Projected land use change following current trends and associated effects on nitrogen export

Madeleine Mineau, Wil Wollheim, Rob Stewart, and Alexandra Thorn
University of New Hampshire
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Introduction

• Land use change is a leading threat to water quality

• Coastal NH is particularly at high risk for adverse water quality from land conversion from forest to developed
Question

What is the effect of projected land use change on watershed nitrogen export?

• Land cover scenarios
• River network model
Scenarios to Land Cover

Initial conditions

Existing land cover types
- Forest *
- Wetlands
- Rivers & lakes
- Developed *
- Agriculture/grass *
- Other

Physical characteristics
- Elevation
- Slope
- Soil/drainage
- Floodplains

Social characteristics
- Population *
- Conserved land *

* change in scenarios

Land cover change

DEVELOPMENT
- Current trends: Extrapolate recent trends
- Community amenity: NH Climate Action Plan
- Backyard amenity: Population + zoning

Output
Decadal land cover maps for each scenario

Thorn et al. Unpublished
Probability Developed

Elevation

Elevation ≤ 120 m

- ≤ 64.4 km to Boston
  - Yes
  - No

- ≤ 4.8 km to major road
  - Yes: Prob. = 15.1%
  - No: Prob. = 5.4%

- ≤ 6.4 km to 8000+ pop. town
  - Yes: Prob. = 5.1%
  - No: Prob. = 1.1%

Elevation ≤ 166 m

- No

≤ 5.4 km to 8000+ pop. town

- Yes
  - Classified as flood plain (any category)?
    - Yes
      - Prob. = 7.4%
    - No: Prob. = 0.4%

- No: Prob. = 2.8%

≤ 76.5 km to Boston

- Is grassland / agriculture?
  - Yes
    - Prob. = 1.7%
  - No

≤ 42 m from developed land

- Yes
  - Prob. = 2.6%
- No
  - Prob. = 0.1%

Thorn et al. Unpublished
Probability Developed

Elevation

Distance from Boston

- Elevation $\leq 120$ m
  - $\leq 64.4$ km to Boston
    - Yes
      - $\leq 4.8$ km to major road
        - Yes: Prob. = 15.1%
        - No: Prob. = 5.4%
    - No
      - $\leq 6.4$ km to 8000+ pop. town
        - Yes
          - Prob. = 5.1%
        - No: Prob. = 1.1%

- Elevation $\leq 166$ m
  - No
    - Is grassland / agriculture?
      - Yes: Prob. = 1.7%
      - No
        - $\leq 54$ km to 8000+ pop. town
          - Yes: Prob. = 7.4%
          - No: Prob. = 0.4%
        - Classified as flood plain (any category)?
          - Yes: Prob. = 2.8%
          - No: Prob. = 0.1%

- $\leq 76.5$ km to Boston
  - $\leq 42$ m from developed land
    - Yes: Prob. = 2.6%
    - No: Prob. = 0.1%

Thorn et al. Unpublished
Development Zones - NH

Probability of development

- 0%
- 1.3%
- 2.6%
- 3.9%
- 5.2%
- 6.5%
- 7.8%
- 9.0%
- >10.0%

Thorn et al. Unpublished
Recent trends - Lamprey

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

Urban & Developed Land (Lamprey River Watershed)

100yearfloods.org
Land use change
Current trends

2010

Percent developed land

2050 ↑ 44%
2090 ↑ 88%

2050
2090

0 20 40 Kilometers
Land use change
2050

Percent developed land
High: 100
Low: 0

67% ↑
Land use change
2090

Percent developed land
High: 100
Low: 0

134% ↑
FrAMES Model

DIN = Dissolved Inorganic Nitrogen

Modeled 2009 - 2011
N export response

DIN export t/y
2009 – 2011
Measured: 57.5
Modeled: 58

Change in DIN export t/y

Lamprey

2050
2090
Model DIN loading

3.5x asymptote of urban

Runoff (mm d⁻¹)
- . . . . 0.11
- . . . . 0.22
- . . . . 1.1
- . . . . 2.2

↑ Agr  ↑ Urb

% Urban or Agriculture Land Use

DIN (mg L⁻¹)
Change in point source?

Assume change in point source output is proportional to population change.
Population change

Change in population of towns that intersect Lamprey watershed 2000 – 2010

12% increase over 10y
Potential changes in point sources

If increase is proportional to population increase, we would expect:
Total change in DIN export

Annual DIN export t/y
2009 – 2011:  57.5
2090:   70.9

Increase from:
23% non-point sources
77% point sources
Next steps

• Finalize land use scenarios
• Include interactions with future climate
• Coupled terrestrial – aquatic model
Questions?

Lampreyriver.org