New Hampshire’s Watersheds at a Crossroads
Coordinating a Response to Climate Change, Population Growth and Land-Use Change Using the DPSIR Model

2013 Water and Watershed Conference
Plymouth State University
March 22, 2013

Chris Skoglund
New Hampshire of Departmental Resources
Presentation Overview

- Provide Background
- Describe DPSIR Framework
- Map Climate and Land Use Issues
- Review Key Findings
Goal 1.1.1:
DES will consider and integrate *climate change mitigation and adaptation* across all existing DES program areas.

Goal 2.1.4:
DES will evaluate the effect of all DES Programs on *land use and land development patterns*, and modify policies and procedures to encourage efficient land use of land and other best practices.
Indications of Impaired Health

Sources of Stress

- Physical alteration
  - Impervious surfaces
  - Dams and culverts

- Non-Point Source (NPS) pollution
  - Residential lawn applications
  - Increased automobile traffic
  - Bacterial contamination
Indications of Impaired Health

“Traditional” Impairments

- Water quantity
  - Groundwater
  - Surface water
- Water quality
  - Drinking water
  - Aquatic life
- Biological Communities
  - Reduced fish runs and shellfish populations
  - Presence of invasive species
Indications of Impaired Health

Loss of Ecosystem Services

- Water supply provision
- Water filtration and purification
- Groundwater recharge
- Flood and drought mitigation
- Wildlife habitat
- Recreation opportunities
“New” Sources of Stress

Altered Climate Conditions

- Warmer average temps.
- Increase in precipitation
- Increase in extreme events
- Increase in incidence of flooding & drought

Wake and Markham, 2005; Wake et al., 2006; Wake et al., 2011
Complex System
Land Use, Hydrology & Climate Change

Need a tool to make sense of complexity and identify intervention points
Methods

Applied **DPSIR Framework** to manage complexity and assess opportunities to intervene in the system:

- Drivers (D)
- Pressures (P)
- State (S)
- Impacts (I)
- Responses (R)
Driver

Population Growth

Date from US Census Bureau
Driver

Carbon Dioxide Emissions

Atmospheric CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

PARTS PER MILLION

YEAR


320 340 360 380

January 2012
Pressure
Changing Land Use Patterns

![Map showing land use patterns over time: 1950, 1970, and 2010]
Pressure

Rising Global Temperatures: 1970 - Present

Goddard Institute for Space Studies/NASA
State

Altered Landforms and Landscapes

- Impervious surface cover
- Wetlands loss
- Altered drainage pathways
  - Dams
  - Culverts/Restrictions
- Riparian zones loss
- Recharge area impairment
State

Altered Climate Conditions in the Northeast

- Increased average annual and seasonal temperature
  - Warmer summer temps.
  - Warmer winter temps.

- Changes in precipitation pattern
  - Increase in annual precipitation and winter precipitation
  - Decrease in winter snowfall
  - Increase in extreme precipitation events
  - Increase in incidence of summer drought

- Change in seasons

Wake and Markham, 2005; Wake et al., 2006
Impact

Altered Hydrology

- Increased stormwater runoff
- Reduced infiltration
- Reduced water supply
- Reduced groundwater recharge
- Reduced flood and drought mitigation
Impact

Climate Change

- Earlier & shorter spring runoff
- Increase incidence of flooding
- Increased dam & culvert breaching
- Increased frequency of 1-3 month droughts

Dover
May, 2006
Fosters Daily Democrat

Dover
April, 2007
C. Skoglund
Synergistic Impacts

*Climate Change + Land Use Change*

- Increased flooding frequency
- Increased flooding intensity
- “Enhanced” flashier flows
  - Higher high flows
  - Lower low flows
- More severe drought
- Increased coastal storm surge
Response

Factors to Consider

- Some level of threats from climate change are unavoidable

- Land-use patterns will exacerbate that vulnerability

- Impacts of population growth and land-use change are not inevitable

- Managing for watershed function to avoid climate change impacts.
Driver
Population Growth & GHG Emissions

Pressure
Land-Use Change & Global Temperature Increase

Response
Managing for watershed function to avoid climate change impacts.

Impact
Land-Use & Climate Impacts and Combined Impacts

State
Altered Landscape & Hydrology and Regional & Local Climate

Slow & Avoid
Response

An Opportunity for Crossover

Managing for watershed function and ecosystem services to avoid land use and climate change impacts.

1. Maintain existing natural functions.
2. Restore degraded natural landscapes and functions.
3. Supplement ecosystem services with technology.
Response

Maintain Existing Natural Functions

- Open space preservation
  - Conservation and corridor easements
  - Floodplain & riparian buffer protection

- Focused development
  - Higher-density development
  - Concentrated activity centers
  - Infill development
Response

*Restore degraded natural landscapes and functions*

- Stormwater management
- Removal of relic structures
- Replace undersized bridges and culverts
- Streambank restoration
- Streamside planting
- Riparian buffer restoration
Response

Supplement Ecosystem Services with Technology

- Low impact development
  - Porous pavement
  - Gravel filters
  - Bioretention basins

- Stream crossing
  - Design with new conditions in mind
  - Replace/retrofit undersized bridges and culverts

- Water supply
  - Water conservation
  - Leak detection
  - Artificial aquifer recharge
Key Findings

- DPSIR Framework useful to manage complexity - characterize system and identify leverage points
- Land use MITIGATION and climate change ADAPTATION are inextricably tied
- Can manage watersheds and climate change by focusing on ecosystem services
- Findings and Framework can inform initiatives underway
Questions and/or Comments?

Chris Skoglund
Energy & Climate Analyst
Christopher.skoglund@des.nh.gov
(603) 271-7624

Air Resources Division
NH Department of Environmental Services