New Hampshire’s Changing Climate, Land Cover, and Ecosystems

Clean and abundant water is a foundation of New Hampshire’s quality of life and is vital for healthy environments, individuals, communities, and a vibrant economy. Changes in climate and land cover will change the magnitude, timing, and storage of water flow from watersheds and present potential challenges for water management in New Hampshire. In the future an increase in annual and extreme precipitation will likely contribute to increased flooding. In addition, a projected increase in the duration and magnitude of summertime dry periods, coupled with an increased population, will likely stress water supplies.

**RIVER DISCHARGE**

**WHAT CAN WE EXPECT IN THE FUTURE?**

- With New Hampshire climate getting warmer and wetter, and forests becoming more efficient at using water due to higher atmospheric CO₂, annual average runoff and maximum runoff will likely increase.

**WATER SHORTFALLS**

**WHAT HAVE WE SEEN SINCE 1995 FOR THE MERRIMACK RIVER?**

- Water supply shortfalls (hydrologic supply of available surface water not meeting daily demand) averaged about 2 million person-days per year.

**WHAT CAN WE EXPECT IN THE FUTURE?**

- Given current land use, the duration of dry periods varies by climate scenario, increasing less than 20% by mid-century and decreasing up to 60% by late century. Stress to water supply is highly dependent on the form and location of how land is developed.
- Dispersed buildout and greater population increases shortfalls by 14-85% by mid-century and 400-500% by late-century depending on climate scenario.

**FLOODING**

**WHAT HAVE WE SEEN SINCE 1995 FOR THE MERRIMACK RIVER?**

- A conservative estimate is 170 to 260 river miles experienced flooding above the historic 100-year recurrence interval from 1995-2014.

**WHAT CAN WE EXPECT IN THE FUTURE?**

- Projected increases in storm magnitude will cause greater flooding throughout the century.
- By mid-century, 100-year flood exceedances could increase 3–4 times.
- By late century, 100-year flood exceedances could increase 4–13 times due to increased imperviousness and higher-intensity storms.

**SNOW VOLUME**

**WHAT HAVE WE SEEN SINCE 1995 FOR THE MERRIMACK RIVER?**

- Maximum daily snowpack depth averaged across the watershed was 3.7 inches water equivalent depth.

**WHAT CAN WE EXPECT IN THE FUTURE?**

- Projected warmer New Hampshire winters reduce maximum snowpack by 5–30% at mid-century and by 20–50% late-century.
METHODS: Simulations use a linked terrestrial – aquatic model (PnET-FrAMES) tested against current conditions using a network of snow pack and stream flow measurements. Metrics of flooding and water shortfalls use simulated runoff compared to USGS studies that produced a distributed estimate of 100-year flood flows, and estimates of summer water demand for NH. Estimates of shortfalls do not account for ground water supplies.

MODELS: Existing forest (PnET-CN) and aquatic (FrAMES) models were coupled to provide estimates of environmental conditions under different scenarios. PnET-CN (Photosynthetic EvapoTranspiration model with Carbon and Nitrogen) simulates forest water dynamics. FrAMES (Framework for Aquatic Modeling in the Earth System) is a gridded model that represents land cover and land use to simulate runoff dynamics through watersheds. PnET-FrAMES represented the Merrimack and Piscataqua River Watersheds with a grid resolution of 1.5 km².

CONTEMPORARY VALIDATION: Verification of PnET-FrAMES under recent historical conditions used climate from NASA Modern Era-Retrospective Analysis for Research and Applications for the period of 1980-2014. Output corresponded well with station (gage) measurements for discharge (U.S. Geological Survey – USGS) and snow-pack depth (NH Community Collaborative Rain, Hail and Snow Network; ddc-albedo.sr.unh.edu).

LAND USE DATA: Two land cover scenarios encompass the widest divergence in land-cover change: present-day land cover and Backyard Amenities, which prioritizes large building lots and increases impervious areas dramatically. More info at: ddc-landcover.sr.unh.edu

FUTURE CLIMATE DATA: Future climate projections used statistically downscaled climate simulations derived from the Geophysical Fluid Dynamics Laboratory CM2.1 model (Hayhoe 2007). Two scenarios represent a wide range of potential future climate: lower emission (B1, 550 ppm CO₂ by 2100) and higher CO₂ emission (A1FI, 970 ppm CO₂ by 2100).

REFERENCES


NOTES

ACCESS TO DATA: Daily discharge for multiple climate and land cover scenarios covering the time period 1995 -2099 is available on the NH EPSCoR Data Discovery Center: ddc.unh.edu.

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