A Resilient Watershed: Applying an Integrative and Adaptive Approach to a Long-Term Management of the Muskoka Watershed

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Purpose

Climate-related changes are already being witnessed across Canada, and despite ongoing efforts towards mitigation, there lies responsibility across all levels of government to adapt to these and to other predicted impacts. The Muskoka region is no different, and has experienced changes to its air, land and water, which are systems that effect valued services such as drinking water, angling, biodiversity, and recreational activities.

The consideration of complex interactions between stressors, and an understanding of the relationships between diverse stakeholders, are crucial to the region's ability to plan and manage for an increasingly uncertain, potentially volatile future see Figure 1).

Though Muskoka has taken action to improve regional watershed monitoring, however uncertainties continue to face the region as we look to the future.

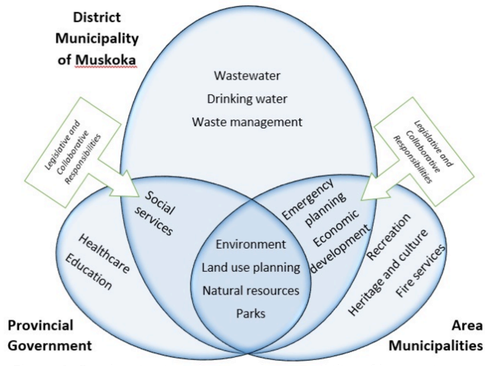

Figure 1. *Overlapping jurisdictions of responsibility of key service responsibilities in Muskoka relating to water. Adapted from District Municipality of Muskoka (DMM, 2016).*

Importance of Watershed Monitoring & Management Approaches

Monitoring indicators of ecosystem health, and considering potential future impacts of these indicators, are imperative for creating a resilient ecological community able to continue functioning in the face of ecological challenges as it allows for identifying early warnings and emerging challenges (Walker, 2004; Lemieux et al., 2014). ARM and IWRM are two common approaches to watershed management (Walters & Hilborn, 1978; Medema, McIntosh, & Jeffrey, 2008). Increasing complexity and uncertainty have created a growing trend to combine both approaches (Medema, McIntosh, & Jeffrey, 2008; Engle et al., 2011).

Table 1: *Definition and Comparison of terms relating to Watershed Monitoring and Management*

Adaptive Resource Management (ARM)	Integrated Water Resources Management (IWRM)	Cumulative effects assessment and motoring (CEAM)
ARM is a systems approach to deal with environmental change and uncertainty by bringing a diverse set of stakeholders together to facilitate learning (Holling, 1978).	WRM coordinates management of water, land and related resources, to equitably maximize economic and social welfare without compromising vital ecosystems (Medema, McIntosh, & Jeffrey, 2008).	Cumulative effects are changes to the biophysical, social, economic, and cultural environments caused by the combination of past, present and 'reasonably foreseeable' future actions (Renewable Resources & Environment, 2007; 2010). CEAM is the process of monitoring, tracking and predicting accumulating environmental change relative to established limits (Dubé, 2015).
ARM encourages collaboration and flexibility.	IRWM considers the larger system, not just the physical area of water.	CEAM allows the watershed to evolve and correct itself, and enables early detection of issues.

The two approaches, when taken together, have been shown to offer the following theoretical benefits over other water management (Engle et al., 2011):

1. Increase effectiveness by improved integration of social, ecological and hydrological systems;
2. Add legitimacy and improve stakeholder cooperation through participation and democratic decision making;
3. Incorporate expertise through different forms of knowledge as well as the promotion of social learning; and
4. Promote flexibility and adaptability through iterative learning, managing and experimentation.

The Muskoka Watershed Context

In addition to various water management responsibilities, stakeholders all work together in the region to ensure watershed-level health and sustainability. Stakeholders have different priorities, powers, and time-frames, which depend on the scale and political jurisdictions in which they work. Figure 2 depicts stakeholders who are actively involved in the monitoring and/or decision-making process. Though each subgrouping represents similar interests, it is important to recognize the unique needs, interests, and abilities of each stakeholder. All stakeholders need to be involved in the process (monitoring, consultation, decision-making, etc.) in order to develop ownership of a holistic climate change adaptation strategy.

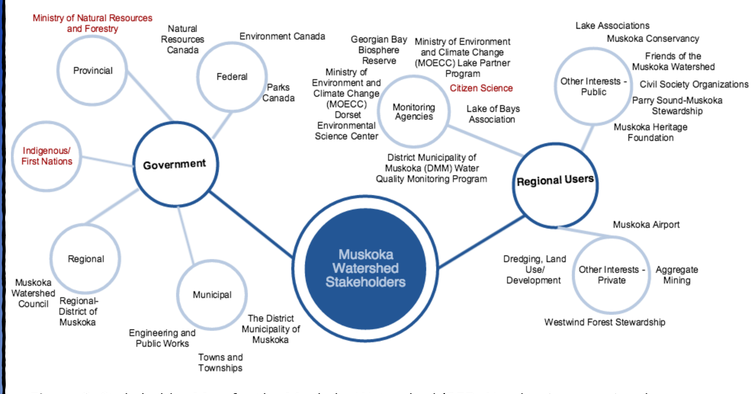

Figure 2. *Stakeholder Map for the Muskoka Watershed (RED: Need to increase involvement; BLACK: Currently involved).*

Methods

This study was conducted by reviewing lessons from Canadian Water Network's Canadian Watershed Research Consortium, other regions (Lake Simcoe, Lake Superior), currently used communication strategies by MWC, and through various conversations with actors (i.e. researchers, managers, etc) working in Muskoka.

Mapping a Way Forward: Adopting a Regional

Effective climate change policy processes are iterative, and assessments should be multidimensional. Cumulative effects assessment and monitoring satisfies this to a large degree, though other actions such as vulnerability analyses (Stein & Edelson, 2011; Lemieux et al., 2014) appear to be complementary and effective as decision support tools. Locally available tools and techniques should be used to their full advantage.

Overall, adaptation is key in management systems, resilience is the primary goal in ecological systems and relevance to localities is important. Figure 3 maps the recommended path for Muskoka to take highlighting tools and next steps to integrate more adaptive monitoring and management processes.Climate Strategy

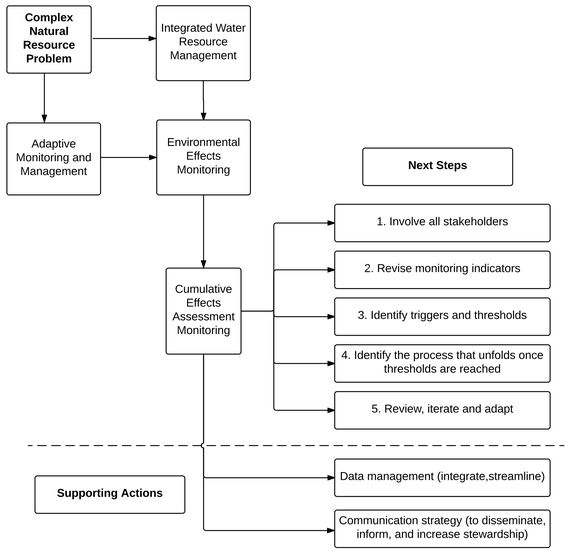

Figure 3. *Proposed components to adopting climate-resilient watershed management practice, by way of CEAM.*

Recommendations

1. *Identify Monitoring Indicators.* Progressing towards CEAM requires a consensus by monitoring entities regarding what is being measured, and how.

2. *Develop a Centrally Managed Data System.* This would increase transparency, improve access to data (addressing high turnover in research personnel by improving continuity), enhance efficiency and highlight trends in the data.

3. *Improve Communication Strategies.* Improving congruence and continuity in the expression of report card indicators, symbols, and measurement units, would make temporal or spatial trends more clear. Background reports have quality information, but are overwhelming in size and depth.

Conclusion

As shown in Figure 3, we suggest Muskoka do the following: identify consistent indicators to support CEAM; develop a centrally managed data system, and; improve communication strategies. A revision of decision-making processes should be further explored to ensure a comprehensive and systems-based approach. In summary, action on the analyses and recommendations in this summary report would mean a long-term commitment, but one that can reduce vulnerabilities and improve collaboration, thus resulting in a stronger, healthier and more resilient community and watershed despite future climate uncertainties.

Acknowledgements

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