ClimAID:
Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State

NYSERDA EMEP Meeting
Albany, New York
October 15th, 2009
<table>
<thead>
<tr>
<th>Timeline</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Project Overview</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Climate</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Sector highlights</td>
<td>5 min each</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Water Resources</td>
<td></td>
</tr>
<tr>
<td>Conclusions &amp; Recommendations</td>
<td>5 minutes</td>
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</tbody>
</table>
To provide New York State with cutting-edge information on its vulnerability to climate change and to facilitate the development of adaptation policies informed by both local experience and state-of-the-art scientific knowledge.
Sectors
- Agriculture/Ecosystems
- Coastal Zones
- Energy
- Public Health
- Transportation/Communication
- Water Resources

Key Themes
- Climate Risks
- Vulnerability
- Adaptation

Cross Cutting Elements
- Science/Policy Linkages
- Economic Policy Linkages
- Environmental Justice
NOV 2008: Kickoff
MAR 2009: Project Team Mtg
OCT 2009: Project Team Mtg
SPRING 2010: Project Team Mtg

SPRING 2009: Initial stakeholder meetings
JULY 2009: PAC feedback & Mtg
FALL 2009: Follow-up stakeholder meetings
NOV 2009: PAC feedback & Mtg

SPRING 2010: Expert Reviews of final drafts, Focus on developing outreach tools
Report Outline – Current Plan

Summary for Policymakers
I. Introduction
II. Vulnerability and Adaptation
III. Equity, Economics, and Science-Policy Linkages
IV. Climate Risks
V. Sector Chapters
   a. Water
   b. Coastal Zones
   b. Ecosystems
   c. Agriculture
   d. Energy
   e. Transportation
   f. Communication
   g. Public Health
VI. Conclusions and Recommendations
VII. Appendices; a. Glossary & Acronyms; b. Benchmark Adapt. Study Review

- Sector Description*
- Stakeholder Engagement & Key Climate-related Decisions*
- Sector-specific Vulnerabilities* **
- Sector-specific Climate Risks* **
- Sector-specific Adaptation Strategies* **
- Highlighted Case Study with CCE Input
- Sector-specific Science-Policy Linkages* **
- Conclusions and Recommendations

*Includes CCE Contributions as appropriate
**Includes Other Case Studies as appropriate
Highlighted case studies for each sector

- **Agriculture** – Apple and grape production
- **Communications Infrastructure** – Ice storm
- **Ecosystems** – Winter recreation
- **Energy** – Heat waves
- **Ocean Coastal Zones** – Nor’easter
- **Public Health** – Air quality
- **Transportation Infrastructure** – 100-year storm in NYC metro region
- **Water Resources** – Susquehanna River flooding
Products

- Final report
- Project presentations
- Sector reports, brochures
- Newspaper articles
- Briefings/conferences
- Coordination with NYSERDA’s Outreach Contractors
- Peer-reviewed publications
- Website
Stakeholder Interactions

- **Spring 2009**: Initial Stakeholder Meetings
- **Late Spring 2009**: Stakeholder Surveys
- **Throughout 2009**: Interaction with Stakeholder Focus Groups
- **Spring 2010**: Follow-up Stakeholder Meetings
CLIMATE SCIENCE
Integrating Mechanisms: Climate

Key Products

- Providing state-of-the-art climate information
- Quantitative and qualitative projections, statewide and by region
- Sector-specific climate products
- Regional climate modeling and statistical downscaling
## Quantitative Projections by Region: Mean Changes

### Region 5

<table>
<thead>
<tr>
<th></th>
<th>Baseline(^1) 1971-2000</th>
<th>2020s</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min (Central Range)</td>
<td>50° F</td>
<td>0.5 (1.5 to 3.0)</td>
<td>2.5 (3.0 to 5.5)</td>
<td>3.0 (4.0 to 8.0)</td>
</tr>
<tr>
<td>Max</td>
<td>50° F</td>
<td>3.5° F</td>
<td>7.5° F</td>
<td>10.0° F</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min (Central Range)</td>
<td>51 in</td>
<td>- 5 (0 to + 5) 10 %</td>
<td>-5 (0 to + 10) 10 %</td>
<td>0 (5 to 10) 15%</td>
</tr>
<tr>
<td>Max</td>
<td>51 in</td>
<td>10 %</td>
<td>10 %</td>
<td>15%</td>
</tr>
</tbody>
</table>

### Region 6

<table>
<thead>
<tr>
<th></th>
<th>Baseline(^1) 1971-2000</th>
<th>2020s</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min (Central Range)</td>
<td>44° F</td>
<td>+ 0.5 (1.5 to 3.0)</td>
<td>+ 2.5 (3.5 to 5.5)</td>
<td>+ 3.0 (4.5 to 9.0)</td>
</tr>
<tr>
<td>Max</td>
<td>44° F</td>
<td>4.0° F</td>
<td>7.5° F</td>
<td>10.5° F</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min (Central Range)</td>
<td>51 in</td>
<td>- 5 (0 to + 5) 15 %</td>
<td>-5 (0 to + 10) 15%</td>
<td>-5 (+ 5 to 15) 20%</td>
</tr>
<tr>
<td>Max</td>
<td>51 in</td>
<td>15 %</td>
<td>15%</td>
<td>20%</td>
</tr>
</tbody>
</table>

\(^1\) The baselines for each region are the average of the values across all the stations in the region.

\(^2\) The minimum, central range (middle 67%), and maximum of values from model-based probabilities across the GCMs and greenhouse gas emissions scenarios is shown.

Source: CCSR
## Climate Scenarios

### Sea level rise

<table>
<thead>
<tr>
<th></th>
<th>New York City</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline (1971-2000)</td>
<td>2020s</td>
</tr>
<tr>
<td>Sea level rise</td>
<td></td>
<td>2020s</td>
</tr>
<tr>
<td>Central range</td>
<td>NA</td>
<td>+ 2 to 5 in</td>
</tr>
<tr>
<td>Rapid Ice-Melt</td>
<td>NA</td>
<td>~ 5 to 10 in</td>
</tr>
<tr>
<td>Sea level rise</td>
<td></td>
<td>2020s</td>
</tr>
<tr>
<td>Central range</td>
<td>NA</td>
<td>+ 1 to 4 in</td>
</tr>
<tr>
<td>Rapid Ice-Melt</td>
<td>NA</td>
<td>~ 4 to 9 in</td>
</tr>
</tbody>
</table>

The coastal zones sector is helping to support the development of a simple hydrodynamic model for the Hudson River. This modeling effort is being led by Jery Stedinger at Cornell. The coastal zones chapter will include the effort as a case study; this model may ultimately improve our understanding of key processes including tidal cycles and storm surge flooding.

1 Shown is the central range (middle 67%) of values from model-based probabilities. Rounded to the nearest inch.
2 The model-based sea level rise projections may represent the range of possible outcomes less completely than the temperature and precipitation projections.
3 "Rapid ice-melt scenario" is based on acceleration of recent rates of ice melt in the Greenland and West Antarctic Ice sheets and paleoclimate studies.

Source: CCSR
Select Examples

- **Coastal**: Sea surface temperatures
- **Energy**: Hourly temperature data
- **Public Health**: Daily temperature projections
- **Water Resources**: Palmer Drought Severity Index (a measure of longer-term dryness/wetness)
Integrating Mechanisms: Climate

- Validation of global climate model output
  - Mean values, climatology, trends, and variance
- Evaluation of NARCCAP
- Analysis of uncertainty
- Climate change (and climate change impact and adaptation) indicators

Source: NARCCAP

CRCM+CGCM3 Change in Seasonal Avg Precip
JJA 2041–2070 minus 1971–2000 %

Source: NARCCAP
HIGHLIGHTS OF TWO SECTORS
Focus on Two Sectors

CLIMATE-PROTECTED NYS
Reduced Vulnerability and Enhanced Adaptive Capacity
ENERGY: Team

Steve Hammer, Columbia University
Lily Parshall, Columbia University
Michael Bobker, CUNY Institute for Urban Systems
ENERGY: Stakeholder Process

Two tracks

1. Detailed interviews to discuss climate planning, anticipated impacts, changes in operating practices
   • Generators & Distribution Utilities: NYPA, NRG, TransCanada, Con Edison, RGE, NYSEG, National Grid, Central Hudson
   • Some utilities are already taking changes on board; for others climate change is a brand new issue

2. Demand forecasting
   Efforts to improve how climate change is characterized in the NYISO demand forecast modeling
ENERGY: Stakeholder Engagement

Team is working with stakeholders to identify:
- vulnerabilities & impacts
- timing
- decisions
- potential adaptation strategies

### NYSERDA Climate Change Adaptation Assessment for New York State

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>Probability</th>
<th>Vulnerability &amp; Impacts</th>
<th>Timing</th>
<th>Decisions</th>
<th>Adaptation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer temperatures</td>
<td>Extremely</td>
<td>Increased energy demand → equipment failure</td>
<td>Regulate and enforce building and landscape design codes to reduce energy demand; Reduce/recover energy subsidies so prices reflect true cost</td>
<td>Increase peak or overall system capacity; Install solar PV technology to reduce effects of peak demand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Likely</td>
<td>Decreased energy demand</td>
<td>Adequate water management rules to protect hydropower availability</td>
<td></td>
<td>Use increased winter stream flow to refill hydropower dam reservoirs; develop non-hydropower generation resources</td>
</tr>
<tr>
<td>Decline in stream flow</td>
<td>Region</td>
<td>Decreased summer stream flow → decreased hydropower availability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase storm-related coastal flooding due to sea level rise</td>
<td>Very Likely</td>
<td>Energy plants vulnerable to flooding; alteration of water intake and outflow pipes; loss of cooling water capacity</td>
<td>Establish new coastal power plant siting rules to minimize flood risk</td>
<td></td>
<td>Adopt flood prevention or abatement plans; protect infrastructure with dykes/berms;</td>
</tr>
</tbody>
</table>

### Table Notes:

- **Warmer temperatures**
  - Extremely likely:
  - Increased energy demand → equipment failure
  - Regulate and enforce building and landscape design codes to reduce energy demand.
  - Reduce/recover energy subsidies so prices reflect true cost.
  - Increase peak or overall system capacity; install solar PV technology to reduce effects of peak demand.

- **Decline in stream flow**
  - Region:
  - Decreased summer stream flow → decreased hydropower availability
  - Adequate water management rules to protect hydropower availability

- **Increase storm-related coastal flooding due to sea level rise**
  - Very likely:
  - Energy plants vulnerable to flooding; alteration of water intake and outflow pipes; loss of cooling water capacity
  - Establish new coastal power plant siting rules to minimize flood risk
  - Adopt flood prevention or abatement plans; protect infrastructure with dykes/berms.
Climate-related vulnerabilities and impacts

Supply
- **Flooding of water-side facilities** (sea level rise, storm surge, extreme rainfall events)
- **Water-cooling related impacts** (drought, turbidity from storm events, water temperature)
- **Air temperature** (equipment breakdown during extreme heat events, decreased power plant output or transmission/distribution line throughput capacity, snow vs. rain = timing of hydro availability)
- **Drought** (hydro availability)
- **Resource availability** (hydro, solar, wind availability)

Demand
- Changes in seasonal and diurnal load patterns (winter peaking = reduced demand due to warming; summer peaking = length of extreme heat waves + changing air conditioning saturation rates)
# Extreme Events

<table>
<thead>
<tr>
<th>Extreme Event</th>
<th>Baseline (1971 – 2000)</th>
<th>2020s</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td># of days/yr with max temp exceeding:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 °F</td>
<td>7</td>
<td>9 to 14</td>
<td>15 to 28</td>
<td>20 to 51</td>
</tr>
<tr>
<td>95 °F</td>
<td>0.71</td>
<td>1 to 2</td>
<td>2 to 7</td>
<td>4 to 18</td>
</tr>
<tr>
<td># of heat waves/yr^2</td>
<td>0.8</td>
<td>1 to 2</td>
<td>0.6 to 2</td>
<td>3 to 7</td>
</tr>
<tr>
<td>average duration</td>
<td>4</td>
<td>4 to 4</td>
<td>4 to 5</td>
<td>5 to 6</td>
</tr>
<tr>
<td># of days/yr with min temp below:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32°F</td>
<td>124</td>
<td>95 to 107</td>
<td>79 to 95</td>
<td>63 to 87</td>
</tr>
<tr>
<td>0 °F</td>
<td>3</td>
<td>1 to 2</td>
<td>0.7 to 1</td>
<td>0.3 to 0.9</td>
</tr>
<tr>
<td>Cooling degree days^3</td>
<td>649</td>
<td>785 to 940</td>
<td>957 to 1252</td>
<td>1089 to 1688</td>
</tr>
<tr>
<td>Heating degree days</td>
<td>6093</td>
<td>5297 to 5666</td>
<td>4749 to 5276</td>
<td>4071 to 5022</td>
</tr>
<tr>
<td># of days/yr with rainfall exceeding:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inch</td>
<td>15</td>
<td>14 to 16</td>
<td>15 to 17</td>
<td>14 to 16</td>
</tr>
<tr>
<td>2 inches</td>
<td>3</td>
<td>3 to 3</td>
<td>3 to 3</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Drought occurs, on average^4</td>
<td>~ once every 100 yrs</td>
<td>~ once every 30 to 55 yrs</td>
<td>~ once every 10 to 50 yrs</td>
<td>~ once every 5 to 30 yrs</td>
</tr>
</tbody>
</table>

1 Decimal places shown for values <1, although this does not indicate higher accuracy/certainty. More generally, the high precision and narrow range shown here are due to the fact these results are model-based. Due to multiple uncertainties, actual values and range are not known to the level of precision shown in this table.

2 Defined as 3+ consecutive days with maximum temperature exceeding 90 °F

3 A degree day is the difference between a day’s average temperature and 65°F. Cooling degree days are those where the mean temperature exceeds 65 °F and heating degree days are those where the mean temperature falls below 65 °F.

4 Based on the minima of the Palmer Drought Severity Index (PSDI) over any 12 consecutive months.

Source: CCSR
**ENERGY: Adaptation**

Adaptation Strategy Development in Practice
*(examples – lit review only, additional examples to be included based on stakeholder surveys)*

<table>
<thead>
<tr>
<th>Energy Supply</th>
<th>Energy Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anticipatory strategies</strong></td>
<td><strong>New building designs/codes to reduce cooling demand</strong></td>
</tr>
<tr>
<td>• Dikes/berms (power plant flooding)</td>
<td>• Public education</td>
</tr>
<tr>
<td>• Power plant siting</td>
<td>• Air cooling</td>
</tr>
<tr>
<td>• Solar PV reduces peak demand</td>
<td>• Tree planting &amp; cool roofs</td>
</tr>
<tr>
<td>• Additional generation supply to offset anticipated hydro reductions or decreased throughput/output</td>
<td>• Establish more robust demand response</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Reactive strategies</strong></th>
<th><strong>Fans vs. air-conditioning</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Automate/improve system restoration to speed return to full power</td>
<td>• Tree planting &amp; cool roofs</td>
</tr>
<tr>
<td>• De-rate cables or generators</td>
<td>• Weatherization programs (significant overlap with adaptive strategies, partly a function of timing)</td>
</tr>
<tr>
<td>• Change water management rules for other users</td>
<td></td>
</tr>
</tbody>
</table>
Climate Change Impacts on Hydro Output on NYPA facilities

- Great Lakes expected to experience lake level decline due to decreased precipitation, evaporation, etc.
- Declines may have varying impacts at Niagara vs. Massena due to difference in facility design (gravity + pumped storage vs. run of river)
- Additional analysis needed to discern past impacts of drought on NYPA power output
- Challenges arise due to international treaties re: water availability for Niagara Falls during tourist season
WATER RESOURCES: Team

Art DeGaetano
Andrew McDonald
Susan Riha
Rebecca Schneider
Stephen Shaw
Lee Tryhorn

Orange Co. Water Supply case study:
Allan Frei (Hunter College, CUNY)

Susquehanna River Flooding Case study:
Robin Leichenko (Rutgers)
Yehuda Klein (CUNY)
Peter Vancura (Rutgers)
Burrell Montz (SUNY Binghamton)
Stakeholders work with team to identify:
- vulnerabilities & impacts
- timing
- decisions
- potential adaptation strategies

Representatives from:
• NYS Federation of Lake Associations
• NYS Chapter, American Public Works Association
• Cornell Cooperative Extension Educators
• Private Landowners
• NYS Dept. Environmental Conservation
• NYS Wetland and Floodplain Managers
## Water Supply Across New York

<table>
<thead>
<tr>
<th>Category</th>
<th>Sensitivity to Climate Change</th>
<th>Population Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Draw from Large Waterbodies</td>
<td>Low</td>
<td>2,000,000</td>
</tr>
<tr>
<td>2. NYC System</td>
<td>Moderate</td>
<td>8,300,000</td>
</tr>
<tr>
<td>3. Other Reservoir Systems</td>
<td>Moderate</td>
<td>1,300,000</td>
</tr>
<tr>
<td>4. Run-of-the-river on small drainage</td>
<td>High</td>
<td>62,000</td>
</tr>
<tr>
<td>5. Long Island GW</td>
<td>Moderate</td>
<td>3,200,000</td>
</tr>
<tr>
<td>6. Other Primary Aquifers</td>
<td>Moderate</td>
<td>650,000</td>
</tr>
<tr>
<td>7. Homeowner Well Water</td>
<td>Moderate to High</td>
<td>1,900,000</td>
</tr>
<tr>
<td>8. Other Small Water Supply Systems (GW or SW)</td>
<td>Moderate to High</td>
<td>1,600,000</td>
</tr>
</tbody>
</table>

Total = 19,000,000
WATER RESOURCES: Climate

Flooding -- relative contribution of rain vs pet will lead to floods or droughts, and uncertainty

Amount of 100 yr storm in NYS (mm)
Model: HADCM3 Scenario: A2

Obs how a much steeper increase of 10% per decade from 1960-present!

less snow / more rain + larger storm rainfall amounts + longer growing season + more ET/ drier soils = ?
Adaptation Strategy Development in Practice

1. “Do nothing/Business as usual”

2. Incremental

3. Identify “no regrets/ win-win” options:
   - Scaleable CSO mitigation strategies
   - Green stormwater infrastructure in urbanized areas
   - Water use conservation
Adaptation Strategy Development in Practice

1. Strategic expenditures on "no regret" options that result in a net public benefit whether or not climate change projections are realized.

2. Organizational and operational changes that provide more flexible and targeted responses to observed and projected climate changes.

3. Robust monitoring efforts that expand the collection of environmental data important to making management decisions but that also advances our fundamental understanding of the impacts of climate on New York’s water resources.

4. Policy options which will provide incentives for structural options.
Evaluation of Cross Cutting Elements:

**Equity:** Relative vulnerability to flooding for communities based on age, income, race

**Economics:** Costs, benefits associated with different flood response options: (a) no response, (b) increasing barriers, levees, (c) phased withdrawal from high-risk areas, (d) watershed management to reduce flood-contributing runoff

**Science-policy linkages:** Interactions among science-based BMPs, existing legislation, insurance industry changes, and potential policy implications.
Conclusions & Next Steps

**SPRING 2010:**
- Ongoing *stakeholder* interaction
- Continued collaboration with *state-wide climate change initiatives* (SLR TF, Climate Action Council, Cost curves study)
- *Expert Reviews* of final drafts
- *Conclusions & recommendations*
- Focus on developing *outreach tools*

**NOV 2009:**
- PAC feedback & Mtg

**SPRING 2010:**
- Project Team Mtg
  - ClimAID Report