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Analyzing the Biophysical Characteristics of the Grand River Watershed and Evolving Impacts: Protecting Watershed Health Through Strategic Management

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Abstract:

SDG 6 Target 6.6 places emphasis on the protection and restoration of water related ecosystems. The assumption is that for SDG 6 itself to succeed, the resource base must be treated as more than simply a source for human wants and needs. Nature's intrinsic value must be recognized and respected. However, watersheds face a variety of challenges as social and environmental variables transform their biophysical characteristics. The health of a watershed is directly impacted by the associated activity taking place within its region. Based within the Kitchener, Waterloo, Guelph, and Cambridge region, almost a million people live within the Grand River watershed in Southern Ontario, Canada. The region has seen an exponential increase in urbanization and agricultural practices, all variables which have affected the health of the Grand River watershed. This paper analyzes the biophysical characteristics found within the Grand River watershed and uses those findings to highlight the environmental and socio-economic variables that have influenced the health of the watershed. It outlines how the Grand River watershed and its management strategies work in tandem with SDG 6, particularly targets 6.5 and 6.6. The findings of this paper show that while the Grand River Conservation Authority lays the basis for achieving Targets 6.5 and 6.6, success is hampered by fragmentation of authority,

limited human and financial resources, and information gaps. The paper concludes that the coordinated pursuit of cross-sector partnerships can help overcome these challenges.

Key Words:

Watershed, Grand River, management, SDG 6, health, urbanization, partnerships, Integrated Water Resource Management, agriculture, ecosystem, Grand River Conservation Authority, southeastern Ontario, climate change

Introduction

The Sustainable Development Goals (SDGs) introduced by the United Nations and adopted by countries around the globe in 2015 take a holistic approach to sustainability (United Nations General Assembly [UNGA], 2015); they succeed at categorizing development challenges within distinct calls to action. SDG 6 – "ensure availability and sustainable management of water and sanitation for all" – positions the far-reaching and broad range of water issues into tangible objectives to be used in large- or small-scale contexts (UNGA, 2015). These objectives can be applied within the boundaries of watersheds, as these particular water systems face unique challenges as environmental and socio-economic impacts transform their biophysical characteristics and associated ecosystems. The Grand River watershed in Southern Ontario, Canada, is a particularly relevant case to examine because it provides insights into management strategies that promote sustainability and watershed health. With a distinct history of integrated water resource management (IWRM), the Grand River watershed offers important lessons of adaptation for regions under transformation (Veale & Cooke, 2017).

SDG 6 cannot be achieved out of a degraded ecosystem, thus the ability to achieve water and sanitation for all is dependent on more than water delivery systems and filtration plants. All

activity taking place in the region – in this case, the Grand River watershed – must be considered in order to understand the health of the watershed. These factors need to be accounted for to ensure the successful management and use of watershed systems. This paper aims to prove that the Grand River watershed and its management strategies work in tandem with SDG 6, particularly targets 6.5 and 6.6, and that it provides an effective and sustainable framework for protecting and restoring water-related ecosystems. It will first examine the biophysical characteristics of the Grand River watershed and analyze the environmental and socio-economic variables upon it. It will then move into an exploration of the management systems currently in place, critically assessing their effectiveness as they relate to SDG 6. Lastly, it will propose recommendations to improve the implementation of SDG targets that may be used to improve the overall health of the Grand River watershed.

Background

In order to assess the management strategies utilized within the Grand River watershed in Southern Ontario, Canada, the characteristics that shape the demand and supply of the water source must first be understood. In comparison to a large portion of Ontario that sources their water mainly from the Great Lakes, the Grand River watershed and the 39 municipalities and two First Nations territories that makeup the region, do not (Veale & Cooke, 2017). Rather, the Grand River watershed serves as an abundant, albeit limited, water source. The watershed covers an area of approximately 6800 square kilometres with the length of its rivers and streams totaling around 11,000 kilometres (Grand River Conservation Authority [GRCA], n.d.-a). It is important to note that in some cases, only a portion of a municipality falls within the watershed, presenting unique circumstances for implementing management structures. The water flows from Dufferin Highlands into Lake Erie at Port Maitland, with most of its water supply needs satisfied by

groundwater sources and river systems taking, and a remaining and relatively small 4 percent, being sourced from the Great Lakes (Etienne, 2014).

With close to one million people living in the watershed, concentrated in the urban areas of Kitchener, Waterloo, Guelph, Cambridge and Brantford, the region has and continues to experience rapid urbanization (Liu et al., 2016). While these cities continue to grow approximately 70 percent of the watershed is still made up of farms and land used for agricultural activity (GRCA, n.d.-a). These numbers are significant, indicating the population density of the watershed's urban areas in an estimated 30 percent of the watershed area. This human sprawl has altered the demand pressures on the Grand River watershed, with municipal water demand accounting for over 60 per cent of the total volume of water used in the watershed annually (Etienne, 2014).

Changes to infrastructure, coming largely from the expansion of housing onto land traditionally used for agriculture, has impacted the activity taking place in the Grand River watershed and thus the watershed itself. The exponential increase of urbanization occurring in the region has not only impacted the demand on the water supply, but has created new, complex risks of contamination to it (Jyrkama & Sykes, 2007). The expanding human activity, paired with environmental impacts of a changing climate, pose a degree of uncertainty for the stability of the watershed as recharge rates of the water supply are sensitive to these changes (Jyrkama & Sykes, 2007). However, for many decades, there has been comprehensive and evolving management practices in place in the Grand River watershed. A Grand River Conservation Authority (GRCA) report from 1998 stated that one of their top watershed management issues includes, "Keeping the watershed healthy (economically, socially, and environmentally) while accommodating for

growth." (p. 8). It is evident that a balance between human and environmental priorities has been a pillar of the Grand River watershed management strategies.

The region has a long history of watershed management, with the province of Ontario forming the Grand River Conservation Commission in 1932, the first watershed agency in Canada, to monitor and manage reservoirs in the area (Veale & Cooke, 2017). This merged with the Grand Valley Conservation Authority in 1966, another conservation group conducting management in the region, to form what is now the Grand River Conservation Authority (Veale & Cooke, 2017). This group has served as the leading management organization for the watershed since then, with comprehensive efforts to protect the health of the Grand River watershed in place. The province of Ontario has played a significant role in the watershed's management history, conducting water testing in the region since the 1960's (Francis, 1996). Furthermore, there has been an overwhelming amount of community engagement surrounding watershed health, with over 80 organizations working on environmental monitoring and protection of the Grand River watershed since the 1990's (Francis, 1996). Through an understanding of the characteristics and history that shape the Grand River watershed, an analysis of the current management strategies can be better informed.

Exploration of Management Systems

The way a system is managed will have direct impacts on its ability to be operational. In tandem with this, in order for a system to be sustainable it must have effective management strategies set in place. Certain practices are required to be implemented in order for the system to succeed. Watershed management strategies reflect this; the strategies work to implement practices that protect and improve water quality and other natural resources found within the watershed (Liu, 2016). Integrated water resource approaches should be applied to watershed

management systems. In using the inputs of the economy, environment, and society, a sustainable management strategy can be applied to watershed health. Watershed management strategies should reflect the targets found within SDG 6, and by using an integrated approach this can be achieved. Effective watershed management systems work to identify the variables that can have a negative impact on watershed health. By outlining these variables these systems have the ability to set in place mitigation strategies that can protect the watershed from adverse impacts.

In order to provide lasting solutions, it is important to learn from the mistakes of the past. Looking at past management strategies can provide key insights into how future management strategies can be the most efficient. The Grand River Watershed Authority (GRWA) in 1997 published a document focused on the state of the watershed at the time. Its focus was on how to ensure the continuation of growth for the watershed, with an emphasis on ensuring its health and simultaneously its ability to prosperous. The document predated the Millennium Development Goals (MDGs), but included similar language used by the MDGs and SDGs. The document comes in tandem with SDG 6, target 6.6 “protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes (UNGA, 2015).” The document highlights the importance of protecting aquatic life within the Grand River watershed, it goes on to outline that in doing this the surrounding ecosystem will be able to thrive. It directly equates the protection of life under water to sustainability, a key facet of the SDGs, particularly SDG 14 Life Under Water. While this document predates the MDGs and SDGs it uses similar language making it ahead of its time. Through analyzing population growth and business development the document outlines the socio-economic factors that affect the Grand River Watershed. In doing so it provide a multi-faceted understanding of the watershed and provides the space to bring the

community into contextual conversation surrounding the watershed. The human influence on resources sometimes goes overlooked by water management systems, but the GRWA makes a point of including it within its discourse surrounding the watershed. This document was ahead of its time, it highlighted key variables, used progressive language, and proposed innovative strategies for the Grand River watershed going into the new millennium. It should be used as a guideline for best practices within the realm of watershed management.

The current Grand River watershed plan produced in 2014 takes the sentiments highlighted by the 1997 publication and outlines them in a more nuanced manner. In particular it looks at the socio-economic variables beyond simply population growth and business development, but by the needs of the municipal, industrial and commercial communities (Etienne, 2014). In doing this the plan outlines key gaps within the system and proposes solutions to fill them. It places a focus on sustainable water use, and while SDG 6 is not mentioned throughout the publication, the solutions proposed place a direct focus on facets outlined within the SDG and its targets. Its emphasis on finding the balance between ecosystem health and human health is a key component of an integrated water management approach, the internationally accepted approach to resource management. While the document does not mention the SDGs, it uses the same language and speaks to the impact the SDGs have had on sustainability. By analyzing management systems of the past and present insights can be given into how to create effective water management strategies. Through comparing and contrasting the GRWA document published in 1997, to its most current publication published in 2014, it is clear to see where the GRWA has grown, and where work is still required. The GRWA has maintained the balance between supply and demand, but there is still room for growth. Through

placing an emphasis on using an IWRM approach to maintain the Grand River watershed, the GRWA works in tandem with the targets and goals set out by SDG 6.

Variables Influencing Watershed Health

Any activity that occurs in a watershed will have an effect on the quality of the resource. The case of the Grand River watershed clearly outlines this. Within the past thirty years urban development in the Kitchener-Waterloo region has increased exponentially. This development has changed the environmental makeup of the land, and in turn the watershed. With the region becoming increasingly urbanized, activities such as lawn care, water diversion, and septic maintenance have increased as well, with direct effects on the resources found in the watershed. As mentioned previously, watershed management strategies have begun to realize the importance of including these factors within their planning processes. In including socio-economic and environmental variables within watershed management discourse, effective partnerships can be created. To successfully manage watershed health, these partnerships are essential (Margerum 2004). In past management strategies of the Grand River watershed, the voices of the community were overlooked, by leaving these critical insights out of the discussion valuable information was lost. The Grand River watershed's setting within a rapidly developing region of southeastern Ontario that hosts an intensive agricultural sector means there are substantial environmental variables influencing the health of the watershed. Runoff from farmland is heavy in nitrogen, phosphorus, and soil particulate matter; urbanization is increasing non-point source (NPS) pollution and impacting the flora and fauna biodiversity; climate change poses uncertain risks to groundwater recharge rates. While these are just a few of the risks facing the land and water within the watershed's boundaries, it is critical to understand all the environmental impacts affecting the watershed. This is crucial as a precursor to determining the steps that must be taken

to mitigate these effects. Understanding the environmental variables that influence the health of the watershed is imperative to the development of future management plans and other water-related projects to address the needs of ecosystem and the many people who rely on the Grand River for clean water. This section will analyze the influences of the agricultural sector, urban development, and climate change on the health of the Grand River watershed, and explore the impacts on the environment and aquatic life within it. This section will highlight certain socio-economic and environmental variables that have come to influence the Grand River watershed. It will analyze the influences of urbanization, the agricultural sector, and climate change on the health on the health of the Grand River watershed. It will use these variables to outline a variety of factors at play within a watershed, demonstrating the need for a multi-faceted water management system.

Urbanization

As the municipalities within the Grand River watershed expand, the influence of urbanization on the health of the watershed becomes apparent. Homes and farms have been built within the watershed, and as a result community members (homeowners, farmers) have the ability to identify the activities that have negatively affected their resources. With the rise of urban development, farmers who were once the sole proprietors of their land have seen a change in the quality of their natural resources. The increase of development has led to land that was once arable to become a sterile entity. The agricultural mid-west in the United States provides insights into this. As a result of urban development farmers in Iowa were unable to grow crops like they used to because of the chemicals that have infiltrated their land sources, in turn negatively affecting the watershed (Ryan, 2003). If these farmers did not speak out in attempt to stop this from continuing, watershed managers would not have been able to include mitigation

mechanisms within their planning processes. Farmers spoke out against what was occurring and in turn better management practices were able to be set in place. The voices of community members need to be included to properly understand the socio-economic impacts on a watershed.

Within urbanization there are environmental variables at play as well. Land use changes, urban runoff, and municipal wastewater discharges all impact the quality of the water and the habitability for aquatic species. Converting forested and wetland areas into housing developments, commercial properties, and paved roadways dramatically increases the amount of impervious surfaces within the watershed. As a result, water cannot easily infiltrate into the groundwater system and is funneled through drain systems, increasing the overall amount of runoff entering the watershed and decreasing groundwater recharge rates (Tang et al., 2005). The added surface runoff in rivers and streams can increase the erosion of river banks as more water travels faster through surface water channels (Tang et al., 2005). Additionally, this runoff can carry materials such as road salt, oil, garbage, and lawn fertilizers directly into the water system, which degrade the water quality. According to Tang et al. (2005), "monitoring and modeling studies have shown consistently that urban pollutant loads increase with watershed imperviousness" (p.35). As the Grand River watershed develops on its current trajectory, the percentage of impermeable land within the watershed will no doubt increase as well.

Discharging wastewater from municipal systems provides a pathway for antimicrobials, fecal coliform matter, and nutrients to enter the watershed. In the Grand River watershed, there are 30 wastewater treatment plants serving the area (Couperus et al., 2016), which each release treated wastewater directly into the Grand River and its tributaries. This discharge can carry organic matter, pharmaceuticals such as antibiotics, hormones, and toxic compounds such as ammonia (Tetreault et al., 2012). Despite recent infrastructure development that improved the

quality of effluent (Tetreault et al., 2012), many chemical compounds from human and animals are able to bypass the treatment system and enter the environment, travelling downstream and becoming more concentrated. Exposure to antimicrobials can build resistance to these compounds, and while there needs to be more research into the impacts of this on aquatic life, the constant exposure can harm the growth and reproductive capabilities of the animals and pose threats to water quality as a whole (Couperus et al., 2016). Wastewater discharge can also add high levels of phosphorus and nitrogen (Igbinosa & Okoh, 2009), which can contribute to nutrient loading and eutrophication of the river. Without adequate treatment of wastewater prior to release, chemicals and nutrients enter the watershed, impacting the health of the species that depend on clean water.

Urban runoff and wastewater discharge has been shown to have a direct impact on fish species within the Grand River. According to a study by Tetreault et al. (2012), fish populations downstream of discharge points were found to have “altered gonadal development, impaired capacity to produce sex steroids, and high rates of intersex” (p.457) compared to similar fish not in a degraded habitat. Additionally, the study found distorted species diversity and abundance as a result of the discharge, with reductions in environmentally-sensitive darter species and increases in sucker species, which are more tolerant to poor conditions (Tetreault et al., 2012). Another study, conducted by Gillis et al. (2017), found that mussel populations declined over 60 percent and species abundance was diminished downstream of wastewater discharge points compared to upstream. These examples are only a handful of the species that depend on the Grand River watershed for survival, but the demonstrated changes to their population and dispersal are indicative of greater watershed health challenges.

With the increase of urbanization within the Grand River watershed comes the increase of those dependent on it as a source of drinking water. The Grand River watershed is the source of drinking water in the Kitchener-Waterloo region. It is vital that the watershed is protected from pollution and contaminants in order to ensure the physical wellbeing of those within the region. The number of people living within the region has been rapidly on the rise, and as such the Grand River watershed is being used more frequently and for a variety of different reasons. From commercial to industrial to personal purposes, the watershed is being used to service a diverse set of needs. It is important to note that the exponential population growth seen within the region is occurring within the centre of the watershed. This was noted in both the 1997 State of the Watershed and Water Management plan published by the GRWA. Urbanization is occurring within the core of the watershed, and as such management strategies should be made accordingly.

Agricultural Influences

Agriculture is the dominant use of the Grand River watershed, which requires a significant amount of land, water, and chemical resources. Not only do farmers need sufficient water for crop irrigation and livestock, they may also contribute to “deforestation, eutrophication of water bodies, salinization of soil and depletion of water resources” (Odegard & van der Voet, 2014, p.51), through cropland expansion, heavy fertilizer use, and their chosen tillage practices (Ritter, 2012). According to a 2011 GRCA report titled *Water Use Inventory Report for the Grand River Watershed*, the agricultural sector makes up the third and fifth largest water consumers within the watershed, for irrigation use and livestock watering use respectively (Wong, 2011). While irrigation demands may vary depending on “climate, crop type, soil type and the level of drought tolerance the farmer is willing to risk” (p.30), the amount of crop land

that requires irrigation has been increasing (Wong, 2011). Over time, this has the potential to place excessive strain on the available water resources, especially when coupled with growing municipal water needs and unpredictable precipitation events in the watershed (Wong, 2011).

Chemical fertilizers, rich in nitrogen (N) and phosphorus (P), are relied on to increase crop yield and contain nutrients essential for plant growth. Additionally, manure and animal litter are used in place of fertilizers with comparable results, due to similarly high concentrations of N and P (Rodriguez et al., 2011). However, when applied improperly and in excessive amounts, these nutrients saturate surface runoff into nearby streams and rivers and seep into groundwater storage (Environment and Climate Change Canada, 2019). This occurs when plant utilization rates fall below application rates, resulting in a build-up of untouched nutrients that are readily washed into waterways during irrigation or precipitation events (Rodriguez et al., 2011). According to Jones & Downing (2009), "fertilizer and manure amendments dominate nutrient cycles in agricultural watersheds… which directly impairs water quality" (para.1), increasing the fertility of the adjacent and downstream water resources. Consequently, freshwater plants and algae benefit from the influx of nutrients, absorbing oxygen from the water as they flourish, a process called eutrophication (Water Quality Working Group [WQWG], 2011). When this occurs, the overabundance of plant life takes a substantial amount of oxygen from the water, essentially suffocating the animal aquatic life within the waterway. Phosphorus, nitrogen, and dissolved oxygen content can be measured to gauge the risk of eutrophication within the watershed. However, as the Grand River and its tributaries flow downstream towards Lake Erie, the concentration rises, posing more severe threats downstream. The Province of Ontario sets an indicator target of 0.030 mg Total Phosphorus / Litre (mgP/L) of water for rivers within the province, an objective often exceeded in the Grand River watershed, providing ample reserves

for plant matter (WQWG, 2011). Furthermore, this nutrient loading in the waterways poses risks downstream, as "most of the load, or mass of sediment or nutrients transported by the river is likely transferred to a downstream receiver or end point" (WQWG, 2011, p.2), accumulating by the time it reaches Lake Erie. As the concentration rises, so do the risks of eutrophication and damage to aquatic health.

Another major problem downstream from agricultural land use is soil erosion, causing an influx of suspended sediments that deplete the quality of the adjacent water bodies and leads to silting within riverbeds (Fiener, Govers, & Van Oost, 2008). Sediment pollution is measured using turbidity, or "the cloudiness of the water, which is related to the shape, size and concentration of particles suspended in the water" (GRCA, n.d.-b, para.1). Turbidity is influenced by high flow events, such as heavy rainfall, which wash loose soil away (GRCA, n.d.-b). Inadequate soil conservation practices and the absence of plant buffers enables surface runoff to carry loose soil sediment into the water. As a result, turbid water may be more difficult to filter for use in municipal systems and can negatively impact the habitat quality for aquatic life. In the Grand River system, increased use of environmental best practices by farmers has resulted in improvements to the water quality and health of the fisheries (GRCA, n.d.-e). While geologic factors and seasonal water flow rates can influence the levels of nutrients and sediments in the Grand River watershed, methods of agricultural land use play a role in the health of the watershed.

A Changing Climate

Climate change is expected to alter drought and precipitation patterns across the Grand River watershed region, affecting the watershed's water resources. According to Jyrkama and Sykes (2007), climate change is expected to increase the rate of groundwater recharge in the

basin due to increased precipitation and warmer winter temperatures that allow more infiltration, as a result of a reduced snowpack. This influences the watershed's health by warranting an adequate quantity of water; it is not predicted the region will experience a lack of groundwater. At the same time, higher climate change induced rainfall volume coupled with rapid urbanization can lead to heightened risks of flooding within the Grand River and its tributaries. The added surface runoff will carry chemicals and debris into the water and may pose risks to the integrity of the watershed through increasing erosion and impacting water quality.

Temperatures are expected to increase within the watershed, which will likely increase the temperature of the water as well (GRCA, 2014). Warmer water is not able to hold as much oxygen, and may shift the distribution of aquatic species in the watershed to those more tolerant to temperature and dissolved oxygen changes (GRCA, 2014). While the Grand River watershed is not expected to experience groundwater shortages (Jyrkama & Sykes, 2007), an increase in average summer temperatures could place more strain on the surface water resources through increased evaporation, which may affect municipal water supplies. In acknowledging and working within the socio-economic and environmental variables, the Grand River watershed should be looked to as an effective and sustainable framework for resource protection.

Relation to SDG 6

SDG Target 6.5

Target 6.5 of the SDG's states "By 2030, implement integrated water resource management at all levels, including through transboundary cooperation as appropriate" (UNGA, 2015). Due to its size, the Grand River watershed is subject to a number of governing strategies, management plans, and priorities. This can make transboundary cooperation across municipalities and First Nations territories difficult. The GRCA was established as a central body

to address the issues plaguing the Grand River, forming a municipal partnership that focused on the health of the River from a watershed perspective, a novel idea at the time (GRCA, n.d.-c). The *Water Management Plan* developed by the GRCA in 2014 was the result of a collaborative effort between the GRCA, municipalities, counties, First Nations, and provincial and federal government agencies (GRCA, 2014). The *Plan* seeks to form a 'joint call to action' to ensure proper management of water resources throughout the watershed, outlining guiding principles that should be adhered to when making decisions that could impact the watershed (GRCA, 2014). While voluntary, the partnership developed by the *Plan* meant larger stakeholder engagement across the board, including the public, the agricultural community, environmental organizations, and the wider watershed community (GRCA, 2014). These partnerships across all levels of management are essential to the success of a management plan, and displays evidence of the GRCA's commitment to IWRM.

In 1994, the Grand River and its major tributaries were designated as Canadian Heritage Rivers (GRCA, n.d.-d). As part of the process, the GRCA had to prepare a management document that showed vast public and stakeholder consultation and involvement (GRCA, n.d.-d). Due to the River's role in human heritage, recreational benefits, and natural landscape, the designation provided another opportunity for the IWRM in working with municipalities across the watershed. Without wide scale support from governments, First Nations, environmental groups, and private interest groups, it would be impossible to achieve the management required for formal designation.

The Rural Water Quality Program, administered by the GRCA, is yet another example of successful IWRM. This Program is developed for the agricultural community, in partnership with local municipalities who provide funding for the financial incentives and the GRCA who

oversees the administration (Loeffler, n.d.). Over the course of the Program's history, over one million trees have been planted within the watershed, and 142 of wetland buffers and 190 kilometres of windbreaks have been created (Loeffler, n.d.). The success of this program is attributed to the participation of all stakeholders in the creation and guidance of the management strategies (Loeffler, n.d.), leading to increased trust between participants and more effective practices being used to restore the health of the watershed.

SDG Target 6.6

In cohesion with target 6.5, SDG target 6.6 calls for action declaring, "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes." (UNGA, 2015, p.18). As made evident above, IWRM is weaved into the management tools used in the Grand River watershed and this extends to the water-related ecosystems in the region. One notable component of this is the formation and functioning of the Grand River Fisheries Working Group (GRFWG). This was created after the Grand River achieved heritage status in 1994 and later resulted in the publication of the Grand River Fisheries Management Plan in 1998, which serves as a "blueprint to improve the health of our waterways and restore them as habitat for a wider variety of species." (GRCA, n.d.-d). With the aim of identifying issues and finding solutions within the realm of the watershed's fisheries, the GRFWG continues to meet and pursue the management strategies put forth in the Management Plan, their commitment to SDG 6.6 proven by their efforts for over two decades and being awarded Canada's national Recreational Fishery Award in 2009 (Veale & Cooke, 2017).

Moreover, the GRCA has taken significant action to protect local forests, planting over 30 million trees since its establishment in the 1930s (GRCA, n.d.-d). Similar to the management

plan put forth by the GRFWG, the Grand River Watershed Forest Plan outlines targets and guidelines for preserving and enjoying the expansive forest in the region (GRCA, n.d.-d). With over 80 species at risk residing in the watershed, the GRCA, who leads the majority of management efforts in the watershed, serves as an exemplary case of watershed management that works in tandem with SDG 6, particularly targets 6.5 and 6.6, as its recommendations and action plans are tangible for organizations and general community members alike. Through attention to fighting invasive species, restoring land, planting and protecting trees, and responsible fishing, the Grand River watershed shows notable potential for sustainable watershed management (GRCA, n-d.-d.).

Recommendations for IWRM in the Grand River

Target 6.5 of the SDGs is to implement IWRM at all levels by the year 2030 (UN Water, 2016). This is important to implement in order to ensure the sustainable development of watershed areas as well as sustainable water consumption. IWRM focuses on the harmonization of development and environmental protection by taking a holistic approach to water resource management (UN Water, 2016).

Watershed management systems and authorities in Ontario are currently in the process of implementing Integrated Watershed Management (IWM), which is essentially IWRM at a watershed level (Conservation Ontario, 2010). The GRCA is an example of a watershed authority currently implementing IWM throughout the watershed. There are 36 Watershed Conservation Authorities in Ontario. They are public bodies with water management responsibilities. The Conservation Authorities Act (1946) grants broad powers to the authorities including the ability to make regulations restricting and regulating the use of water in or from water bodies within their jurisdiction. This is all subject to the approval of the provincial

Minister (Remedios, 2015). The broad powers of the Ontario Conservation Authorities allow them to respond to natural resource management needs and challenges, even as they evolve and intensify. The needs and challenges of watershed management will continue to change over time, so it is important that their powers should remain broad to continue to facilitate adaptation. (Conservation Halton, n.d.)

The province of Ontario is a Canadian leader in terms of watershed management the efforts of the conservation authorities have been noted internationally for their IWM practices (blue print). In spite of the progress and recognition, there are still several issues and barriers that the conservation authorities face in the implementation of IWM (Conservation Ontario, 2010).

The first barrier to IWM are the fragmented policies and legal systems in place. Water management in Ontario relies on multiple statutes (Remedios, 2015). This is a barrier to IWRM because the numerous regulations can make the legal framework complex and difficult to navigate. In many cases, it is unclear as to how some of the policies and regulations relate to each other. It also causes strain on staff capacity because of the operational and administrative challenges that this complex system poses. Employees have difficulty with knowing and understanding all the different legal statutes and knowing their relevance within watershed management (Remedios, 2015).

It is common within the conservation authorities that staff resources are stretched thin, which limits the ability of the authorities to carry out multiple projects (Conservation Ontario, 2010). Conservation Authorities also have a high employee turnover rate, meaning that staff members typically do not stay within the organizations for long. This poses a problem because it limits the capacity in which the authorities can effectively get their work done. Resources and time are inefficiently used on training incoming staff (Conservation Ontario, 2010).

There is a gap in scientific studies, data collection and the dissemination of information within many watersheds. Even in watersheds where there is a strong presence of scientific and research (like the Grand River), there are still issues with providing adequate public access to the research and findings of the studies as well as the application of the findings to management plans (Conservation Ontario, 2010). The social and political sciences must also be studied further so that management systems and conservation authorities can continue to gain knowledge and adapt to new landscapes (Medema, Mcintosh & Jeffery, 2014).

Another key barrier to IWM implementation is the significant cost of undertaking the implementation actions, developed through watershed plans (Conservation Ontario, 2010). Conservation authorities are currently funded through the levies they impose as well as contracts and individual project funding (Conservation Ontario, 2010). These sources are not always guaranteed and they are not stable. This make makes it difficult for the conservation authorities to plan in the long term and has a negative effect on the staff capacity as well as the overall productivity of the authorities (Conservation Ontario, 2010).

The GRCA can overcome some of these barriers to IWM through an increase in cross sector partnerships and collaborative management. Partnerships are already a key component in IWM theory but they are not being leveraged to full potential (GWP-TAC, 2000). The conservation authorities have partnered and collaborated with a variety of ministries of the provincial government but in order to more effectively implement IWM they must aim to have as many partners as possible and in multiple sectors. Increasing cross sector partnerships can be very beneficial to the conservation authorities in areas such as financial management, strategic planning, external communication, board leadership, mission orientation, and staff management capacities (Shumate, Fu & Cooper, 2018).

Partnerships across all levels of government can help the conservation authorities navigate the complex policy and legal frameworks that are currently in place (Le Pennec & Raufflet 2016). Increasing the number of cross sector partnerships can help the GRCA make gains in organizational capacity. Cross sector partnerships create the opportunity for knowledge and resource sharing that can benefit all those parties involved. (Le Pennec & Raufflet, 2016). Partnerships with research institutions such as universities (like the University of Waterloo) can be beneficial in terms of making data easily available and understandable to the public as well as finding more effective and interesting ways to disseminate knowledge (Environment Canada, 2010). These types of partnerships create a win win opportunity for the all partners involved (Clarke & Crane, 2018). Cross sector partnerships also create an opportunity for additional funding and financial resources (Shumat et al., 2018). Depending on the nature of the partnership and the interests of the parties, this could be advantageous to the GRCA. Many local businesses are consciously seeking to involve themselves in local initiatives (Clarke & Crane, 2018), which is something the GRCA could and should leverage. Through an increase in cross sector partnerships, the GRCA can gain the resources that they need in order to effectively implement IWM within the watershed boundaries.

Conclusion

The GRCA and the watershed management systems in place are working to maintain the biophysical health of the watershed in tandem with the increasing socioeconomic development of the region. The expansion of agricultural practices within the region, the increased urbanization, and the exogenous factor of climate change all have had influences on the overall health of the Grand River watershed. Through utilizing an integrated water resource management approach, the Grand River watershed can be looked to as a framework for best practices. Joint efforts

between the GRCA, First Nations groups, all levels of government, environmental organizations, and the local community have proven to be successful at restoring and managing the watershed and its water-related ecosystems. Using the SDG targets to implement watershed management systems provides effective and sustainable frameworks for protecting and restoring water-related ecosystems within the Grand River watershed.

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