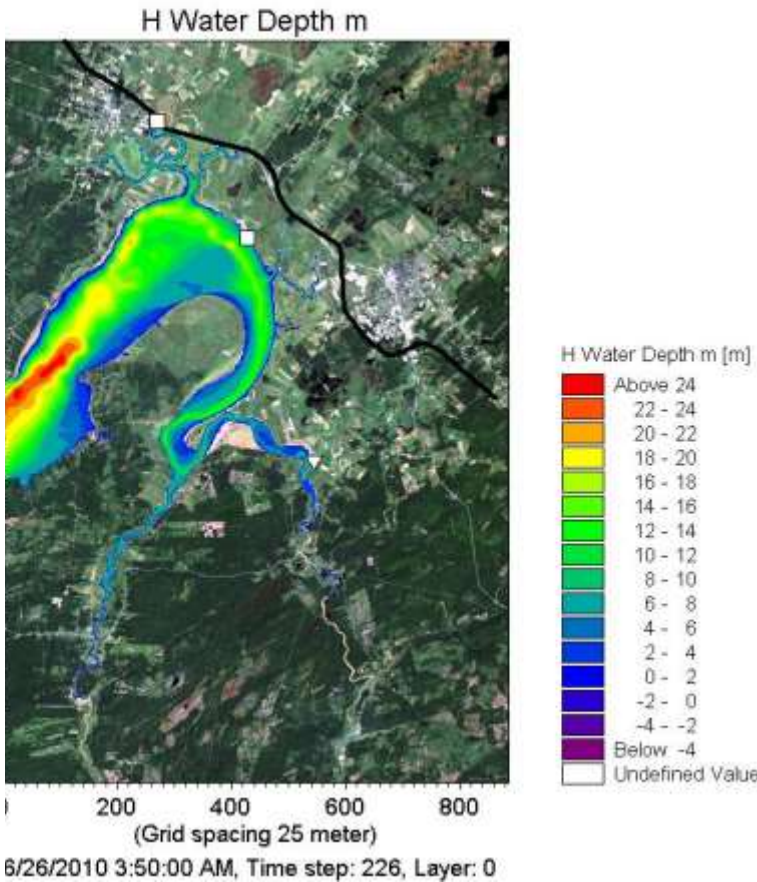
Aboiteau at Nappan River


Nappan Stage and Joggins Webtide Elevation: April 2011
Joggins Webtide Elevation (m)
Nappan Stage (m)
Joggins Webtide elevation (m)
Nappan Stage (m)
8
6
4
2
0
-2
-4
-6
-8
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4/1/2011
4/6/2011
4/11/2011
4/16/2011
4/21/2011
4/26/2011
5/1/2011

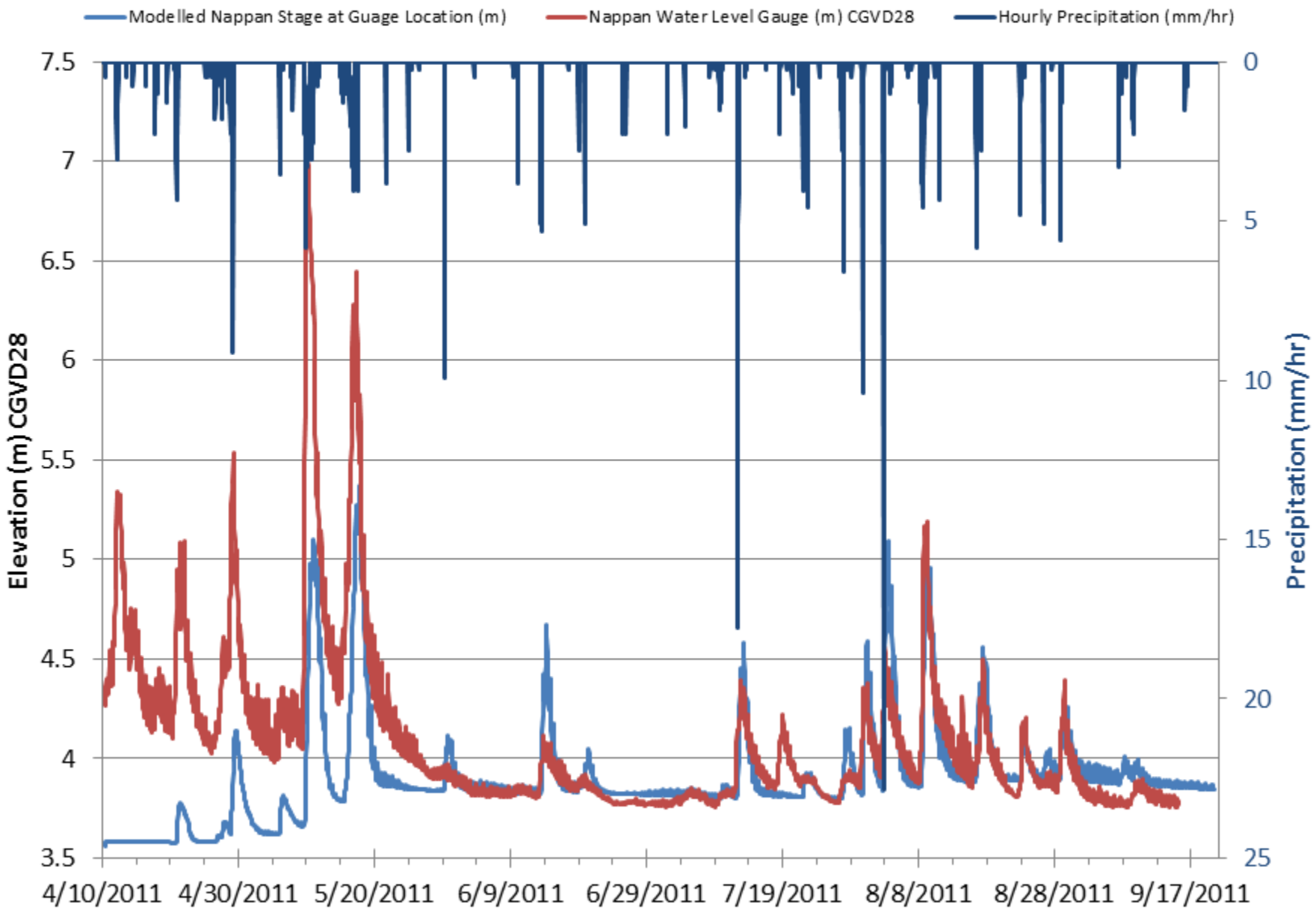

Nappan Stage and Joggins Webtide Elevation: April 5-15 2011
Joggins Webtide Elevation (m)
Nappan Stage (m)
Joggins Webtide elevation (m)
Nappan Stage (m)
8
6
4
2
0
-2
-4
-6
-8
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4/5/2011
4/7/2011
4/9/2011
4/11/2011
4/13/2011
4/15/2011

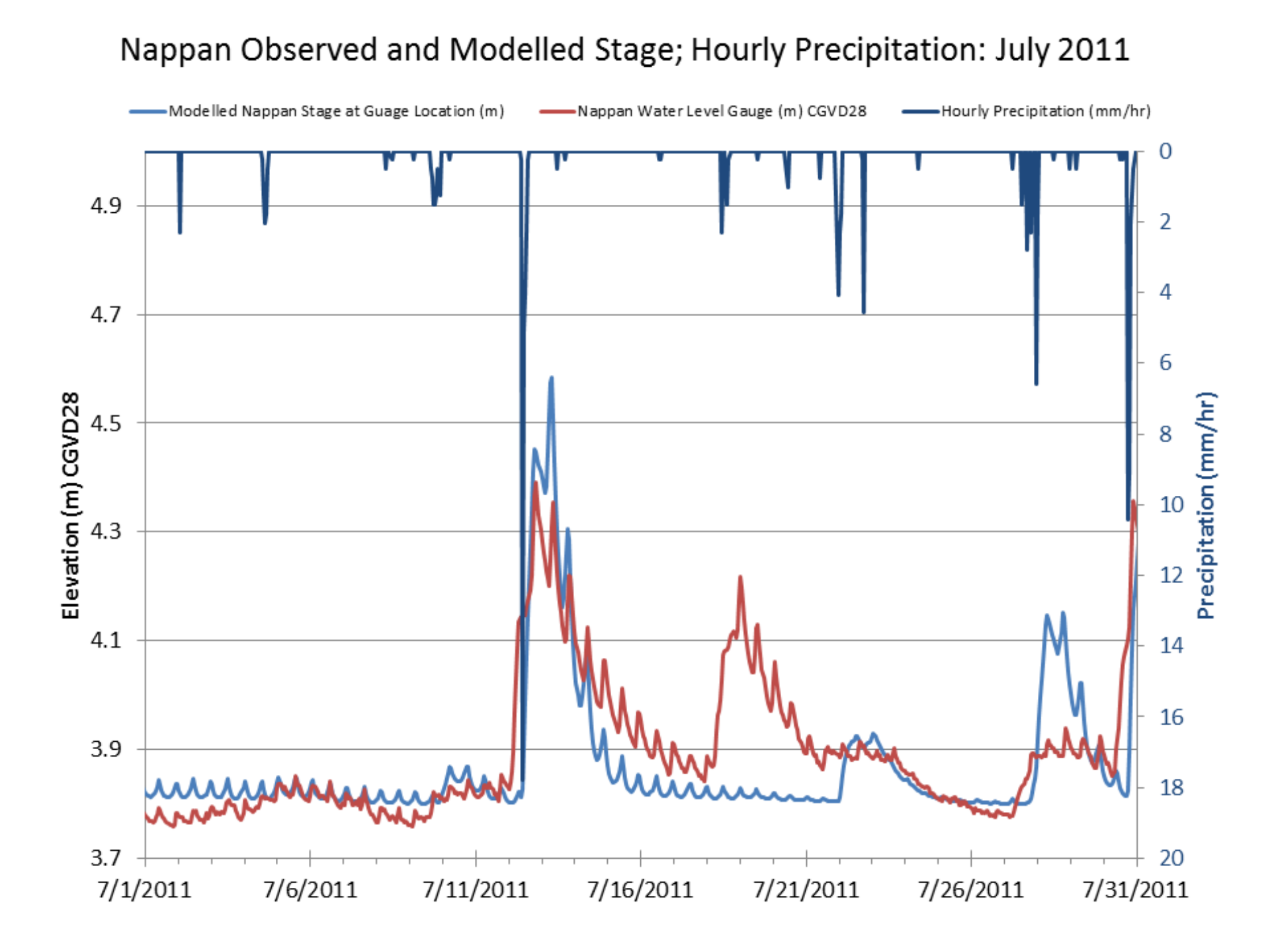
Needed to develop a tide model for the Upper Bay of Fundy
Required to control the gates on the aboiteau at Nappan
Model boundary condition derived from Webtide (DFO)
Does not currently account for storm surge or wind which will influence the water level downstream of the aboiteau



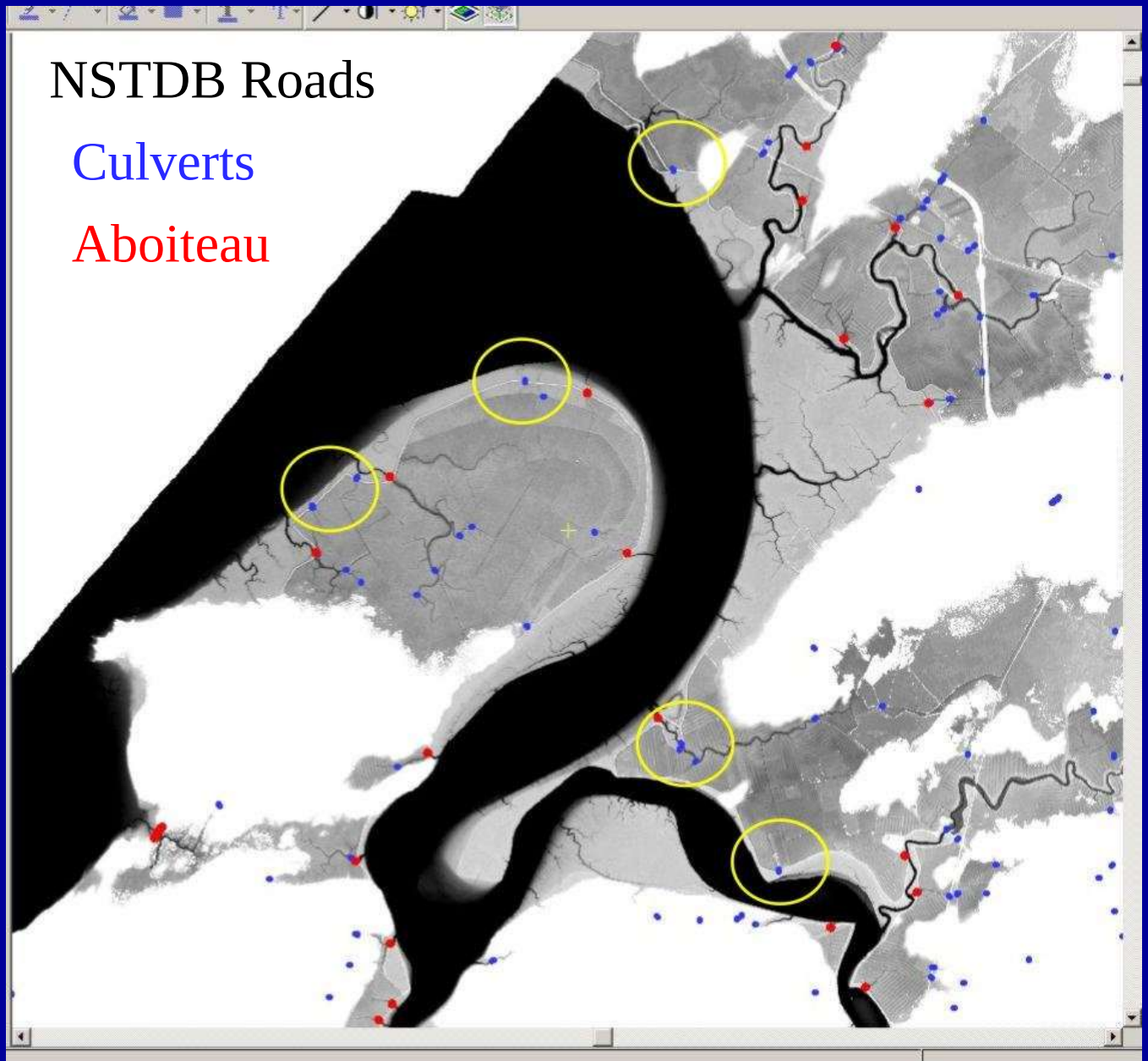


Nappan Observed and Modelled Stage; Hourly Precipitation: April – Sept 2011



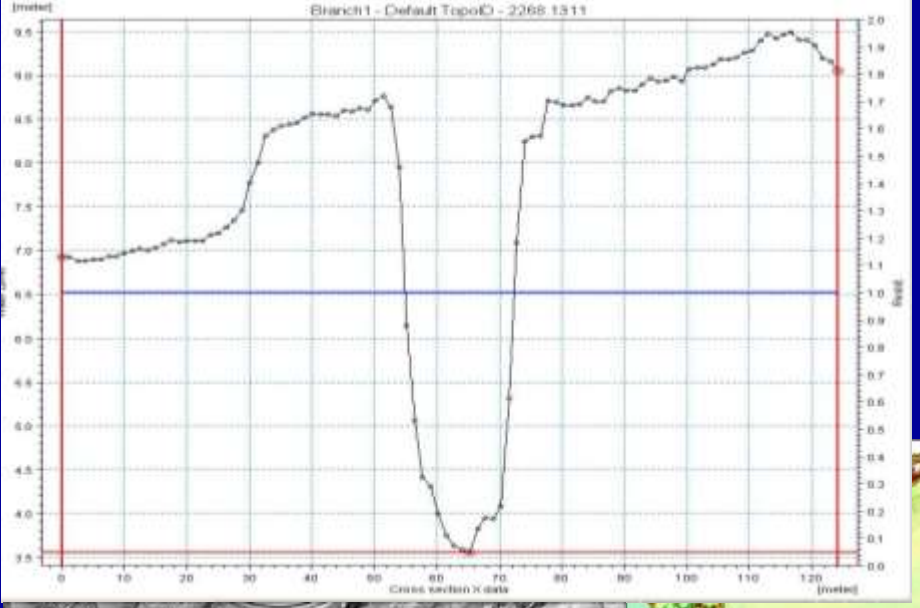

Nappan Observed and Modelled Stage; Hourly Precipitation: July 2011
Modelled Nappan Stage at Guage Location (m)
Nappan Water Level Gauge (m) CGVD28
Hourly Precipitation (mm/hr)
Elevation (m) CGVD28
Precipitation (mm/hr)
4.9
4.7
4.5
4.3
4.1
3.9
3.7
0
2
4
6
8
10
12
14
16
18
20
7/1/2011
7/6/2011
7/11/2011
7/16/2011
7/21/2011
7/26/2011
7/31/2011

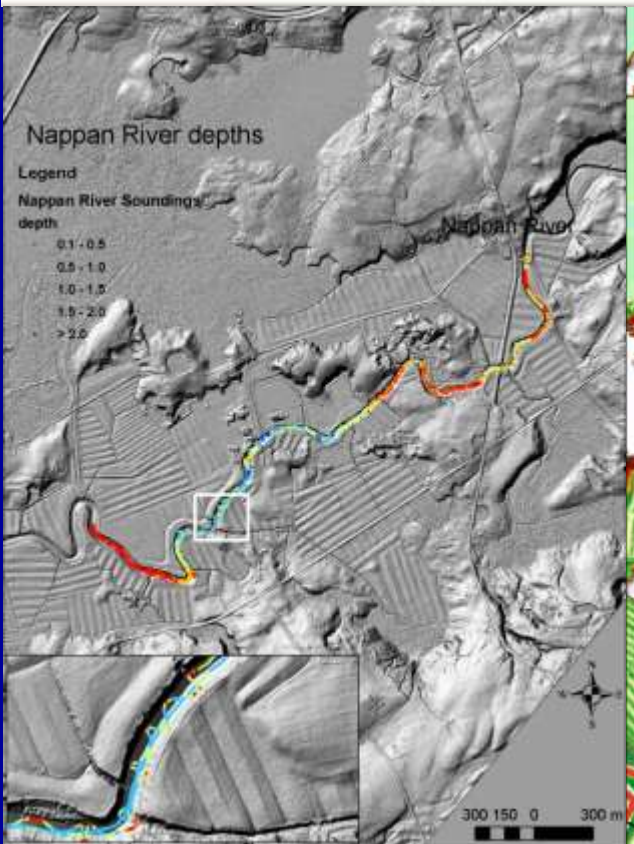
Culvert and hydraulic pathway issues

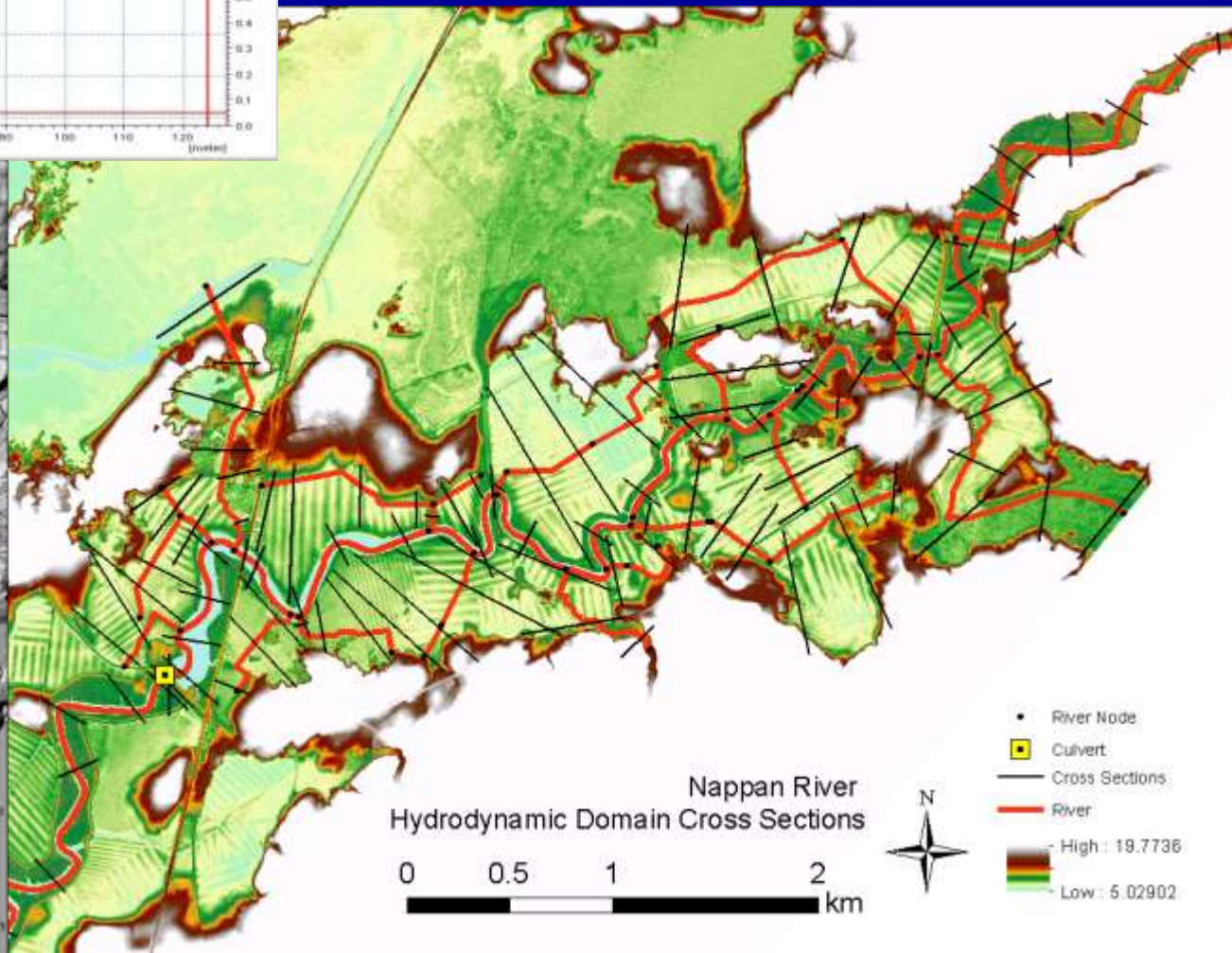


Example of a cross-section, river bed elevations are critical. Bank & floodplain can be derived from the lidar DEM.

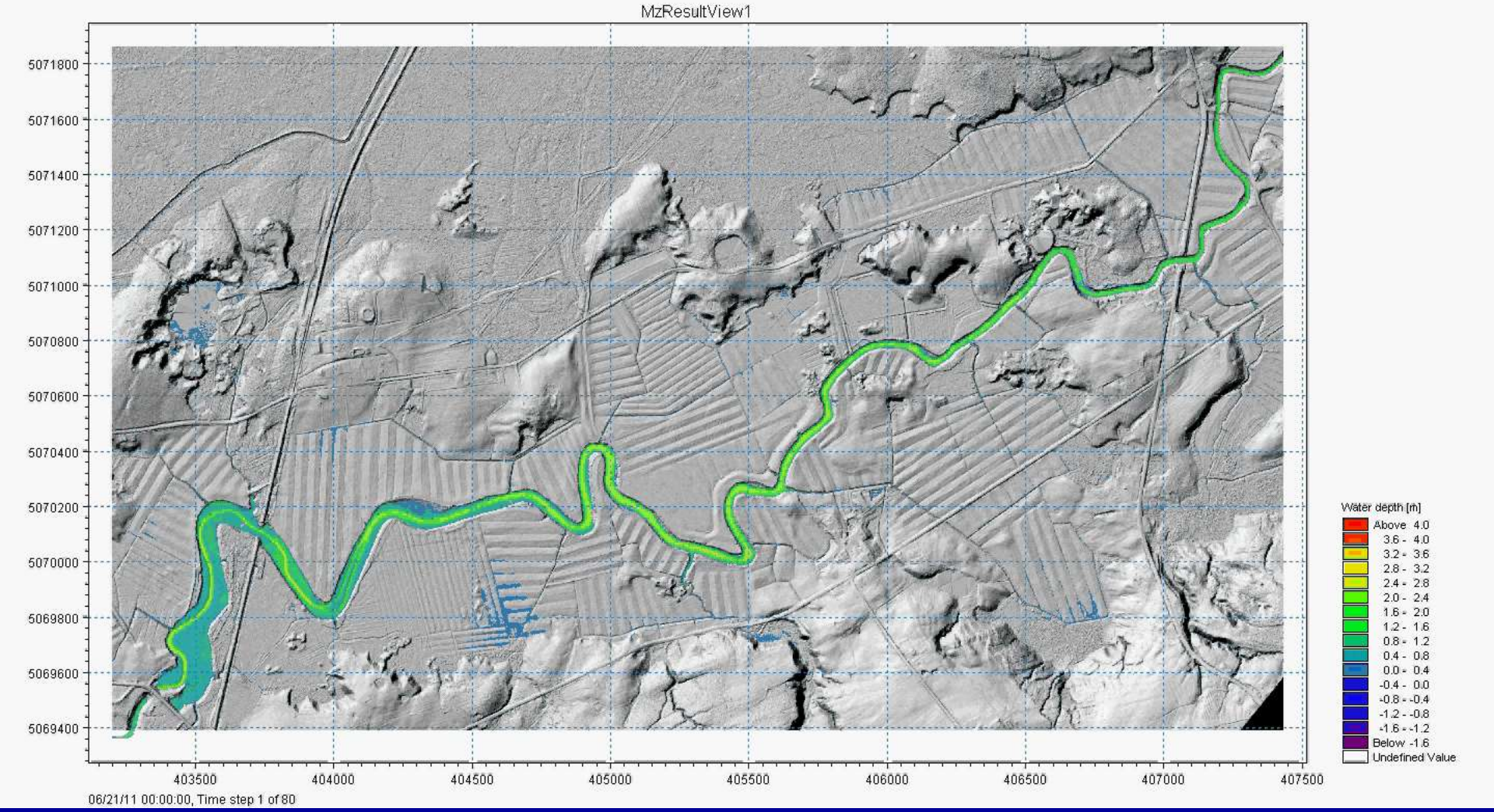
River channels & cross-sections



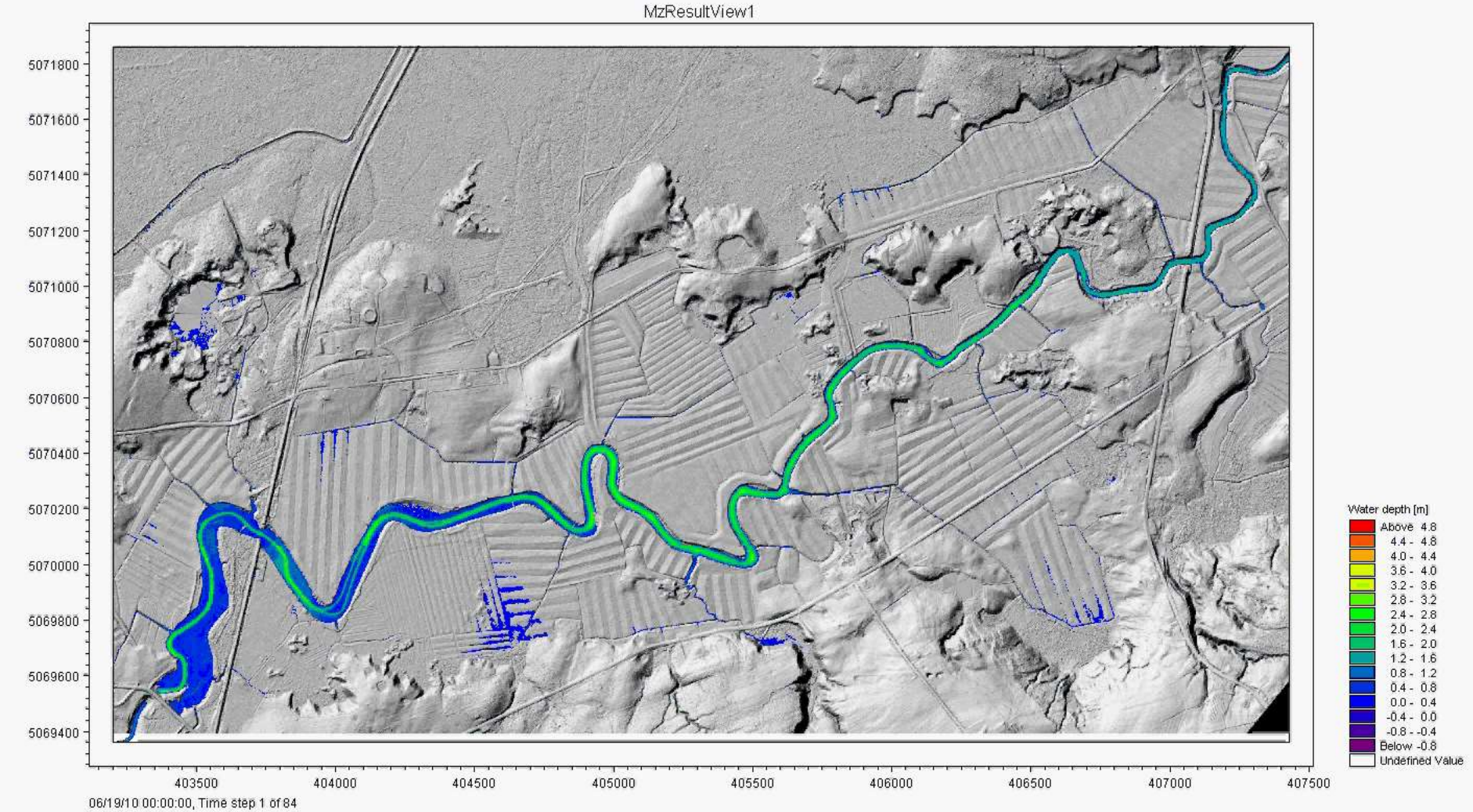




Simulation July 2010



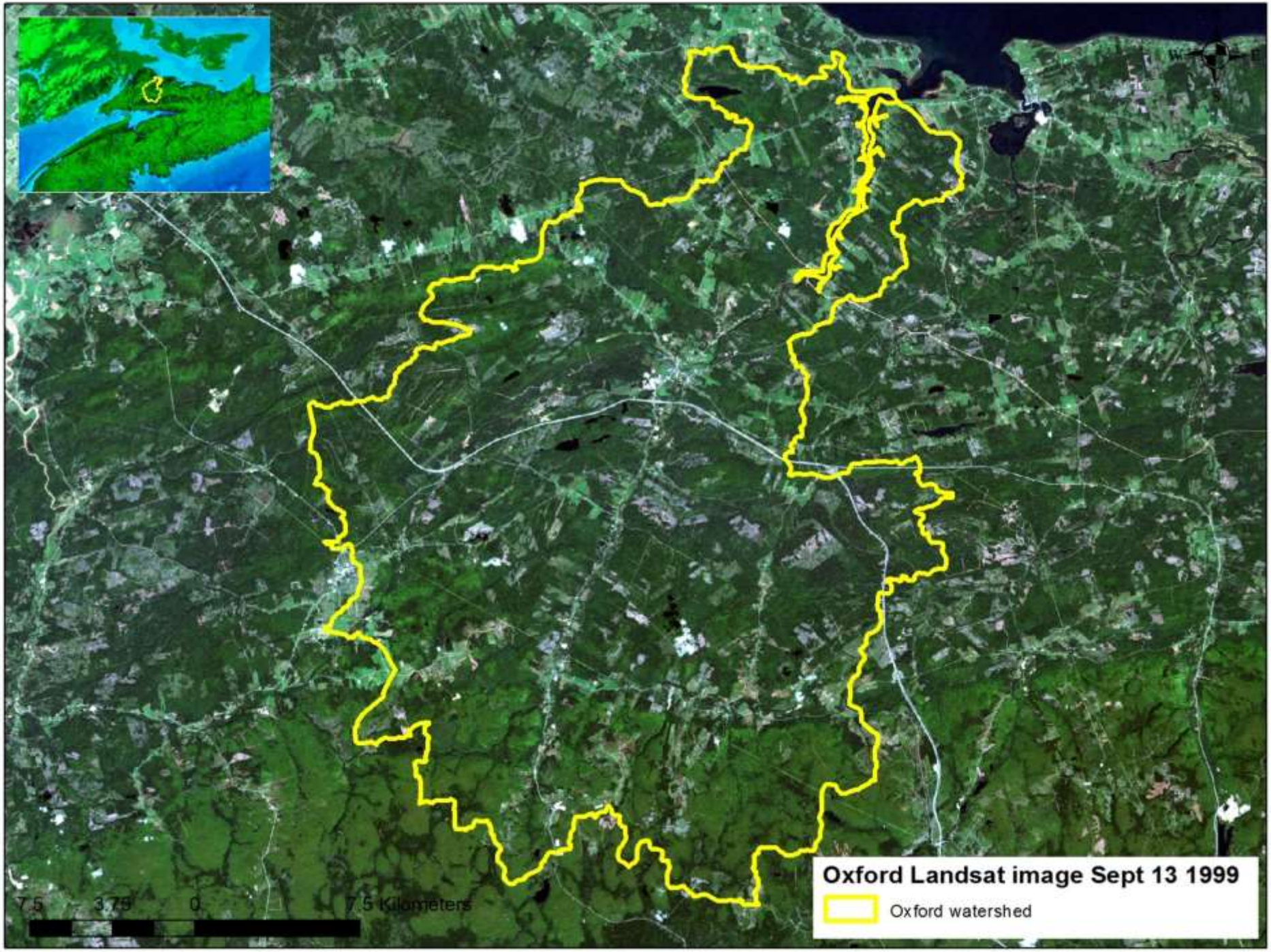
Simulation July 2010, Precip x 3

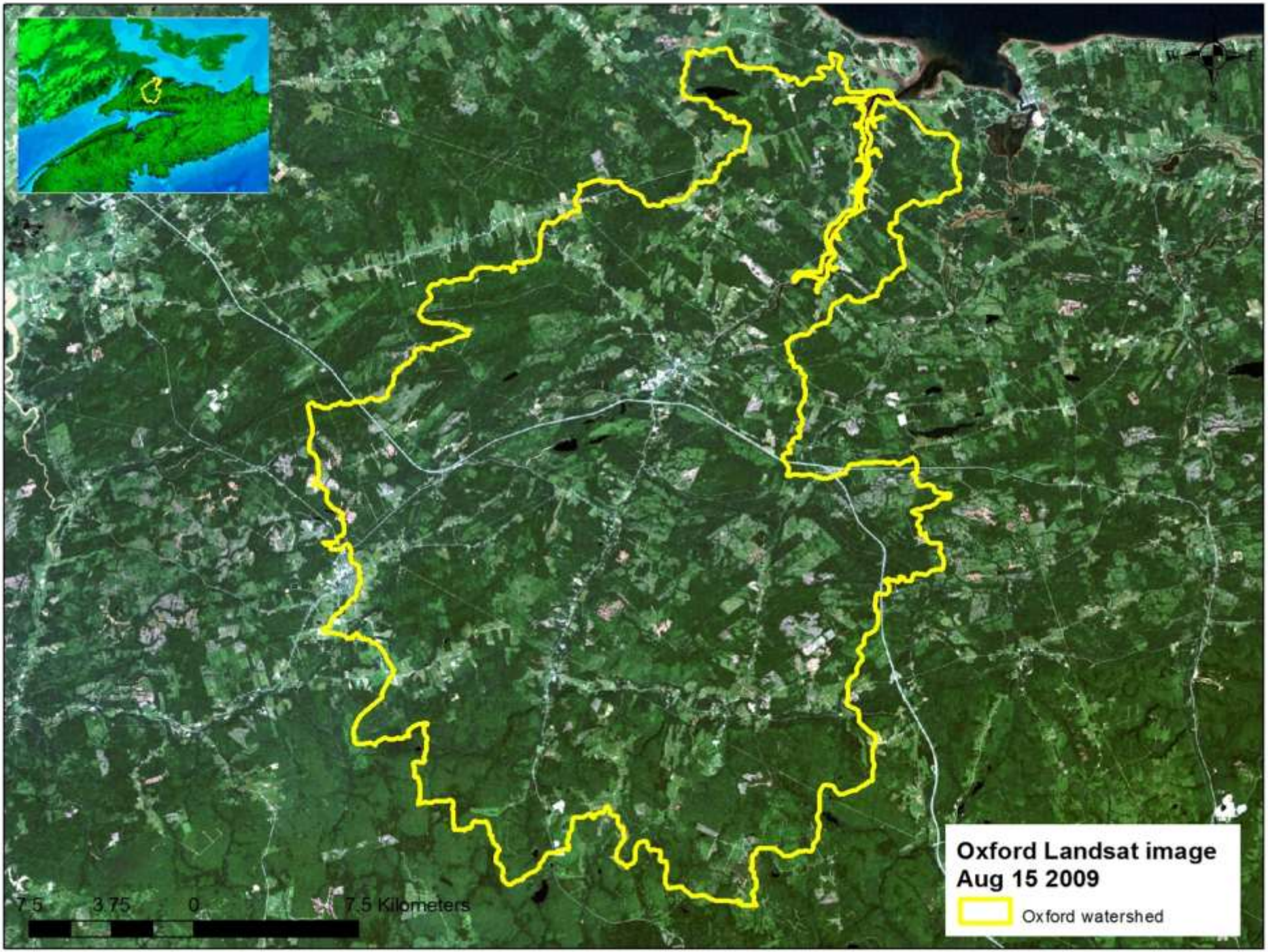


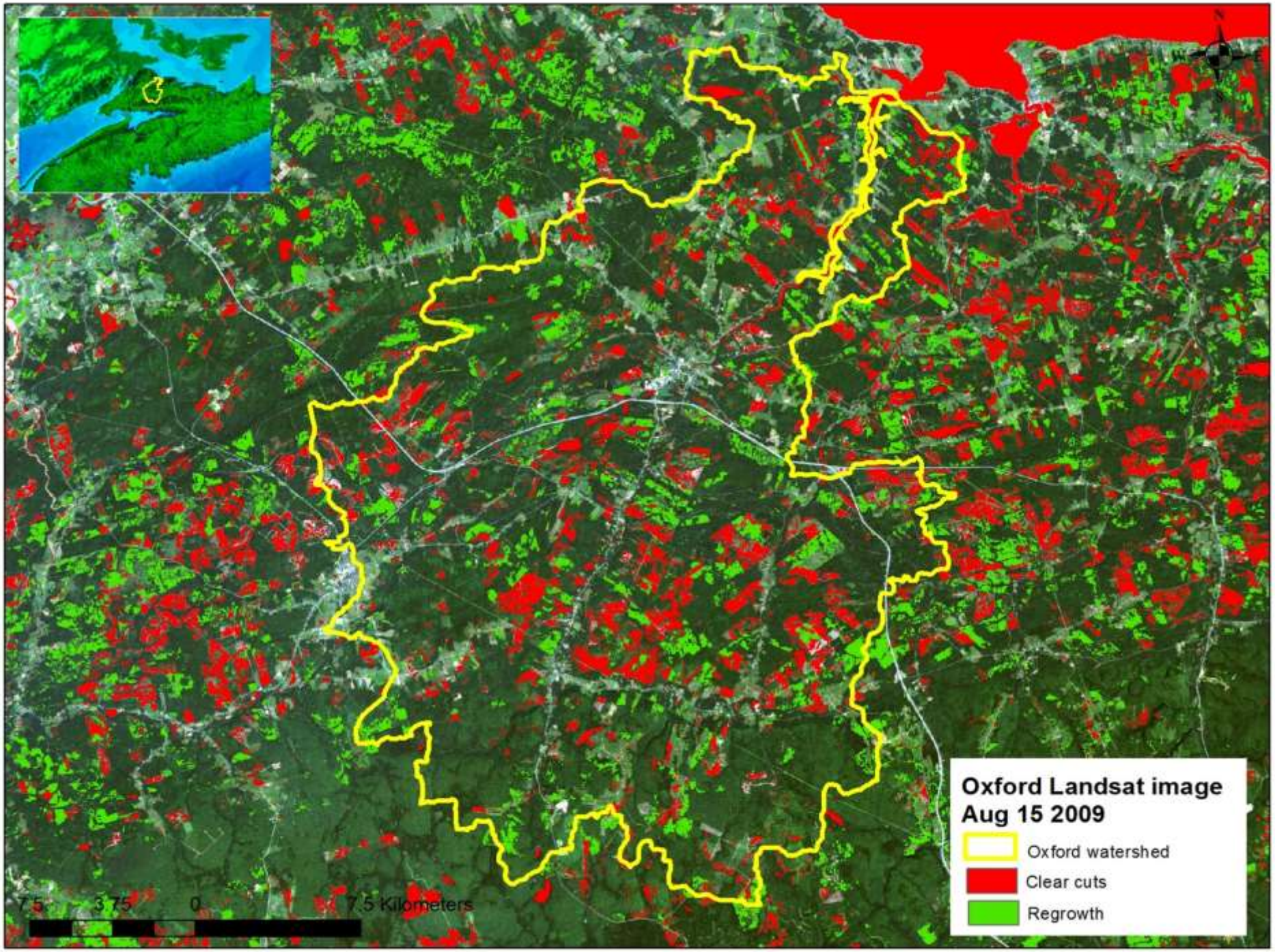
	1980s	2020s	2050s	2080s
Heating Degree Days	4516.7	4167.2	3797.1	3439.6
Cooling Degree Days	85.7	140.8	222.6	322.9
Hot Days (Tmax > 30)	0.6	2.7	6.8	14.6
Very Hot Days (Tmax > 35)	0.0	0.0	0.0	0.1
Cold Days (Tmax < -10)	8.4	7.0	4.9	2.9
Very Cold Days (Tmax < -20)	0.1	0.1	0.0	0.0
Growing Degree Days > 5	1713.5	1929.5	2187.7	2471.0
Growing Degree Days > 10	860.1	1017.0	1206.9	1414.3
Growing Season Length (days)	166.7	176.6	194.2	211.2
Corn Heat Units (CHU)	2468.5	2775.2	3140.5	3501.0
Corn Season Length (days)	136.9	146.0	159.1	170.2
Freeze Free Season (days)	197.3	221.7	241.5	257.0
Days With Rain	124.4	136.3	140.3	144.4
Days With Snow	41.3	50.6	42.7	36.9
Freeze-Thaw Cycles - Annual	95.5	89.1	79.7	72.6
Winter	33.8	35.2	37.6	38.7
Spring	38.3	34.1	26.8	21.6
Summer	0.4	0.3	0.1	0.0
Autumn	23.0	19.6	15.3	12.2
Water Surplus (mm)	708.3	689.3	688.7	694.9
Water Deficit (mm)	43.0	47.9	57.6	68.1
Δ Intensity Short Period Rainfall (%)	0	5	9	16

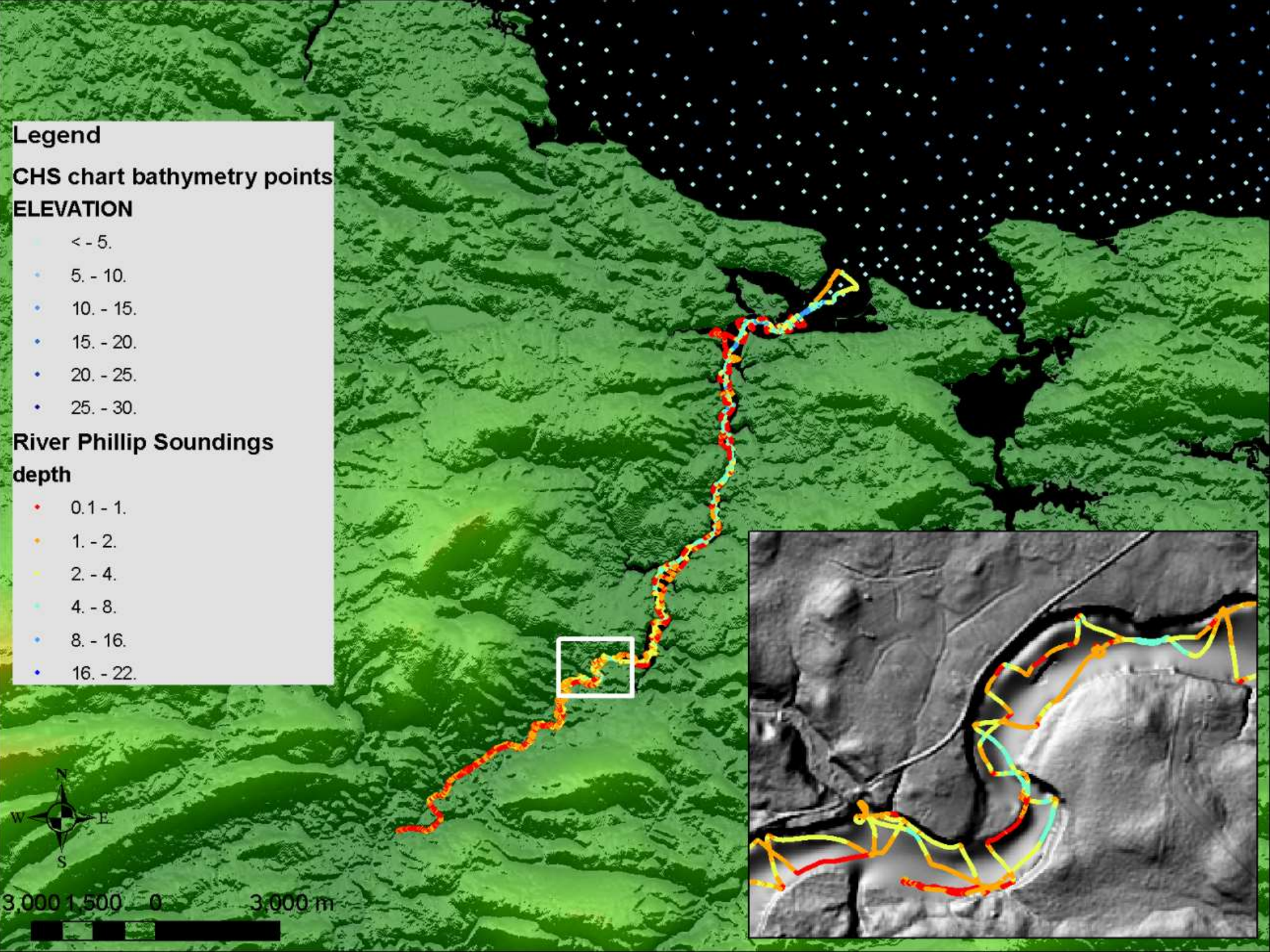
Nappan Station
Richards & Daigle
2011

The Problem: Oxford

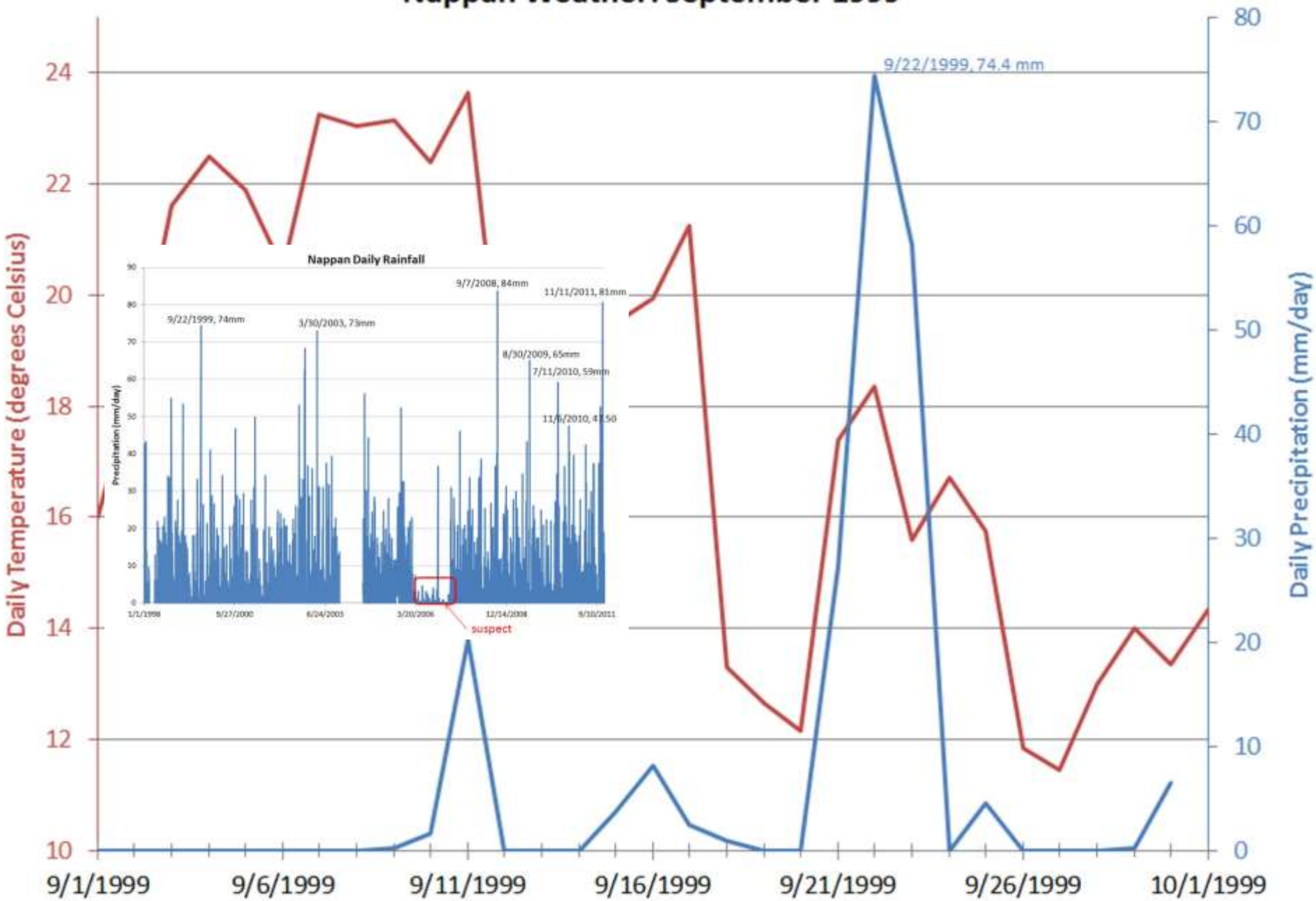

Oxford Landsat image Sept 13 1999
Oxford watershed
7.5 3.75 0 7.5 Kilometers


Oxford Landsat image
Aug 15 2009
Oxford watershed
7.5
3.75
0
7.5 Kilometers

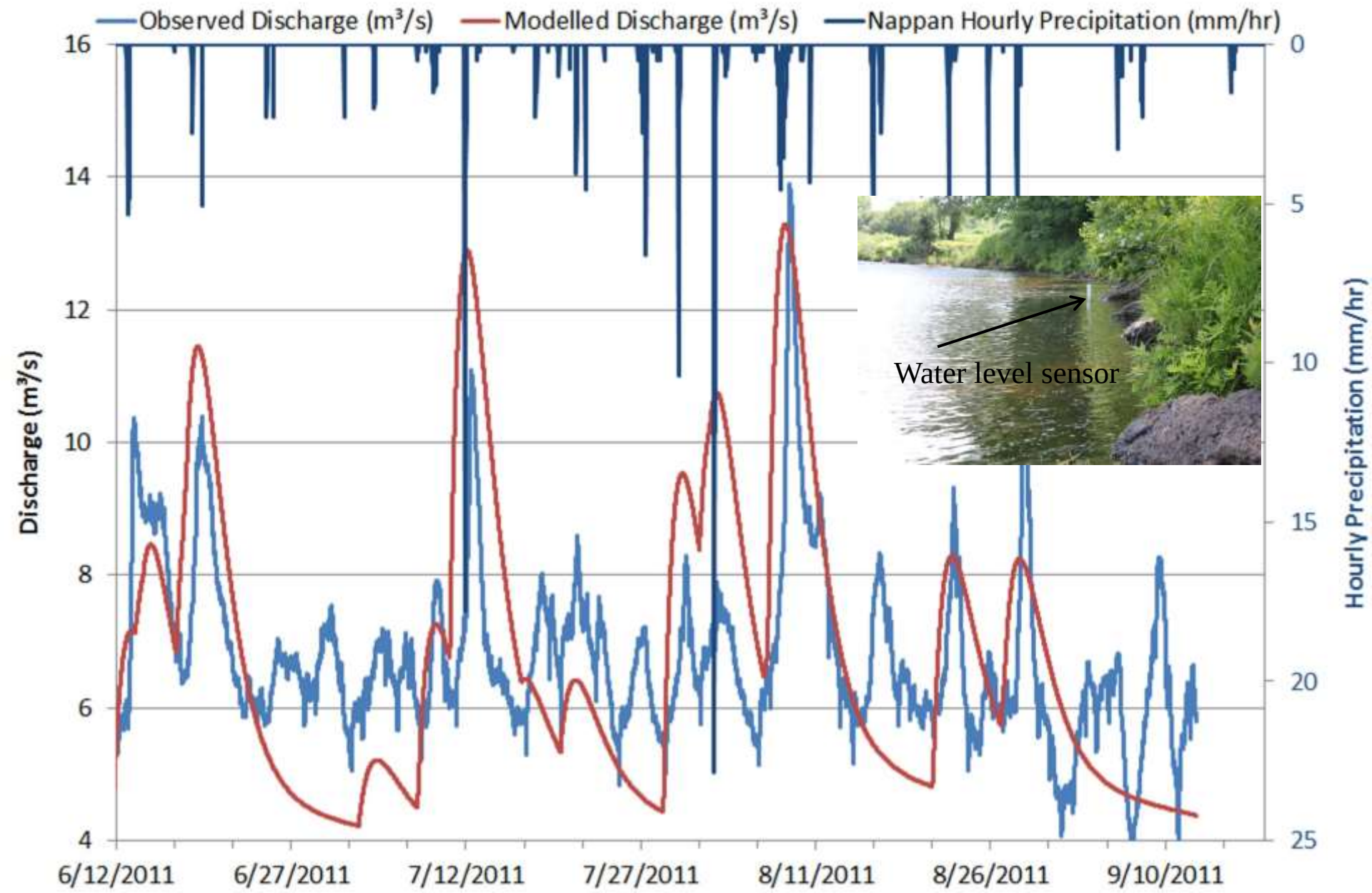

Oxford Landsat image
Aug 15 2009
Oxford watershed
Clear cuts
Regrowth
7.5 3.75 0 7.5 Kilometers


Legend
CHS chart bathymetry points
ELEVATION
< - 5.
5. - 10.
10. - 15.
15. - 20.
20. - 25.
25. - 30.
River Phillip Soundings
depth
0.1 - 1.
1. - 2.
2. - 4.
4. - 8.
8. - 16.
16. - 22.
N
W
E
S
3,000 1,500 0 3,000 m

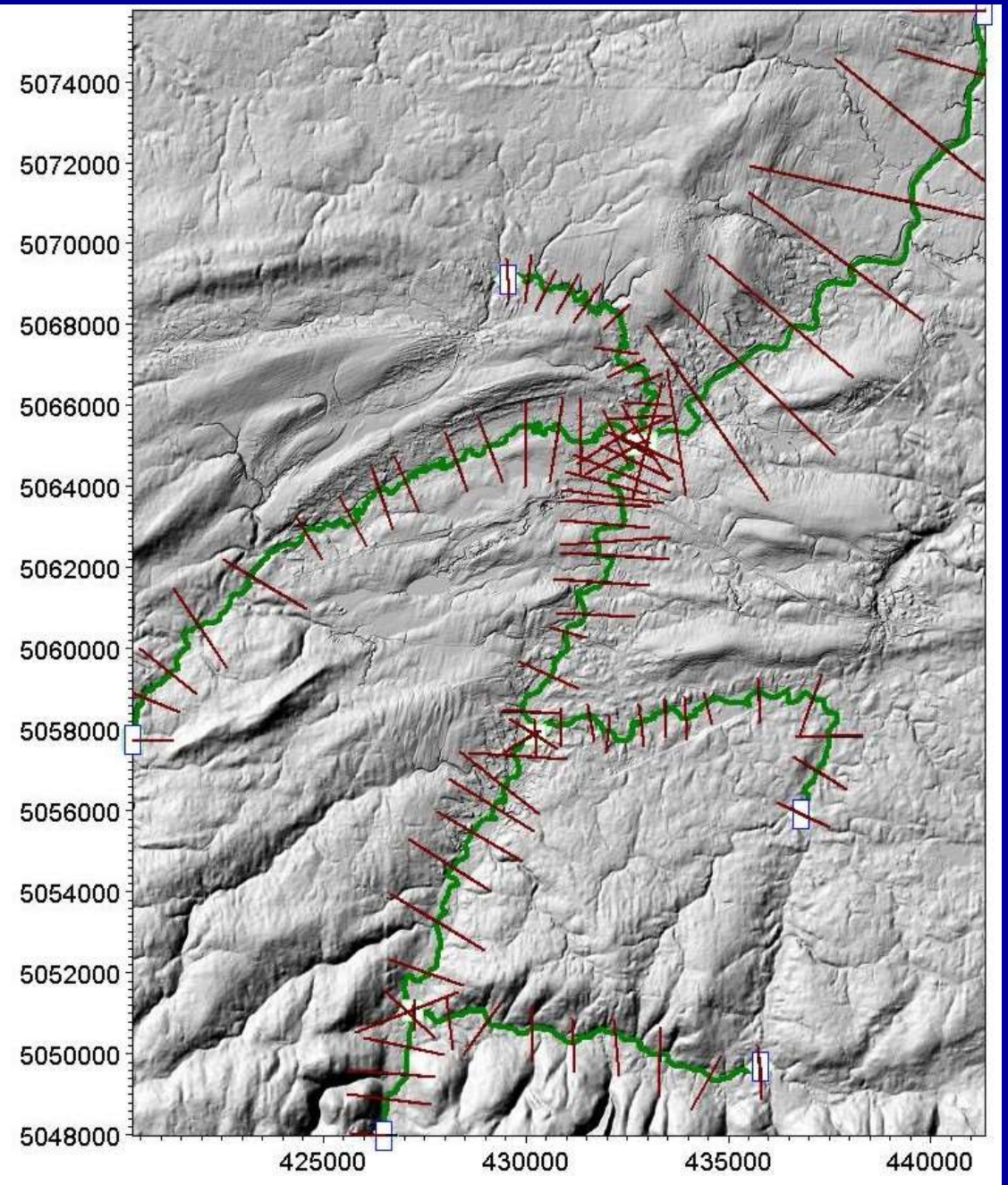
Nappan Weather: September 1999



Oxford Observed and Modelled Discharge + Nappan Precipitation



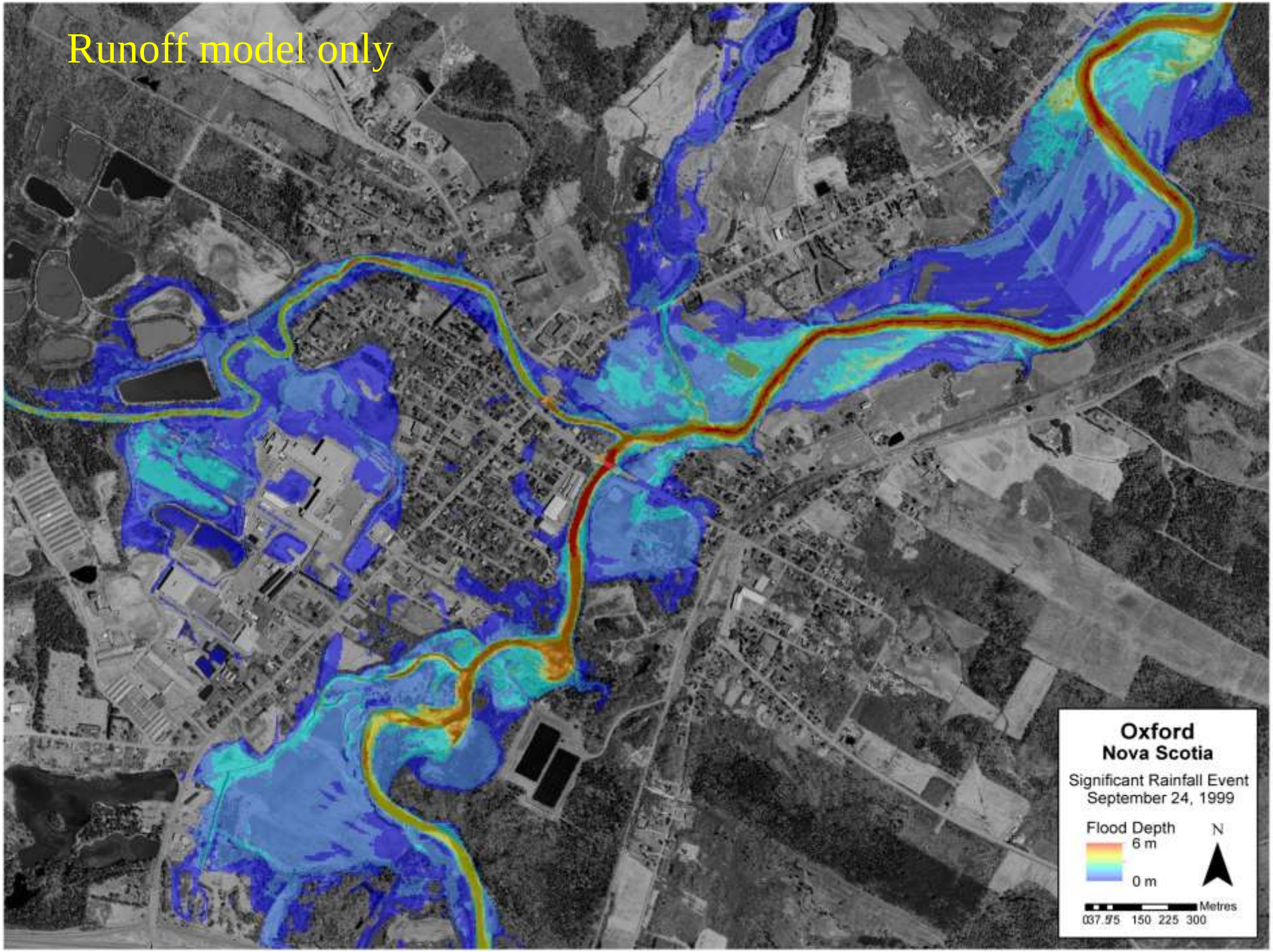
Example of river cross-sections used with the watershed model

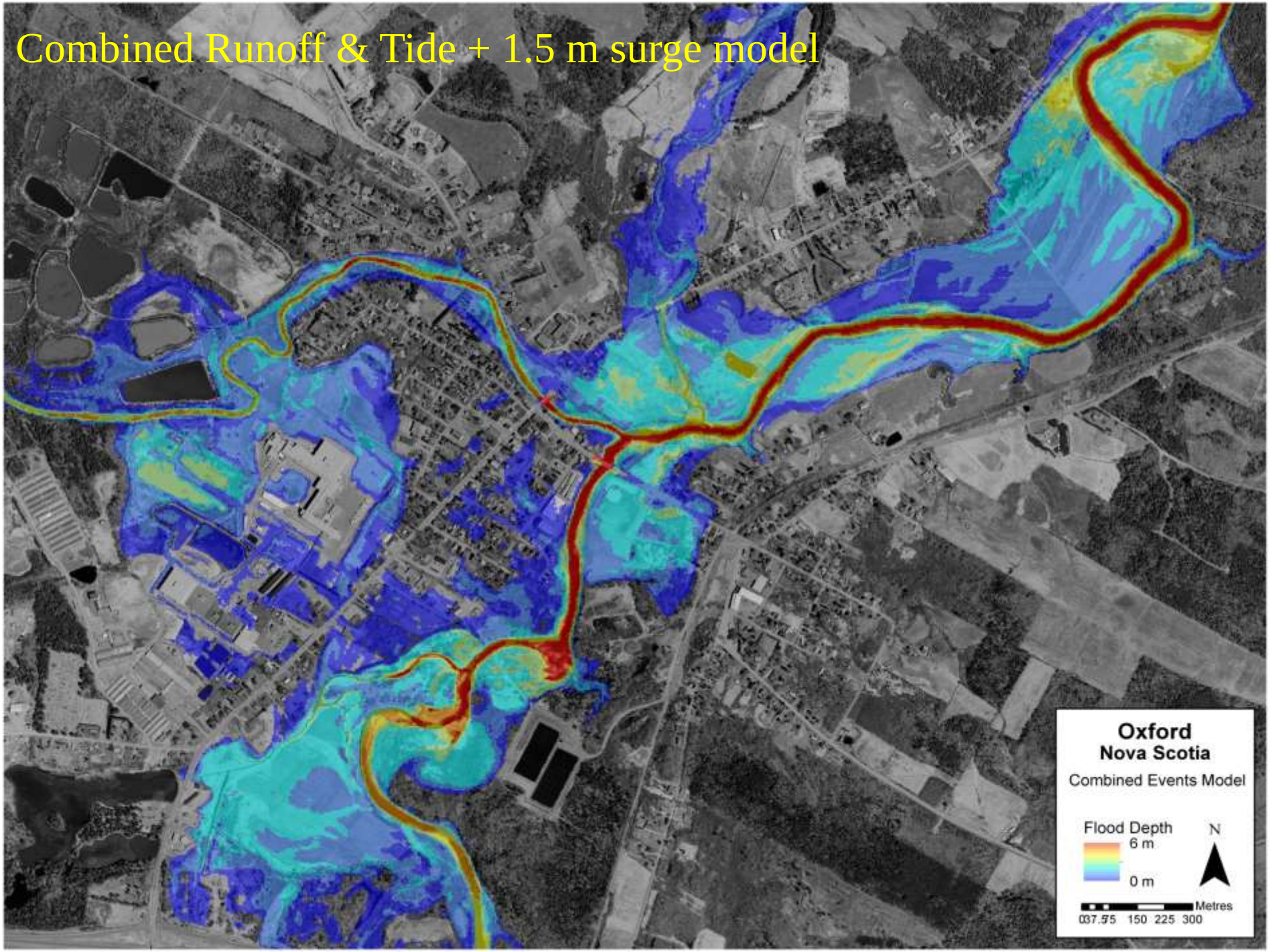


During the Sept 1999 flood many residents remarked that the water levels of the river were related to the stage of the tide.

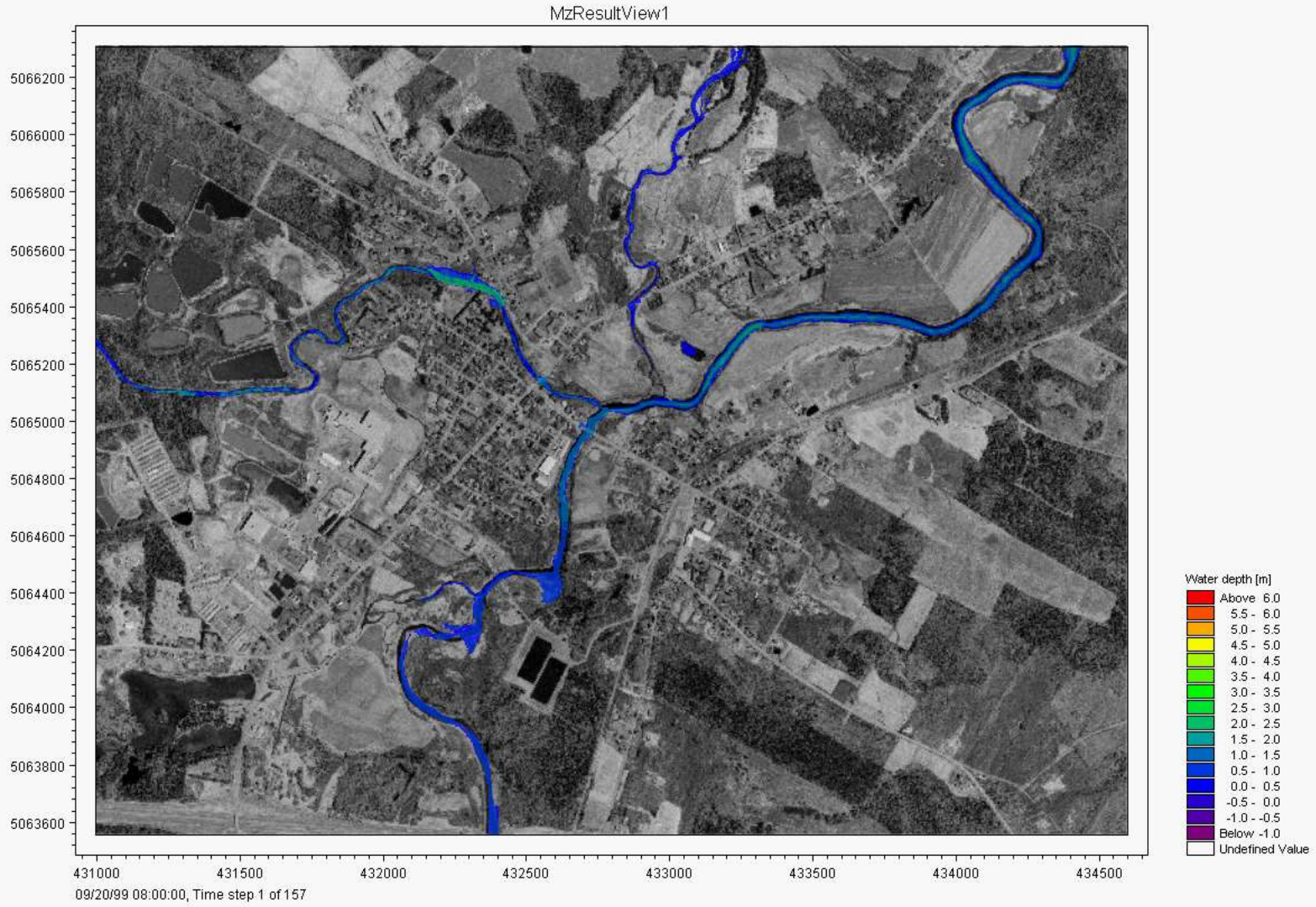
D. Stiff study ignored the tidal influence and the model was only watershed runoff

This motivated this study to link the watershed model with the ocean tide-surge model


Runoff model only
Oxford
Nova Scotia
Significant Rainfall Event
September 24, 1999
Flood Depth
6 m
0 m
N
Metres
037.575 150 225 300


Combined Runoff & Tide + 1.5 m surge model
Oxford
Nova Scotia
Combined Events Model
Flood Depth
6 m
0 m
N
Metres
037.575 150 225 300

Simulation of Sept. 1999 event



Conclusions

- Lidar surface models provide detail of the floodplain, however nothing below the water level
- CHS charts provide soundings in deeper water
- Used depth sounder to collected river bed elevations to produce more accurate cross-section
- Coastal communities along estuaries have a risk of river runoff flooding and storm surge
- These two events often interact and reinforce each other
- We have developed tide-surge models that are coupled with rainfall runoff watershed models to simulate this interaction
- Can increase the rainfall & temperature to simulate possible climate change