

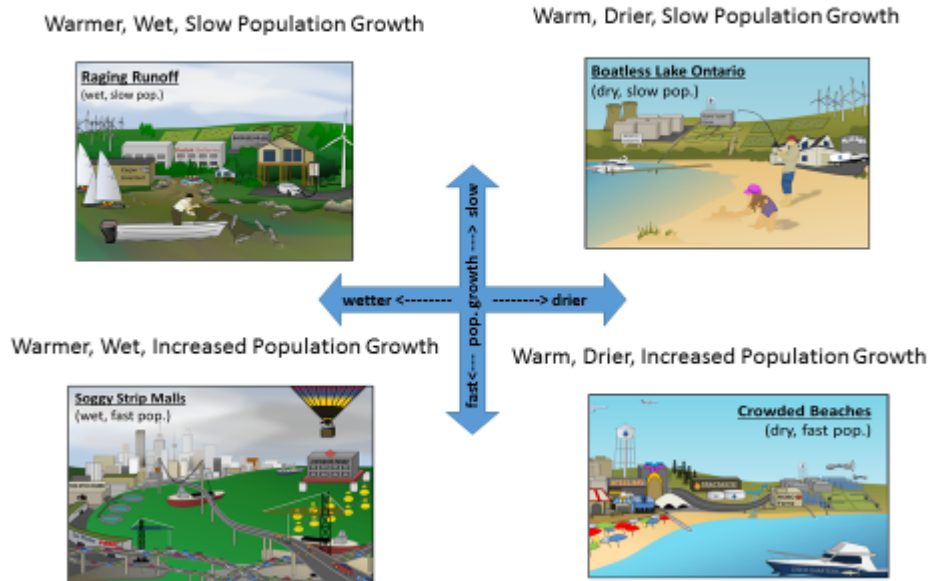
Using Future Scenarios to Identify Potential LAMP and Watershed Planning Measures for Climate Change Adaptation along Lake Ontario:

STAKEHOLDER GENERATED RECOMMENDATIONS

A Report for Lake and Watershed Planners

4 Possible Futures of Lake Ontario

The 2 drivers: climate change precipitation and population growth rates



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Submitted by:

- Dr. Katherine Bunting-Howarth**, Associate Director, New York Sea Grant
- David MacNeill**, Great Lakes Fisheries and Ecosystem Specialist, New York Sea Grant
- Jessica Spaccio**, Extension Specialist, Northeast Regional Climate Center, Cornell University
- Dr. Rebecca Schneider**, Associate Professor, Cornell University, Department of Natural Resources.
- Dr. Brian Weidel**, Research Fisheries Biologist, USGS Biological Field Station
- Dr. Arthur DeGaetano**, Director, Northeast Regional Climate Center; Professor, Cornell University, Department of Earth and Atmospheric Sciences

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Bunting-Howarth, K., D. MacNeill, J. Spaccio, R. Schneider, B. Weidel and A. DeGaetano. 2016. *Using Future Scenarios to Identify Potential LAMP and Watershed Planning Measures for Climate Change Adaptation along Lake Ontario: Stakeholder Generated Recommendations — A Report for Lake and Watershed Planners*. NYSGI-W-15-001. 29 pages.

Executive Summary

Lake Ontario, the fourteenth largest lake in the world, is a vast geographical feature but is nevertheless influenced by human behavior, as evidenced by changes in nutrient concentrations and cycling, species composition, and food web dynamics. Nutrient loads and water clarity observed in Lake Ontario over the past two decades illustrate the potential for human behavior to influence this large and important ecosystem. While scientists work to understand how the ecosystem has changed and anticipate future changes, there is a concurrent need to educate a broader stakeholder group about future uncertainties in the ecosystem and the services it provides (Walker et al. 2002). *Scenario Planning* has proven to be a useful tool to help prepare for uncertain futures. Scenarios developed with multi-disciplinary input represent plausible, but alternate, future conditions of a system of interest (Wack 1985). As such, they can provide a means of understanding potential future impacts, such as those related to climate change, and can help develop local, adaptive decision-making to reduce the severity of those impacts (Wack 1985; Peterson et al. 2003). In 2012, New York Sea Grant organized a scenario workshop, funded by the GLRI (Great Lakes Restoration Initiative) as an exercise to explore possible scenarios for the future of the Lake Ontario ecosystem with input from diverse stakeholders (Workshop I). Two main drivers of ecosystem trajectories were identified climate induced precipitation extremes, and human demographics. Four narratives describing these future states were developed and the underlying conditions were identified by the group.

The four identified scenarios (future states) were as follows.

1. Drier Climate -- Slow Population Growth: "Boatless Lake Ontario"
2. Wet Climate -- Slow Population Growth: "Raging Runoff"
3. Drier Climate -- Fast Population Growth: "Crowded Beaches"
4. Wet Climate -- Fast Population Growth: "Soggy Strip Malls"

With funding from the Great Lakes Integrated Science Assessment program (GLISA), an iterative approach was taken to develop draft recommendations for Lakewide Action and Management Plans (LAMP) (binational plans designed specifically for each of the five Great Lakes) as well as for watershed planners to consider when adapting existing (and new) plans to address climate change. During the May 2015 workshop (Workshop II), draft recommendations were synthesized from diverse stakeholders that considered long term extremes in precipitation (extreme precipitation and drought) and human demographics (slow and rapid population growth) as created in the scenario workshop in September 2012. Follow-up workshops were held in the fall of 2015 (Workshops III-A and B) to gather public input on these draft recommendations. Workshops attendees used their local knowledge, beliefs, and opinions to refine and prioritize potential management and policy actions that would add to the system's resiliency and buffer the impact of future uncertainties.

Recommendations generated through the process fall into five major categories: Water Resource Management; Infrastructure (Transportation, Drinking, Waste and Stormwater); Water-Dependent Business; Land Use Planning, Zoning and Governance; and Ecosystem

Management. These recommendations were made acknowledging potential barriers to implementation such as lack of funding, political will, and understanding of potential future problems.

This report is intended for use by LAMP and watershed managers and planners. The purpose of this report is not to be prescriptive, but to provide a starting point for planners to use when engaging the public and incorporating climate change adaptation recommendations into plans.

Introduction

Within the last decade, interest in the impacts of climate change has significantly increased. Concomitantly, there has been widespread recognition that action must be taken to reduce climate change impacts as well as to adapt to the potential changes. The development of sector-specific adaptive planning, however, has lagged behind. This can, in part, be attributed to uncertainty and the lack of fine-scale climate impact projections for local and regional levels as most projections are for broader geographic areas (Hayhoe, et al. 2008). However, predictive models even at finer scales may never be completely accurate in forecasting future states. Thus, tools to help understand and plan within the context of uncertainty are needed (Wack 1985). The northeastern US, a region predicted to experience both more flooding associated with high frequency rainfalls and more droughts due to warming and longer no-rain periods (Kunkel et al. 2014), is one example highlighting the challenges of planning under predicted high variability.

Many tools are available to assist communities in assessing their vulnerabilities to the impacts of climate in the areas of human health, infrastructure, ecosystems, and emergency response, as well as planning strategies for adapting to the changing climate. Although tools are available, information from previous surveys and studies across the nation continue to make us aware that there is still a gap between communities' awareness of the climate and actual action toward adaptation. In fact, surveys completed in the Great Lakes region that were targeted at local officials and local government staff, clearly indicate that a majority of communities in the Great Lakes region are not currently incorporating climate adaptation concepts into their planning processes, despite the awareness of current and potential impacts of the changing climate. (See Nelson, Dawn, et al. 2011.)

Alternatively, scenario planning has been identified as a useful process that can help organize thinking about uncertain futures. Originally used by militaries and businesses, the scenario planning process has been used increasingly in socio-ecological settings such as the Millennium Ecosystem Assessment <http://www.unep.org/maweb/en/Scenarios.aspx> and the Great Lakes Futures Project <http://uwo.ca/biology/glfpl/>. The greatest strength of the process is helping a diverse audience recognize what different people value about their environment, in this case Lake Ontario and its watershed, and how their activities could impact those resources. The process is flexible, but generally is built from dialog between multiple stakeholders from diverse backgrounds (such as government, scientists, business owners, recreational users,

environmental advocates, and others). The goals of the dialog are to define the ‘system’ in question, the area and resources that are the target of the exercise, and to identify the ‘drivers’, i.e. the forces or key influences that will most likely change the system in the future. Projecting how drivers may unfold give rise to simple yet striking contrasting futures.

Although subjective in nature, the “projected” future states which are generated should be realistic and equally plausible. Participants develop alternative, logically consistent stories (not fanciful predictions—but simple “projections”) about the system’s future based on how the identified uncertainties might unfold. These stories portray both the positive and negative consequences of a future 30-40 years away and include economic, cultural, and ecological elements. A real strength of this process is that, because the stories are developed by individuals who are familiar with the system, the stories reflect local experiences, become more believable, and are accepted by the participants. A powerful learning moment results when stories are shared and workshop participants recognize how simple but uncertain contrasting incidents can lead to cascading events, resulting in drastically different futures. In addition, the tool can be used to assist in identifying the actions that can be taken today to help prepare for these different futures and, in turn, identify actions which can benefit a community no matter what type of future arises.

Scenario Development for Lake Ontario

In September of 2012, a diverse set of stakeholders met for two days at the Cornell Biological Field Station to utilize the scenario planning process to imagine and create four different future scenarios (30-40 years out) for Lake Ontario and its coastal communities (Workshop I). The workshop involved twenty-four diverse stakeholders representing researchers, marina operators, fishermen, small business owners, angling organizations, county tourism and health departments, sport-fishing promotion, charter boat industry, cooperative extension, State watershed managers, shoreline property owners, county soil and water, non-profit groups, and academics from the United States and Canada (Ontario Ministry of Natural Resources). The participants were invited by New York Sea Grant’s Recreational Fisheries Specialist. The invitees were selected based on the diversity of their views and interests that they represent. In addition, they were selected based on knowledge of their ability to work well within groups and not dominate conversations nor simply speak to position statements to the exclusion of engaging in a dialogue.

The initial goal of this exercise was to engage diverse participants in a discussion to exchange their knowledge, opinions and beliefs on the drivers that will shape the future of the ecosystem. The group chose climate change (specifically precipitation changes) and population growth as the major uncertainties (drivers) for designing their narratives about future ecological, social, economic and cultural states on Lake Ontario and its basin. The four identified Lake Ontario futures independently identified by the groups were:

1. Drier Climate- Slow Population Growth: *“Boatless Lake Ontario”*
2. Wet Climate-Slow Population Growth: *“Raging Runoff”*

3. Drier Climate-Fast Population Growth: “Crowded Beaches”
4. Wet Climate-Fast Population Growth: “Soggy Strip Malls”

Schematic diagrams representing the conditions associated with each scenario were developed to help with the visualization in subsequent dialogs (Figure below).

The goal of the 2015 project was to use the four scenarios as a tool in subsequent discussions about recommendations for planning and policy development for addressing uncertainties related to climate change and population growth. This project was designed to build upon Workshop I, which developed the previously discussed scenarios, as the basis for developing a first round of recommendations for Lake and Watershed managers of Lake Ontario and its watersheds to consider when amending and creating plans to address climate change. The project design included three subsequent workshops: one with invited diverse stakeholders (Workshop II) and the other two (Workshops III-A and B) in areas to attract different segments of the greater public.



Illustrations by Brian Weidel and Matthew Paufve, USGS

Workshop II was designed to be a two-day event which would engage similar, and some of the same, stakeholders who participated in Workshop I. The project team included multi-disciplinary groups from the Great Lakes Integrated Science Assessments (GLISA), Northeast Regional Climate Center (NRCC), United States Geological Survey (USGS), Cornell University and New York Sea Grant (NYSG). In addition, in order to increase the likelihood our findings being utilized by state agencies, we invited the NYSDEC’s Lake Ontario LAMP Work Group

representative to join our organizational meetings. Our team included experts in extension, water resource experts, fisheries, scenario planning, public participation as well as climate change. **The ultimate goal of Workshop II was to have participants identify a suite of planning actions that were “win-win”, i.e. that would (a) address issues relevant to multiple stakeholder types, and (b) simultaneously help to buffer potential impacts from more than one of the four future scenarios.**

The final product of Workshop II was a deliberated set of stakeholder driven recommendations for updating the LAMP and local watershed plans, in order to address climate change and become more resilient. Once we synthesized the findings from Workshop II, we attempted to verify these findings and ascertain their “acceptability for adoption” through review by two additional independent groups of stakeholders. This was accomplished through inviting the public to attend two evening workshops (Workshops III-A and B) in different areas of the Lake Ontario Basin. This report contains recommendations identified as “win-win.”

Process Employed

Participants

Invitations to Workshop II were sent starting in March and our intent was to attract as many of the same stakeholders as possible from the 2012 workshop. Our goal was to engage a diverse set of participants. Participants included: planning agencies, federal and state agencies, soil and water conservation districts, environmental and sport-fishing organizations as well as cooperative extension agents representing agricultural interests. Unlike the first workshop, we lacked business and tribal representation.

Presentations: Making the Extremes Plausible

The Northeast Regional Climate Center, United States Geological Survey, New York Sea Grant and Cornell University team members drafted and designed presentations which illustrated the science behind the extremes in precipitation along with the potential impacts on the ecosystem and human infrastructure.

For illustrating and explaining precipitation extremes, the team decided to use specific historical examples. Presentations highlighted data in maps and charts along with historical pictures of those extreme events. A chart of observed annual precipitation, map of observed heavy precipitation events, and a map of projected winter precipitation change were included in the wet scenario. A map of projected dry days, a map of projected snow cover change, and charts of observed and projected lake level were included in the dry scenario. This use of “real-world” data, not “pretend” information gave considerable credibility to the scenarios developed and enhanced the engagement of our stakeholders. Events and pictures chosen visualized for workshop attendees the dry and wet scenarios and their impacts the Lake Ontario watershed.

In a similar fashion, team members from Cornell and USGS provided examples of scientifically based but differing potential impacts on coastal and upstream watershed habitats and water quality in order to ensure the four scenarios present resource changes in substantially different ways. For example, drier conditions could be associated with stream and wetland dry-outs, exposed shorelines at marinas, and dry wells whereas greater precipitation could be associated with flooding, sediment erosion and pollution. In this manner, the participants could brainstorm and generate potential actions that cover a wide range of future ecosystem changes. For each scenario the environmental stressors were explained as well as possible opportunities. Pictures and images were included to support these impacts.

Existing Example Climate Adaption Action

Surveys have found that the majority of Great Lakes regional officials and government staff were not incorporating climate adaptation into planning processes, despite the awareness of current and potential changing climate impacts (See Nelson et al. 2011). Sea Grant programs and regional organizations have drafted recommendations and consolidated case studies and tools (see, for example, Dinse. 2009 and www.greatlakesresilience.org). For this project, NYSG reviewed peer and gray literature, web resources, and contacts throughout the basin to identify activities that other Great Lakes communities have taken to integrate climate change uncertainty into their LAMPs or watershed plans. This 'learning from others' approach prevented duplication of efforts. This work was consolidated into a workshop presentation designed to jump-start participant brainstorming about climate change adaptation planning approaches with example strategies used in other locations and in other similar documents.

Workshop Process

Workshop II was designed to extend over two days in order to give participants time to know each other, feel comfortable talking and working together, and to give them time to mull over both the scenario approach itself and the actual scenarios for which planning was to take place. In this way, deeper thinking went into the recommendations. Group work occurred around each of the scenarios and followed a discussion guide. Attendees were given handouts of their respective scenarios, including descriptive artwork and main points (See Appendix A.).

The essence of this exercise was that each group was charged to create recommendations for what decision-makers should do TODAY to prepare for the assigned scenario POTENTIAL FUTURE (noting that our focus was on recommendations for LAMP and Watershed Plans.)

Breakout sessions occurred on both days for a total of 3.5 hours. The key questions were:

- What do you think we should do today to be more prepared for that potential future?
- What are the barriers to implementing that action? What are ways around the barrier?
- What are the secondary benefits from taking that action?

After this round of brainstorming, the groups were reconvened to share recommendations, identify barriers and ways of surmounting barriers. The next step was critical. The larger group then identified common actions, missing topics, and potential venues for presenting information generated at the workshop. The outcome was a set of stakeholder-driven

recommendations for updating the LAMP and local watershed plans that address climate change and increase resiliency.

Multiple recommendations were generated that could be grouped into the five broad categories of: water resource management, infrastructure, planning and zoning, water-related businesses, and ecosystem management. Recommendations also encompassed types of strategies ranging from education to regulations. Some powerful recommended actions were identified as providing good solutions to address the extremes of all four scenarios. For example, improved capture of stormwater runoff with increased infiltration and groundwater recharge would help reduce both the problems of flooding and droughts and increase water availability for population growth. Such win-win solutions rank high priority for immediate planning action. Other recommendations of note include improved water and stormwater management, increased extent of riparian buffers, wetland and stream hydrology restoration, infrastructure improvement and relocation; as well as social recommendations related to governance, and linking job training to energy and environmental actions. We created a matrix to more concisely package the recommended actions, implementation mechanisms, and opportunities for overcoming barriers to implementation. The column titles are the recommendation categories by topic area and the items along the side present potential methods for implementation and/or tools for overcoming barriers to implementation. (See Appendix B, Summary of “Win-Win” Recommendations.)

In November 2015, the final series of public engagement, Workshops III-A and B were held at opposite ends of the Lake Basin. The audience consisted of interested (and diverse) members of the public that included lakeside residents, environmental action groups, anglers, boaters, state legislator, environmental management agencies, water quality coordinating committees, and other concerned citizens. For both of these workshops, open public attendance was the focus, rather than the invited-only stakeholder focus of the first two workshops. These workshops were organized to gather public input on these recommendations to be presented to state and federal agencies on how to address uncertainties related to extreme weather patterns and population change in lake and watershed management plans. Workshops III-A and B were held in very different parts of the watershed (Rochester and Watertown) and scheduled for evening in the hope that a more diverse representative public could attend. A press release was generated which was picked up by 28 local papers and other media outlets. In addition, the Great Lakes Information Network was used to publicize the workshops as well as the email list for the Great Lakes Action Agenda held by NYSDEC. Twitter and Facebook were also used.

Workshops III-A and B were designed to briefly share the uncertainties related to precipitation due to climate change and its impacts on our socioecological system and then present the synthesized recommendations from the May workshop. The group was given about an hour to rotate through five stations. Each station had its own theme: water resource management, infrastructure, water-dependent business, land use/zoning, and ecosystem management. At each station, groups were asked to discuss the actions and add to or modify existing actions or recommendations. Flip charts and markers were again the primary tool for gathering input. Posters of the recommendation summary table were made and displayed at each station. At

the conclusion, the groups were asked to prioritize all of the presented recommendations. They used sticky dots to denote one recommendation at each station they felt was the best.

Overall, Workshops III-A and B validated the key action items identified in Workshop II. The prioritization exercise highlighted actions within each of the categories identified in Workshop II (water resource management, infrastructure, planning and zoning, water-related businesses, and ecosystem management). In addition, Workshops III-A and B highlighted additional areas for inquiry, such as management of onsite wastewater treatment and disposal systems.

Stakeholder Generated Recommendations

Below are the recommendations generated by stakeholders who participated in the workshops. Given the time available during the workshop, they cover a broad range of topics, generally, and reflect the type of actions this diverse stakeholder group felt would be appropriate for addressing both extremes associated with climate change generated precipitation and population growth. Readers of this report may have additional information and knowledge beyond that of the workshop participants, such as existing requirements, new initiatives and other nuanced details. However, these recommendations are significant to all readers as they illustrate the wealth of local knowledge, local priorities and a need for more public engagement and education related to potential impacts of uncertain futures on lake and watershed resources.

Water Resource Management

Recommended Action #1: Provide stormwater storage features (both natural and man-made) to have a more consistent water supply during droughts (source of supply) while providing some flood mitigation and storage during wet periods (source of a sink).

Discussion This action is targeted at stormwater management practices. Many times the focus on stormwater occurs during wet events and thus, many of the recommendations are for these types of precipitation events. However, stormwater features that retain water can be helpful for drought situations. Potential responses to this recommendation could include the use of retention/detention ponds and recharge structures where applicable, as well as other green infrastructure approaches. The use of storm water structures for storage will allow water to be available in dry times. Such structures could be used for residential and agricultural water supply needs.

Barriers

- Knowledge of how to correctly build and maintain
- Costs
- Public dislike for locating water storage near homes
- Child safety
- Locating, developing and building retention structures
- Appropriate technology and engineering specifications for structure capacity

Potential Solutions

- Education of the public and some stakeholder groups about the need and benefits of these structures could generate grassroots support
- Cost/benefit analysis or other economic studies could more clearly illustrate relative benefits
- Enlisting the support of, and working closely with, engineers and climatologists could lead to more technical information for siting and designing
- Outreach
- Use public areas, easements and land trusts
- Improve turf management and other vegetative approaches to controlling and storing water

Recommended Action #2: Manage stormwater for water quality and beneficial use.

Discussion Stormwater management was discussed by all groups in all extremes. This recommendation focuses on enhancing water quality of stormwater. It calls for improved standards and technology for stormwater management especially in areas where existing stormwater regulations are not applicable. During Workshop III, a participant argued that the flooding and water quality issues at the Lake's edge could not be addressed without also paying attention to land use and stormwater activities in the headwaters. Unintended benefits include public green space, healthy streams and wetlands, reduced erosion, improved soil health, and improved public health and safety.

Barriers

- Lack of political will to expand coverage, strengthen and/or enforce stormwater regulations
- Need new and improved engineering technology and standards
- Need to update best management practices and regulations
- Need more funding for improving ongoing long-term management oversight and implementation
- Politics are driven by downstate New York
- Zoning laws which allow building in high risk areas

Potential Solutions

- Education and outreach programs for the public as well as specific stakeholder groups
- Public and private partnerships to create improved standards and practices
- Create stormwater management partnerships between lakefront property owners and up-stream farmers facilitated by action from towns, counties and other municipalities in order to better manage and invest in water management and/or stormwater controls
- Research related to the practices
- Use inter-municipal agreements on larger scale and move resources up and down stream to invest in solving problems on a watershed basis
- Increase funding for community groups, watershed groups, county environmental management councils, water quality coordinating councils, etc. to implement on-the-ground water quality projects

Recommended Action #3: Consider appropriate allocation and valuation of clean water resources throughout the basin.

Discussion Comprehensive water use policy is needed. Existing regulatory water withdrawal programs are active in New York but only for systems which have the capacity to extract 100,000 gallons per day

or more. Local governments should consider charging for the true cost of clean water. If governments and/or businesses move closer to valuing water at true cost rates, water management may improve.

Barriers

- Lack of watershed groups advocating for the practice
- Water is not priced so as to reflect the true cost of maintaining a potable, sustainable supply
- No severance tax imposed on water as on other natural resources (oil, gas, etc.)
- Lack of political will
- Need to protect the politically/economically disadvantaged

Potential Solutions

- Education and outreach to the public and targeted stakeholder groups
- Learn from trends in our historic use
- Semantics of how new allocation rules would be presented
- Research on the real costs of providing clean water
- Encourage public private partnerships and collaborations
- Use capital use plans
- Protect water supply; more emphasis on water conservation/use
- Meter water, including both public supplies and wells, to better understand usage
- Tax charge for use and extraction of the resource

Recommended Action #4: Enhance water and environmental quality monitoring programs for waterways through improved collaboration and public involvement.

Discussion Monitoring is recognized as a critical element for successful preparation, planning and adaptation to climate change. However, monitoring programs are underfunded and need to be improved by extensive networking. Monitoring efforts should be comprehensive, covering many parts of the watershed. This item was prioritized at the follow-up workshops.

Barriers

- Capacity of the activity (whether government, academic or volunteer monitoring)
- Funding availability for the activity
- Need to synthesize data and identify where programs are most needed so that efforts are not duplicated

Potential Solutions

- Government should partner with schools and student conservation groups to expand capacity and coverage
- Expand capacity, outreach, and support for existing public/private collaborative efforts such as CSLAP and WAVE
- Enhanced volunteer programs (including K-12) with proper quality assurance/quality control procedures

Infrastructure (Transportation, Wastewater, Drinking water, Stormwater)

Recommended Action #5: Define and prioritize needed infrastructure upgrades and improvements for maintaining or enhancing water quality, including (where possible) moving critical drinking, wastewater, and transportation infrastructure out of floodplains.

Discussion This action addresses a monumental task of assessing, prioritizing and upgrading (or even relocating) infrastructure which supports our transportation system as well as water management systems. Much of our transportation network includes extensive, minimally managed roadside ditch networks and culverts which are now undersized due to changes in upstream land use as well as changes in frequency and intensity of severe storm events. In some instances, the increased use of green infrastructure can assist in some water management issues. This recommendation also addresses wastewater treatment plants, septic systems, the repair of all aging infrastructure, and dealing with leaks in all of these systems. The construction and maintenance of stormwater control/prevention systems, improvement of public transportation, and relocation of wastewater treatment and drinking water plants out of floodplains could be included in this action. An unintended benefit is efficiency and benefits to green environments. During Workshop III the expense of infrastructure relocation was stressed as an issue and a potential solution was noted as the implementation of berms and other physical practices to protect existing infrastructure in vulnerable locations.

Barriers

- Lack of consensus on how to prioritize needs within and between the sectors
- Funding for infrastructure improvements
- Technical expertise and funding is lacking for inspection and engineering
- Differences in management due to home rule may discourage prioritization and efficiencies
- No state level coordination

Potential Solutions

- Educate the public and facilitate cross-municipal boundary discussions
- Provide economic analyses on different scales to assist decision-makers
- Enact growth boundaries
- Increase connections with schools, vocational tech
- Create jobs, labor
- Develop water districts
- Improve inspection and maintenance operations
- Develop incentives for inter-municipal cooperation in watershed management
- Encourage service agreements among local governments and pool resources accordingly
- Develop uses for wastewater
- Realign FEMA reimbursement for replacement costs (as the existing programs do not allow for improvement just replacement)

Recommended Action #6: Site all types of infrastructure (drinking water, wastewater, transportation) in order to promote sustainable community growth.

Discussion This recommendation urges governments to plan infrastructure for growth such that public infrastructure (such as water and sewer) are provided in areas targeted for growth thus avoiding

inadvertent building booms due to the provision of public services. Proactive planning would prepare for infrastructure expansion ahead of growth. This would allow infrastructure to be properly updated as it is built and improved, removing the need for costly expansions in the future. Thoughtful decisions can be made regarding locations as to avoid building in vulnerable areas.

Barriers

- Lack of data (water, population, and road conditions)
- Lack of flexible policies
- Reactive policies
- Home rule prevents considering growth plans across governments
- Lack of local contractors with experience in green infrastructure technology

Potential Solutions

- Improve data management
- Develop proactive and flexible policies
- Encourage regional/metropolitan inter-municipal cooperation and collaboration

Recommended Action #7: Develop design standards and alternate systems specification for green infrastructure, alternate transportation modes, alternative uses and treatment of wastewater and other alternative forms of infrastructure.

Discussion Careful consideration for alternative uses of wastewater are needed. This action includes the need for new and frequently updated design criteria, proactive growth management and planning (prepare infrastructure and land use in advance of population boom), open space planning, selective use of toll roads and mass transit alternatives. Unintended benefits are more efficient, faster fixes and a possible decrease in taxes. Once reviewed during Workshop III, more basic recommendations were added such as septic system maintenance and inspections, enforcement of existing and new standards as well as reducing combined and sanitary sewer overflow, and connecting communities through greenways.

Barriers

- Lack of engineering knowledge
- Lack of standards and specifications
- Funding

Potential Solutions

- Require contractors to learn about green infrastructure as part of licensing and certifications
- Give businesses incentives for installing green infrastructure
- Consider adding “energy” infrastructure (could provide future savings)

Land Use Planning, Zoning and Governance

Recommended Action #8: Encourage and promote the use of open space for water recharge and storage.

Discussion: This recommendation promotes land use planning and zoning which keeps water on the landscape and promotes the creation and protection of open space, green space, and forest areas to

protect water quality and ease flooding, increases water infiltration and groundwater storage, and increases watershed reforestation. This could be accomplished through creating special management areas to protect/maintain wetlands and stream corridors and return flood plains to natural conditions. This issue was prioritized at the follow-up workshops. Unintended benefits are erosion control, less runoff, more green space, more infiltration, reduction in property damage and an increase in public safety.

Barriers

- Reluctance to change
- Need a timeline for shift of landscape to open space
- Landowner rights and perceptions of these facilities
- Lack of political will to require open space
- Lack of funding

Potential Solutions

- Education, outreach, and collaboration
- Create financial incentives through taxes or grants
- Build flexibility into regulatory processes
- More land banking or development rights programs

Recommended Action #9: Revitalize the urban core to concentrate the population and reduce infrastructure cost.

Discussion This action includes encouraging development/redevelopment in existing urban areas, making the urban core better, not just cities but also hamlets and villages. This will reduce infrastructure maintenance and reduce infrastructure needs for newer development in rural areas.

Barriers

- Continued development of new “bedroom” communities
- Need jobs in the urban areas
- Cultural barriers
- Imbalance of political will

Potential Solutions

- Begin by bringing those with limited mobility, such as the elderly, and build a demand for human services (retail, medical, dental) in the urban core
- Allow for denser populations in hamlets

Recommended Action #10: Discourage and phase out development in areas vulnerable to flooding.

Discussion This includes better local planning and flood plain management that discourages development in flood prone areas while maintaining natural flow regimes of rivers and streams and reducing risk. Unintended benefits are flourishing fish and wildlife, improved biogeochemical processes, and reconnecting humans with nature.

Barriers

- Current zoning laws do not adequately prevent development in floodplains
- Property rights advocates may oppose any movement to restrict development rights, even for legitimate public health and safety and environmental reasons
- Inability of property owners to move
- Property tax issues
- Existing public infrastructure, including roads to these properties
- Lack of funding to move people out of those areas
- Psychological unwillingness to move
- Subsidized flood insurance supports living in areas in high risk of flooding

Potential Solutions

- Reassess property values with risks in mind
- Improve zoning laws to reduce development in flood plains and discourage future development
- Use land trusts and easement programs to prevent development or redevelopment
- Strengthen FEMA community rating system (education and funds to move)
- Use a phased approach (no new buildings) to preventing new development and then curtailing redevelopment
- Increase insurance rates to dissuade additional building
- Encourage land swaps because of true regional planning
- Use tax incentives to get people out of high risk areas

Recommended Action #11: Promote appropriate use of brownfields and restoration where possible in order to improve the environment and the economy.

Discussion The use of brownfields not only cleans up the immediate area, improving the local environment and potentially reducing contaminants in runoff, but also allows other space to remain undeveloped, green, and open. The cleanup and redevelopment of brownfields creates jobs and may increase nearby property values.

Barriers

- Facilitating infrastructure is not ready
- Group's lack of knowledge
- Funding

Potential Solutions

- Grants and low interest loans available from EPA's Brownfields program
- Technical assistance and job training from EPA's Brownfields program

Recommended Action #12: Mitigate impacts of climate change on vulnerable populations by providing additional transportation, infrastructure, and education resources for these groups.

Discussion Climate change disproportionately affects elderly, young, sick, disabled, and low-income people. These populations need easily accessible assistance from social service departments. Sustainable communities can be supported by agricultural land and community cooperation. Free and

reliable public transportation can provide access to jobs, schools, and medical services for those who cannot afford their own transportation or who are unable to drive. This also ties into the transportation recommendation of alternate transportation modes; better public transportation will benefit the community as a whole. Education and training for existing jobs can create needed employees for updating infrastructure.

Barriers

- Funding
- Lack of coordination of community and government programs

Potential Solutions

- Bonds, grants
- Education and outreach
- Increase resources to Department of Social Services Office of the Aging, emerging technology and medical services
- Create partnerships among DSS programs and departments
- Design sustainable communities

Recommended Action #13: Planning and zoning should incorporate principles of Ecosystem Based Management.

Discussion Watershed, wildlife and other habitats, source water protection areas, and other natural boundaries would be used as a baseline for developing planning and zoning rules. Ecosystem services (AKA societal benefits from healthy environments) such as biodiversity, water quality, flood control, water retention, soil conservation, erosion control, etc. would be used in decision-making at the local level for planning and zoning. Some communities already use these criteria to score development (natural capital score) during their approval processes. This additional recommendation from the follow-up workshop was shared by several attendees. In addition, State Park Department can demonstrate various practices on public lands which will achieve these goals in order to prove that the concepts work. In addition, land can be conserved through having working forest conservation easements on “smaller” private woodlots.

Barriers

- Existing assumptions in planning may prevent this approach
- Natural features may not align with municipal boundaries

Potential Solutions

- Consider regional approaches to governance
- Use more of a Council of Governments approach

Water-Dependent Businesses (Agriculture, Tourism, Recreational Boating & Fishing)

Recommended Action #14: Integrate agricultural practices with energy production (such as biomass energy).

Discussion The agricultural industry has a history in creating value-added products. New technologies in the sector already exist, such as biofuels. Investment in the creation of even more technologies which

create multiple benefits, especially from wastes, will make the watershed more resilient in the future. Better management of agricultural wastes from larger dairies will reduce water quality risks and improve aesthetics (reduce nutrient runoff and associated impacts such as a nuisance and/or harmful algal blooms).

Barriers

- Cost of construction
- Lack of proven technology
- Accessibility to financing and technology
- Licensing of new facilities
- Decommissioning of existing facilities

Potential Solutions

- Need agricultural and electrical engineering expertise
- Use BOCES instructors and students to train on new technology
- Income from potential water and energy savings and energy generation
- Provide farmers with incentives to implement best practices

Recommended Action #15: Promote research and development of new agricultural technologies as well as new industries and jobs related to these technologies.

Discussion This action includes promoting research and development, updating best management practices, reducing impacts on the environment, and creating economic benefit from farm-waste and biomass energy projects. The recommended action supports an increased focus on technology development related to agriculture. Investing in research and development for new technologies which would provide farmers with evidence-based information that new approaches are beneficial and cost effective. In addition, the research findings should be demonstrated in the field. Demonstration projects showing how potential new crops and crop-related technologies work would provide growers with proven models suitable for changing growing conditions. Unintended benefits of this activity are more efficient use of land and energy, increase in jobs and change in job structure to more economically viable jobs.

Barriers

- Funding limited for research and start-up businesses
- Comfort and perceived reduced risk in continuing to use tested techniques and practices

Potential Solutions

- Cost sharing of new implementation practices (example: Methane digesters on livestock manure, biomass energy, more climate resistant crops)
- Use public and/or private funding for new technology research and/or demonstration projects
- Education and outreach for the public along with collaboration with public and private sectors
- Regulatory reform to allow for new practices
- Amend Farm Bill to meet sustainable farming needs through new technologies and practices

Recommended Action #16: Consider encouraging greenhouse production of agricultural products to expand industry.

Discussion Even in dry times, our region will likely have more water than other parts of the country. Enhancing controlled environmental agriculture (greenhouses) can maintain agricultural production in the region and augment production of some crops. As places like California experience more droughts and have a reduced capacity to produce crops such as tomatoes and spinach, New York can benefit by utilizing greenhouses to grow these types of crops irrespective of the season.

Barriers

- Few loans available for this practice
- Research needed on best practices and sustainable types of structures for our area (heavy snowfalls, frequent cloud cover); energy intensive
- Shifts in climate (increased in temperatures) may reduce the need

Potential Solutions

- Government programs for loans
- Education and outreach
- Federal and state cost-share and grants
- Rely on our climatologists for predicting shifts in climate

Recommended Action #17: Enhance resiliency of recreation and tourism industries by planning for increased climate variability.

Discussion Warmer temperature will lead to a change in ice cover, snow versus rain, and warmer water temperatures. Ice fishing and snow sports may give way to longer fishing and boating seasons. Existing recreation and tourism businesses will need to prepare for these changes. Increased recreation opportunities suitable to both wet and dry conditions will help maintain a healthy economic environment as long as we ensure public access to water. Focusing on environmentally-based tourism simultaneously increases economic vitality and fosters more resilient landscapes. This recommendation also could support a new National Marine Sanctuary for the Lake.

Barrier

- Funding for industry promotion

Potential Solutions

- Raise funds for investment through selling the water
- Make connections with community leaders
- Income from tourism
- Increase use of under-utilized byways such as (Seaway trail, N. Adirondacks, Olympic and black river maple) as a method to increase tourism

Recommended Action #18: Support fisheries monitoring and research to provide information to guide stocking decisions in a changing climate.

Discussion Climate change, especially increases in temperature and changes in precipitation patterns, may impact which fish species or strains are best suited to live and breed in Lake Ontario. Continued

(and improved) support of fisheries monitoring and research is needed to provide reliable information for responsive management decisions regarding fish stocking in a changing climate.

Barriers

- Funds for research
- New equipment for hatcheries to raise different species

Potential Solutions

- Protect and enhance in-lake and spawning habitats for multiple species, and encourage natural (wild) reproduction of sportfish.
- Diversify prey fish and sportfish populations by supporting restoration of native species.

Ecosystem Management

Recommended Action #19: Restore and protect streams and wetlands throughout the basin.

Discussion Restoring the hydrology of the basin will help in times of drought or flooding. The recommendation calls for protecting, enhancing, and restoring the natural hydrologic regime of streams, lakes, wetlands, riparian buffers, upland areas of watersheds, and other areas to restore hydrology. Unintended benefits of implementing this action could be improved fish and wildlife habitat, reduced algal blooms, increased community resilience, improved resident quality of life, improved biogeochemical processes, reduced mosquito populations and related disease, and increased reconnection of humans with their natural environment.

Barriers

- Expense, limited funds
- Property owners may not support restoration or protection measures
- Zoning may encourage loss or degradation of these features
- Public resistance/perception to changes in the wetlands and stream corridors
- Lack of current regulation for the amount of water extracted from groundwater which feeds streams and wetlands

Potential Solutions

- Education and grassroots support
- Increase understanding of the link between healthy streams and wetlands and a robust economy
- Economic analyses may show benefits
- Monitor and inventory current watershed resources
- Determine value of natural resources
- Provide incentives for homeowners/private property owners for protecting these features through developing a program that pays for ecosystem services
- Watershed-based governance would protect these features

Recommended Action #20: Create and enhance systems for early detection and response to new invasive species (pest, plant, animal and aquatic).

Discussion Invasive species have threatened our coastal, riparian, wetland, and lake food web resources and these species invasions are likely to increase. Currently, invasive species cost the Great Lakes region millions of dollars annually. Proactive responses need to be taken to develop comprehensive monitoring programs for new invasive species.

Barriers

- Information gaps regarding potential invaders and changes in the environment
- Public distrust or lack of belief in science

Potential Solutions

- Enhance Partnership for Regional Invasive Species Management (PRISM) capacity
- Redefine “what is invasive” given the potential changes in the environment
- Increase outreach to people who are in jobs and enjoy recreational pursuits that place them in habitats likely to harbor new invasive species

Recommended Action #21: Increase early detection of human and animal pathogens (new ones, and increases in occurrence of existing ones) that associated with water-related vectors.

Discussion As with invasive species, new and existing pathogens may find that the increasing temperatures and associated ecological changes due to climate change make the basin a hospitable habitat. The approach should be similar to invasive species: improved and more comprehensive monitoring and detection technology. Also, improved access to health care will assist in identifying potential illnesses from these new pathogens.

Barriers

- Lack of capacity (funds, technology, and trained staff)
- Lack of monitoring and diagnostic designs
- Potential new pathogens are currently unknown threats

Potential Solutions

- Invest in technology to detect new pathogens
- Improve natural resource managers’ connections to researchers and medical community
- Improve connection to places where they already live with these issues
- Willingness to implement recommendations (outreach)
- Study fish disease (to better understand how these pathogens spread and how they can be treated)

Potential Next Steps

The purpose of this report to inform Lake and Watershed Managers and Planners about the above recommendation action that can be taken now to prepare for uncertainties related to the need for climate change adaptation *from the perspectives of those who work, live and play in the Lake Ontario basin*. The recommendations were generated by diverse stakeholder groups using as a resource only the four potential future scenarios differentiated by different extreme precipitation and population

growth patterns. The recommendations are powerful because they are win-win solutions that maximize resilience to a wide range of conditions and futures and because they are generated in a room of diverse stakeholders. These actions and ideas are designed to be used when engaging the public in other planning processes (local or regional) as you seek to include climate change provisions in new and existing plans. Many of the recommendations have benefits beyond those associated with climate change and thus may already be present in your planning. Ideas for presenting these recommendations are as follows.

Fact Sheets

These compiled recommendations, barriers and solutions could be the basis for fact sheets produced to fully describe each practice, the existing regulatory or voluntary implementation mechanisms, existing funding sources, other benefits and costs of implementation as well as other types of trade-offs necessary to take a specific action. By using such fact sheets in a planning process, all participants can be brought to the same level of understanding on various issues.

Local Scenario Planning

The process used to generate these recommendations could be used on at a smaller watershed scale and/or over a shorter period of time with a consistent group of diverse stakeholders in order to refine and tailor the recommendations based on local knowledge of water management practices, infrastructure issues and concerns, business climate, ecosystem benefits and concerns as well as other more specific and local barriers to implementation. This process would be best run with local experts in planning, policy, natural sciences and economics participating as well.

“Strawman”

An alternate use could be to simply present these recommendations along with information of how they were generated in order to start a discussion of how a more localized or lake-based planning process could incorporate these ideas. Thus, the recommendations would serve as a starting point.

Conclusion

Public and stakeholder engagement in planning is important for developing a sense of ownership in a plan and for increasing the likelihood of its implementation. Particularly in a home rule state such as New York, many of the recommended actions presented are most appropriately implemented at the local scale. Public and stakeholder support is important in generating the political will for policy change. It is hoped that this report will be used to start dialogs and expand thinking about how planning for climate change should occur in the Lake Ontario basin and how planning under high uncertainty can advance.

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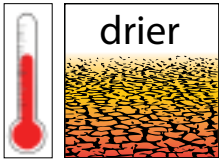
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Appendices

Appendix APage 25
Four Scenarios

Appendix B.....Page 29
Summary of “Win-Win” Recommendations

Climate Scenario Details



- **Warming** temperatures (especially winter)
- More intense short (seasonal) and long-term (multi-year) **droughts**
- Less snowpack contributes to **summer drought**

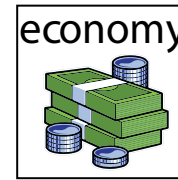
Population Scenario Details



- Compared to other U.S. states, NY experience **slower population growth**



- Increased **dairy production** and **water allocation** to dairy



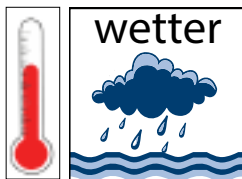
- **Slower economic growth** and **fewer business opportunities**
- Increased **nuclear energy**

| IMPACTED SECTOR | Precipitation Driver (Increased Drought) | Temperature Driver (Warmer Air Temperatures) | Population Driver (Slow Growth) |
|--------------------|---|---|---|
| Land | <ul style="list-style-type: none"> • Surface soils dry out • Exposed shorelines • Decreased property values from aesthetic changes to lakeshore | <ul style="list-style-type: none"> • Longer growing season | <ul style="list-style-type: none"> • Slow conversion of land use |
| Water/Lakes | <ul style="list-style-type: none"> • Lake levels fall • Reduced stream flows • Wetlands dry out | <ul style="list-style-type: none"> • Warmer lake waters • Less ice cover • More evaporation | <ul style="list-style-type: none"> • Increased contamination of raw water sources from agricultural sector • Greater irrigation demands |
| Ecosystem | <ul style="list-style-type: none"> • Loss of lake and wetland habitat • Fewer fish spawning sites • Increased risk of fire • Increased intensity of Harmful Algal Blooms (HABs) | <ul style="list-style-type: none"> • Fewer cold refugia • Fewer cold water fish species • Increase in southern invasive species • Lower lake oxygen | <ul style="list-style-type: none"> • More agricultural pollutants • Increased intensity of Harmful Algal Blooms (HABs) |
| Human | <ul style="list-style-type: none"> • Greater water use demands/diminished well water supplies • Increased need for water quality management • Increased need for drought planning and water conservation policy • Higher irrigation costs • Economic stress (i.e., crop losses, lake/shoreline industry losses, etc) • Increased risk of fire | <ul style="list-style-type: none"> • Increased health risks from extreme heat events • Increased urban heat island effects • Increased risk of dangers and damages from freezing rain events | <ul style="list-style-type: none"> • More agricultural pollution treatment needed |

Raging Runoff

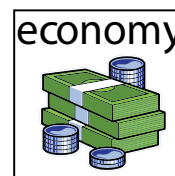
Wetter, Slow-Growth Population

Climate Scenario Details



- Northeast is **wetter** but this **isn't evenly distributed** by season or event
- **Warming** temperatures (especially winter)
- **Extreme precipitation** events more frequent
- More **winter precipitation**
- More precipitation is projected to fall as **rain rather than snow**

Population Scenario Details



- Compared to other U.S. states, NY experience **slower population growth**

- Increased **unsustainable** plant based **biofuel** and **animal** based **agriculture**

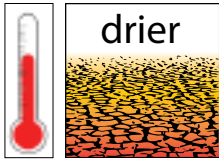
- Struggling alternative **energy** market and **economy**
- **Political stagnancy** and **inflexibility**

| IMPACTED SECTOR | Precipitation Driver (Increased Precipitation) | Temperature Driver (Warmer Air Temperatures) | Population Driver (Slow Growth) |
|--------------------|--|---|---|
| Land | <ul style="list-style-type: none"> • More stormwater runoff • Lakeshore/river flooding • Increased scour, erosion • Increased gully formation • Increased sediments • Increased property damage from floods • Restricted building in flood prone areas | <ul style="list-style-type: none"> • Longer growing season | <ul style="list-style-type: none"> • Slow conversion of land use |
| Water/Lakes | <ul style="list-style-type: none"> • Lake levels rise • More stream flooding • Erosive wave activity | <ul style="list-style-type: none"> • Warmer lake waters • Less ice cover • More evaporation | <ul style="list-style-type: none"> • Increased contamination of raw water sources from agricultural sector • Greater irrigation demands |
| Ecosystem | <ul style="list-style-type: none"> • Increased intensity of Harmful Algal Blooms (HABs) | <ul style="list-style-type: none"> • Lower lake oxygen • Fewer cold refugia • Fewer cold water fish species • Increase in southern invasive species | <ul style="list-style-type: none"> • More agricultural pollutants • Increased intensity of Harmful Algal Blooms (HABs) |
| Human | <ul style="list-style-type: none"> • Sewer overflows • Increased need for water and water quality management • Possible resizing of culverts • Flood damage to infrastructure • Risk of increased waterborne illnesses, and injury/death from flooding • Higher flood mitigation and insurance costs | <ul style="list-style-type: none"> • Increased health risks from extreme heat events • Increased urban heat island effects • Increased risk of dangers and damages from freezing rain events | <ul style="list-style-type: none"> • More agricultural pollution treatment needed |

Crowded Beaches

Drier, Increased Population

Climate Scenario Details



- **Warming** temperatures (especially winter)
- More intense short (seasonal) and long-term (multi-year) **droughts**
- Less snowpack contributes to **summer drought**

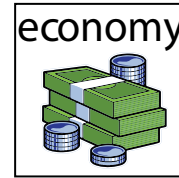
Population Scenario Details



- Rapid population **growth** in NY and Ontario
- Increased **crime**



- Increased conversion of land for **urban sprawl** and **mega farms** (with increased water recycling)



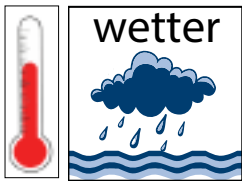
- Technology advances have left immigrant and low-wage workers **unemployed**
- Federal/state **stimulus programs** in action
- Shift from historic sportfishing boats to smaller/lighter vessels
- Increased **tourism**
- New **energy** extraction methods

| IMPACTED SECTOR | Precipitation Driver (Increased Drought) | Temperature Driver (Warmer Air Temperatures) | Population Driver (High Population) |
|--------------------|---|---|---|
| Land | <ul style="list-style-type: none"> • Surface soils dry out • Exposed shorelines • Decreased property values from aesthetic changes to lakeshore | <ul style="list-style-type: none"> • Longer growing season | <ul style="list-style-type: none"> • More impervious land cover |
| Water/Lakes | <ul style="list-style-type: none"> • Lake levels fall • Reduced stream flows • Wetlands dry out | <ul style="list-style-type: none"> • Warmer lake waters • Less ice cover • More evaporation | <ul style="list-style-type: none"> • Greater water use, demands • More stormwater runoff |
| Ecosystem | <ul style="list-style-type: none"> • Loss of lake and wetland habitat • Fewer fish spawning sites • Increased risk of fire • Increased intensity of Harmful Algal Blooms (HABs) | <ul style="list-style-type: none"> • Fewer cold refugia • Fewer cold water fish species • Increase in southern invasive species • Lower lake oxygen | <ul style="list-style-type: none"> • More agricultural pollutants • Increased intensity of Harmful Algal Blooms (HABs) • Increased damage from industrial pollutants |
| Human | <ul style="list-style-type: none"> • Greater water use demands/ diminished well water supplies • Increased need for water quality management • Increased need for drought planning and water conservation policy • Economic stress (i.e., crop losses, lake/shoreline industry losses, etc) • Increased risk of fire | <ul style="list-style-type: none"> • Increased health risks from extreme heat events • Increased urban heat island effects • Increased risk of dangers and damages from freezing rain events | <ul style="list-style-type: none"> • Increased wastewater treatment and disposal needs • Floodplain/shoreline communities at risk from higher water levels |

Soggy Strip Malls

Wetter, Increased Population

Climate Scenario Details



- Northeast is **wetter** but this **isn't evenly distributed** by season or event
- **Warming** temperatures (especially winter)
- **Extreme precipitation** events are more frequent
- More **winter precipitation**
- More precipitation is projected to fall as **rain rather than snow**

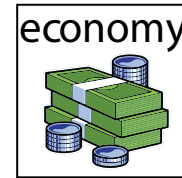
Population Scenario Details



- Rapid population **growth** in NY and Ontario



- Increased conversion of land for **urban sprawl** and **agriculture**
- Increased road/transportation/shipping **development**
- Agriculture shifts to **wet adopted crops** (i.e. rice)



- Increased **alternative energy** development
- Increased **aquaculture** offshore

| IMPACTED SECTOR | Precipitation Driver (Increased Precipitation) | Temperature Driver (Warmer Air Temperatures) | Population Driver (High Population) |
|--------------------|--|---|---|
| Land | <ul style="list-style-type: none"> • More stormwater runoff • Lakeshore/river flooding • Increased scour, erosion • Increased gully formation • Increased sediments | <ul style="list-style-type: none"> • Longer growing season | <ul style="list-style-type: none"> • More impervious land cover |
| Water/Lakes | <ul style="list-style-type: none"> • Lake levels rise • More stream flooding • Erosive wave activity | <ul style="list-style-type: none"> • Warmer lake waters • Less ice cover • More evaporation | <ul style="list-style-type: none"> • Greater water use, demands • More stormwater runoff |
| Ecosystem | <ul style="list-style-type: none"> • Increased intensity of Harmful Algal Blooms (HABs) | <ul style="list-style-type: none"> • Fewer cold refugia • Fewer cold water fish species • Increase in southern invasive species • Lower lake oxygen | <ul style="list-style-type: none"> • More agricultural pollutants • Increased intensity of Harmful Algal Blooms (HABs) • Increased damage from industrial pollutants |
| Human | <ul style="list-style-type: none"> • Sewer overflows • Increased need for water/water quality management • Possible resizing of culverts • Flood damage to infrastructure • Risk of increased waterborne illnesses, and injury/death from flooding • Higher flood mitigation and insurance costs | <ul style="list-style-type: none"> • Increased health risks from extreme heat events • Increased urban heat island effects • Increased risk of dangers and damages from freezing rain events | <ul style="list-style-type: none"> • Increased wastewater treatment and disposal needs • Floodplain/shoreline communities at risk from higher water levels |

| | Water Resource Management | Infrastructure (transportation, wastewater, drinking water, stormwater) | Land Use Planning, Zoning & Governance | Water Dependent Businesses (Agriculture, Tourism, Boating & Fishing) | Ecosystem Management |
|-------------------------------|--|--|---|---|--|
| ACTION ITEMS | Manage stormwater for quality and quantity | Prioritize upgrades, improvements and relocations (out of flood plains) | Revitalize urban core to reduce infrastructure cost through concentrating population | Align funding opportunities at state and federal level with needs | Create and enhance systems for early detection & response of invasive species (pest, plant, animal, aquatic) |
| | Allocate water use | Design and site with growth in mind | Discourage living in vulnerable areas | Integrate agricultural practices with energy needs (such as biomass) | Increase early detection of new pathogens |
| | Provide for storage (natural and man-made), green-infrastructure approaches | Develop standards and alternate systems (green infrastructure, alternate transportation modes) | Encourage open space for water recharge and storage | Consider increased greenhouse production | Stream and wetland restoration and other methods to restore hydrology |
| | | Real cost pricing for water | Promote use of brownfields Promote research & development of new technologies and develop industries & jobs related to new technologies Provide additional resources for vulnerable populations | Store water for potential droughts Invest in science to determine best recreational species for long-term stocking Enhance recreation/tourism industries via new programs | Protect, enhance & restore riparian buffers |
| Regulatory Policy | Develop, implement, revisit allocation rules | Revisit rules and policies to be more adaptive to new technologies, technique and design standards | Local laws, ordinance, taxation review for resilience to extreme weather | Amend Farm Bill to meet sustainable farming needs | |
| | Revisit rules and policies to allow for more innovation in engineering standards | Update design criteria for future conditions & allow for innovations | Infrastructure development policy to manage growth | | |
| Education Outreach | Needed | Needed | Needed | Needed | Needed |
| Funding | Consider charging for the true cost of water | User fee for transportation | Bonds, grants | Federal and state cost-share and grants Tourism | Cost-share; state funding |
| | State grant programs | True cost water | | | |
| Engineering standards and R&D | Needed | Needed | Needed | Needed | Needed |
| Governance | Consider inter-municipal agreements | Consider inter-municipal agreements | Home rule | | |
| | Encourage service consolidation among local governments | Encourage service consolidation among local governments | Consider inter-municipal agreements, coordination, consolidation | | |
| Monitoring | Monitoring programs for waterways & stormwater (quality and quantity) | Fund inspection programs to assist in the prioritization of upgrades and relocations | | | Monitoring programs for detection of invasive species & pathogens |