Changing Climate and Land Use: Consequences for 100-Year Flooding in the Lamprey River Watershed of New Hampshire

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Changing Climate and Land Use: Consequences for 100-Year Flooding in the Lamprey River Watershed of New Hampshire

ASFPM 18 May 2011 Louisville, KY

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Lisa Townson & Julia Peterson, UNH Cooperative Extension
John Echeverria and Peg Elmer, Vermont Law School

Funded by NOAA Cooperative Institute for Coastal & Estuarine Environmental Technology
Engaged Scholarship at UNH

At UNH, engaged scholarship is defined as:

“a mutually beneficial collaboration between UNH and community partners for the purpose of generating and applying relevant knowledge to directly benefit the public”

Carnegie Foundation for the Advancement of Teaching officially recognized the University of New Hampshire as a “Community Engaged” university (2008)
Assessing Flood Risk - Lamprey River Watershed

Project Objectives:

• Assess flood risk associated with combined land use and climate change scenarios out to 2100
• Produce maps of the 100-year flood risk boundaries and river discharge at specific locations
• Demonstrate the use of our products to support land use decision-making in coastal communities
• Serve as a model for other New England watersheds
• Address legal issues of using projected flood information
Lamprey River Watershed, New Hampshire
Assessing Flood Risk - Lamprey River Watershed

Advisory Committee
municipal, regional, state, federal and non-profit representation

Cliff Sinnott, Rockingham Planning Commission (Chair)
Joanne Cassulo, NH Office of Energy and Planning
David Cedarholm, Durham Public Works
Cynthia Copeland, Strafford Regional Planning Commission
Michael Goetz, FEMA Region 1
Diane Hardy, Newmarket Planning Department
Sharon Meeker, Lamprey River Advisory Committee
Jack Munn, Southern New Hampshire Planning Commission
Jennifer Perry, Exeter Public Works
Ron Poltak & Becky Weidman, NEIWPC
Keith Robinson, USGS
Carl Spang/Dawn Genes, Lamprey River Watershed Association
Eric Williams, NH Department of Environmental Services
Assessing Flood Risk - Lamprey River Watershed

Population (all towns with at least a portion of their area in the watershed)

Urban & Developed Land (Lamprey River Watershed)
4 Inch Precipitation Events by Decade 1948 - 2007

Durham, NH

Lawrence, MA
100-year Rainfall Estimates

TP-40 Rainfall Frequency Atlas used for effective conditions = 6.3”

Northeast Regional Climate Center Atlas for Extreme Precipitation for current conditions = 8.5”
Assessing Flood Risk - Lamprey River Watershed

Daily Discharge for Lamprey River near Newmarket, NH
July 1934 - July 2010

FIS 100 year flood (7300 cfs)

Year

discharge (cubic feet per second)

0 2000 4000 6000 8000


4/7 1987

5/15-16 2006

4/17-18 2007

3/15-17 2010
Costs from Presidentially Declared Disasters in NH
Assessing Flood Risk - Lamprey River Watershed

Technical Analysis
- Construct hydrologic and hydraulic model
- Develop land use and climate change scenarios
- Run model; plot cross-sections; map results

Dissemination
- Advisory Group & Focus Groups
- Community Workshops
- Municipal & Regional Planners
- NH GRANIT website

Evaluation and Feedback
Hydrology Overview

GIS
Preprocessed Spatial Hydrology Data Base

HEC-GeoHMS (ArcHydro Tools) to process DEM

Standard Hydrologic Grid Hydrologic Rainfall Analysis Project

Delineate Watershed and Sub-watershed

DEM Reconditioning

Runoff Parameters

Stream Network

HEC-HMS Input File
Land Use Within the Watershed

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>CN</th>
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<tbody>
<tr>
<td>W6510</td>
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</table>
Calibrating the Watershed
Hydraulic Overview

GIS Preprocessed Spatial Hydrology Data Base

HEC-GeoRAS (ArcView)

Create Stream Stationing and Reaches

Create Stream Cross Sections

Extract Elevation Data

HEC-RAS Input File

RAS Mapping
April 2007: modeled = 34.4’ observed = 34.1’
March 2010: modeled = 33.6’ observed = 33.3’
Current 100 yr flood = 35.8’
FIS 100 yr flood = 33.0’
Part F - Site Location
Proposed Northeast Lidar Project Area
Phase I - ARRA funded coastal region

Northeast lidar project area
- ARRA data collection - 50785 sq. mi.
- State share collection - 1541 sq. mi.
- Parker/Ipswich addition - 153 sq. mi.
- Barnstable County addition - 402 sq. mi.
- Data already in CLICK - 860 sq. mi.
- Other 2010 collection - 1656 sq. mi.
- Data already collected - 6606 sq. mi.

Total Area = 16,303 square miles
Total Coastline = 10,500 linear miles
Population = 19.9 million
Households = 7.5 million

Version 5 April 26, 2010
Assessing Flood Risk - Lamprey River Watershed

Land Use & Climate Scenarios to be Evaluated (6 total)

<table>
<thead>
<tr>
<th>Land Use Condition</th>
<th>Climate Condition</th>
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<tr>
<td></td>
<td>FIS Conditions</td>
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<tr>
<td>FIS Conditions 1981</td>
<td>6.3&quot;</td>
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<tr>
<td>Current Conditions (2005)</td>
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<tr>
<td>Build-out conditions</td>
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<tr>
<td>Build-out with LID</td>
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Projecting Future Climate Change for the Northeast: Greenhouse Gas Emission Scenarios
<table>
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<tr>
<th>GCM</th>
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<td>HADCM3</td>
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</tr>
<tr>
<td>PCM</td>
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</table>
Mapping Buildout

Starting with total watershed acreage, eliminate:

- Developed land
- Hydric soils/wetlands/surface water
- Steep slopes (> 15%, based on soils)
- Conservation lands; public water supply protection areas

Build out flat terrains first, moving incrementally to steeper slopes

Within a slope category, build out areas closest to roads first
# Buildout Acreage

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Annual Growth Rate</th>
<th>Non-Residential*</th>
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</thead>
<tbody>
<tr>
<td>2006-2030</td>
<td>1.2%</td>
<td>1.7%</td>
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<tr>
<td>2031-2085</td>
<td>0.6%</td>
<td>1.1%</td>
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</table>

*includes redevelopment

Annual Growth Rate from Chapter 2, Regional Transportation Vision, Rockingham Planning Commission, 2009-2035 Long Range Plan
Regional Curve Number
Flood Flows
New Flood Plain Maps and Questions of Legal Authority, Measures and Consequences
In Collaboration with Vermont Law School

1. What is the potential liability of government if they fail to reduce vulnerability to the risk of flood based on UNH’s information?

2. What legal and policy approaches may communities adopt to reduce flood risks in the expanded flood hazard?

3. Do New Hampshire communities have the legal authority to design and implement regulatory controls based on projected conditions (e.g., flooding levels)?

4. What legal standard of scientific and technical reliability must be met in order to support regulatory measures based on current/future environmental conditions?

5. What is the potential regulatory takings exposure if communities impose regulatory controls that are designed to address anticipated future environmental conditions?
Newmarket Effective 100 Year Floodplain