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Summary of Proposal

The summary of your proposal should indicate the challenges or issues to be addressed; the overall goal and objectives of the proposed partnership; and the breadth of the partnership, and the meaningful engagement of the partners involved.

Canada's highly fragmented governance system has been unable to adequately address the myriad of challenges affecting its water resources, including climate change, a highly urbanized population and increasing pollution. A transition is needed to innovative partnerships between public, private and civil society stakeholders to ensure sustainable water resources management. Effective collaborative governance relies on sufficient social learning - a form of deep learning that involves diversity, dissonance, social cohesion and reflexivity in addressing sustainability challenges - to take place, so that stakeholders can increase their understanding of the system and develop transformative strategies for water planning and management.

Several conditions are needed for effective social learning, including vertical and horizontal communication of ideas and knowledge, an enabling and democratic environment, and informal and open discourse. Serious games involve simulations of real-world events and processes, and challenge players to solve contemporary societal problems; they therefore have a purpose beyond entertainment. They offer a largely untapped potential to support social learning by facilitating access to information, enhancing stakeholder involvement, empowering the public to participate in decision making, and providing opportunities to test and analyze the outcomes of management solutions. Little is known about how serious games can be used in the context of collaborative water governance to maximize the potential for social learning.

Our principal research question is whether game-play by stakeholders in the context of water governance enhances their social learning and collaboration. The objectives are to determine, in the context of governance of complex transboundary water systems, 1. how effective existing serious games could be at supporting social learning and 2. how effective existing serious games could be at supporting consensus building and collaboration; and 3. ways that serious games can be developed in the future to maximise the potential benefits. Our focus will be on the Great Lakes-St Lawrence basin due to its complex governance issues.

Serious games will be played by stakeholders in various configurations. Social learning will be assessed through pre- and post-game questionnaires, self-reporting of knowledge acquisition and follow-up interviews to assess long-term knowledge retention. Impacts on collaboration will be assessed using social network analysis.

Our multi-disciplinary partnership includes all required skills and expertise relating to water governance, sustainability, hydrological and ecosystem modeling, social learning, serious games, and their use as interactive learning tools. This project provides a unique opportunity for student training in the rapidly developing field of serious games for collaborative water governance with supervision from experts in a variety of fields, linking research and practice.

Results will be disseminated using open-access methods including an interactive website, academic papers, conferences, a toolkit for practitioners, a policy brief, webinars, and material for training programs for water practitioners. Findings will be incorporated into game instructions to enhance social learning, and games will be demonstrated at water practitioner networking events. Outcomes will be used as the basis of a longer-term research partnership to test theory in other watersheds in Canada and elsewhere. Therefore, the long-term outcome of our proposed research and partnership is a significant contribution to the understanding of how serious games for social learning and collaboration can be used to better comprehend and address the myriad challenges to sustainable water governance.

Personal information will be stored in the Personal Information Bank for the appropriate program.

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GOAL AND PROJECT DESCRIPTION

1   Introduction

In Canada, a nation rich in lakes, rivers, and wetlands, water plays a crucial role in maintaining healthy communities culturally, environmentally and economically. Water governance in Canada has been fragmented, with responsibility divided between federal, provincial and municipal governments (Bakker and Cook 2011). To ensure that the water governance system in Canada can cope given the challenges it is facing, including increasing pressures on water resources from highly urbanized and agricultural developments, contamination of both surface and groundwater bodies, and climate change, a transition from current management regimes to a coordinated sharing of power and responsibilities, and partnerships between public, private and civil society stakeholders is necessary (Adamowski *et al.* 2013). In this context, social learning, which refers to learning achieved by the social group as a whole (Pahl-Wostl et al. 2007), is increasingly viewed as a key element for sustainable water governance (Medema *et al.* 2013, 2014). Social learning is defined for this research as a form of deep learning that involves an investigation, elaboration, and challenging of different perspectives, which in turn can offer an opportunity for collaborative and synergistic development (Wals and Concoran 2012, Wals et al. 2009). It involves an ongoing reflection on objectives, actions and outcomes, as well as on interactions between different participants and the learning that takes place as a result (Pahl-Wostl et al. 2008).

The Great Lakes-St Lawrence basin is the focus of our proposed project and faces a particularly complex set of governance challenges. Jurisdiction is shared between two countries, several states and provinces, and numerous local governments (Bakker and Cook 2011), which leads to the involvement of a diverse range of stakeholders including the general public, industry, farmers, small business owners, and civil servants and politicians of various levels. The basin's complexity and size challenges attempts to understand its dynamics, while limited interactions and disagreements between stakeholders impede management actions (IJC 2013). Such governance challenges require novel methods of encouraging dialogue, while facilitating learning and enabling systemic institutional change, so that decisions can be made from a position of shared knowledge and understanding.

Advanced information and communication technologies (ICT) offer innovative and promising solutions for enhancing social learning and collaborations to overcome water governance challenges, even more so in a transboundary context (Medema *et al.* 2014). Advanced ICT involve the use of computing and networked infrastructure, which could include the use of Web 2.0 tools (e.g. interactive websites, social sharing services), virtual research environments and <u>serious games</u>. Despite their significant potential, the use of advanced ICT to stimulate social learning and collaboration has not been explored in the water resources field in Canada. Serious games, which are the main focus of this research project, have been successfully used in other sectors (e.g. education, military and health) and are now beginning to change the way water is governed (Chew *et al.* 2012, Mayer 2009). These types of games combine computer simulation with role-play as an integrated method for complex policy making while triggering discussion and learning among stakeholders (Zhou 2014). Serious games involve simulations of real-world events or processes designed for the purpose of solving contemporary societal challenges, and these games are therefore designed for a purpose beyond entertainment.

2   Goal and objectives

The long-term goal of this partnership (beyond the PDG grant) is to study the impact of advanced ICT on social learning and stakeholder collaborations for sustainable water governance in Canada and elsewhere. The specific aim of this proposed research project is **to study the role and value of serious games to enhance social learning and collaboration processes for sustainable water governance**. Serious games are games designed to enhance deep learning about real-world challenges. Research on serious games for any purpose in any field of application is multi-disciplinary by nature (Zhou 2014). In line with our proposed research focus the following objectives have been selected to focus the study: **1.** To determine **how effective** existing serious games could be at supporting **social learning** in the context of governance of complex transboundary water systems; **2.** To determine **how**

effective existing serious games could be at supporting **consensus building and collaboration** in the context of governance of complex transboundary water systems; **3.** To consider the ways that serious games (and the process and mechanisms of game-playing) can be developed **in the future** to maximise the potential benefits in the context of governance of complex transboundary water systems.

3   *Theoretical and methodological approaches*

The research will take an empirical, _case study approach_ (Yin 2002) to explore the research agenda outlined above. The Great Lakes-St Lawrence basin has been chosen as the study area due to its complex governance issues; the two specific pilot cases selected are Lake Ontario and Lake Saint-François, a fluvial lake shared by Quebec and Ontario. Attempts to alter management of lake levels in Lake Ontario have been hindered as a result of stakeholder conflicts, as well as a lack of appropriate estimates and compensation for possible damages to housing and infrastructure for riparian communities. Poor water quality of lake Saint-François requires improved policy to ensure that actions of diverse stakeholders are coordinated. Through _in-depth stakeholder analyses_ all relevant stakeholders will be identified and classified according to their role, power, interests, legitimacy and urgency (Elias *et al.* 2004, Inam *et al.* 2014). Two project partners (Signature Games and UNEP-DHI) _bring into the partnership a number of existing serious games for water management_ (e.g. Aqua Republica, Marine Spatial Planning game, Water Game) through which players are tasked with taking decisions to manage a virtual watershed, in a simulation game that lets players see the impact of their actions over time and builds an understanding of the complex interactions of social, environmental and economic factors involved in managing water resources.

A sample of stakeholders will be selected with diverse interests to involve in a number of game-based quasi-experiments (Susskind et al. 2014, Mayer et al. 2013) in the two pilot areas. These experiments will be set up so that six or eight stakeholders are put together at a table, while having three to ten tables playing the same game during a 60-90 minute period. The game-play is followed by a 30-40 minutes discussion of the different results at different tables. At the same time, the game can also be downloaded from the interactive project website by others in the community along with instructions explaining how to play the game and how to discuss the outcomes, as well as online discussion forums and surveys to assess feedback. Experiments will also involve game-play with classes in local schools to assess how stakeholder engagement processes can reach actors not traditionally participating in water management (i.e. youth). Specific research questions and proposed methods are provided below:

Objective 1: To determine <u>how effective</u> existing serious games could be <u>at supporting social learning</u> in the context of complex transboundary water systems	
What are the mechanisms by which serious games support social learning?	A comprehensive literature review has already been conducted through which we are assessing existing serious games in terms of design principles, modes of play, and their potential impact on social learning. In-depth interviews following game-playing will assess stakeholder perceptions of both positive and negative outcomes realised and the process by which this occurred. This process will _build on work conducted by our partner at the University of Waterloo (i.e., the IMMERSe project on digital games)_, specifically how games can best be designed to support learning.
What do different stakeholders need to learn to carry out their role in water governance more effectively?	Learning goals and outcomes will be identified through semi-structured interviews with a broad range of stakeholders. Stakeholders will be asked both what learning could enhance their own capacity to be effective in their own role, and also what learning could enhance other stakeholders ability to be effective in their roles (i.e. they could highlight those areas where they feel their own perspective is misunderstood by other stakeholders). Expert knowledge (including that of members of our team) will also be considered when identifying desired learning goals and outcomes.
To what extent can these learning goals	Participants knowledge and awareness will be assessed in terms of the desired learning goals and outcomes by participant surveys taken before and after game-

and outcomes be realised through game-playing using existing serious games?	play and self-reporting of knowledge acquisition (Harteveld 2012). In-depth interviews conducted directly following game-playing to ask participants their perception of what they learnt by participating in the game. Secondary interview after six months to establish longer term impacts of game-playing.

Objective 2: To determine <u>how effective</u> existing serious games could be <u>at supporting consensus building and collaboration</u> in the context of governance of complex transboundary water systems

To what extent do existing serious games encourage interaction between players and what is the nature of this interaction?	Interaction between players participating in game-play will be analysed using Interaction Analysis (see Jordon and Henderson 1995) applied to recordings of the games. This inter-disciplinary method allows the investigation of human activities in terms of extent of interaction and nature of interaction (whether the interaction is though talk or non-verbal etc.)
To what extent does playing the existing games increase stakeholders ability to empathise with the perspectives of other stakeholders?	Participants empathy towards the issues faced by other stakeholders will be assessed by participant surveys, using Davis's Interpersonal Reactivity Index (1983), taken before and after game-play. In-depth interviews conducted directly following game-playing will ask participants their perception of what they learnt by participating in the game. Secondary interview after six months to establish longer term impacts of game-playing.
To what extend does playing the existing games increase trust and social cohesion amongst stakeholders?	Participants trust towards other stakeholders will be assessed by participant surveys, using an adapted version of the Organisational Trust Inventory (Cummings and Bromiley 1996), taken before and after game-play. Social Network Analysis (Scott 2000), before and after game-playing, will be used to quantitatively measure of the impact of the games on social cohesion. In-depth interviews conducted directly following game-playing will ask participants their perception of how their trust has been affected by participating in the game. Secondary interview after six months to establish longer term impacts of game-playing.
To what extent does game-play support more effective collaborations across political boundaries?	The effectiveness of the collaboration between stakeholders will be assessed by participant surveys, using a tool such as Borden and Perkins (1999) evaluation tool, taken before and after game-play. In-depth interviews conducted directly following game-playing will ask participants their perception of how they perceive the collaborations effectiveness has been affected by participating in the game. Secondary interview after six months to establish longer term impacts of game-playing.

Objective 3: To consider the <u>ways that serious games</u> (and the process and mechanisms of game-playing) can be developed in the future to <u>maximise the potential benefits</u> in the context of governance of complex transboundary water systems

What are the stakeholders perceptions of the role and value of serious games?	In-depth interviews held before game-playing will ask participants their expectations of the role and value of game-play. In this way possible opportunities for and barriers to the use of serious games will be identified. Following game-play sessions, participants will be asked about their experience including whether they enjoyed game-playing and whether they feel they gained insights that will be useful in the future. A follow-up interview after six months will ask participants if any of the outcomes of the game-play impacted on their attitude to, or actions as part of, their role in water governance.
Is there potential to further develop any of the games tested to increase the impact of the games in terms of the identified required learning outcomes?	Once analysis of existing games has taken place our team intends to identify ways in which the games might be further developed and adapted to be more effective for the context as outlined here.

In the future, how might game-play become an institutionalised and integrated component of water resource management processes?	Consideration will be given to existing water management process and opportunities explored to encourage the acceptance and institutionalisation of game-playing as a valued and integral component of this process.

The final deliverable will be an analysis of the serious games that already exist in the water field and other fields (i.e. serious games toolbox), and findings relating to the impact of game-based approaches to enhance water resources planning and management.

4   *Originality and significance*

Advanced ICT tools offer a largely untapped potential to improve water governance by facilitating the flow of and access to information, thereby enhancing overall transparency, accountability and stakeholder participation (Misuraca *et al.* 2012, Sasaki 2010, Medaglia et al. 2010). Serious games in particular provide new opportunities for multidirectional collaborative processes by: bringing diverse stakeholders to the table; providing more equal access to a virtual negotiation or learning space to develop and share knowledge; integrating different knowledge domains; and providing opportunities to test and analyze the outcomes of novel management solutions (Medema *et al.* 2014, Shirky 2011, Giunchiglia and Robertson 2010, Wals *et al.* 2009). Serious games can provide support in embodying collaborative governance models and processes that enable stakeholders at different levels to form, engage, create, learn and share group knowledge creation (Kyla *et* al. 2013, European Commission 2009). To date, however, **serious games have not been used in the water sector in Canada**.

Outside Canada, serious games developed for the water sector include e.g. Aqua Republica, CauxOperation, Marine Spatial Planning game, the UVA Bay Game and the Climategame (Mayer et al. 2013, Islam and Susskind 2012, Chew *et al.* 2012, 2013, Learmonth *et al.* 2011). The Water Diplomacy Workshop (www.waterdiplomacy.org) provides detailed reports of games used at their workshops. Other examples are events where programmers and practitioners collaborate to develop digital solutions for a specific purpose (www.waterhackathon.org). One such event will be organized for the first time in Canada in 2015 (www.aquahacking.com), and the ROBVQ is partnered with this project. More research is required to explore the role and value of game-play to enhance social learning and collaboration processes in the context of complex water governance issues, and assess the impact of serious games on such processes (Souchere *et al.* 2010, Mayer 2009). Our multidisciplinary partnership will study these impacts while connecting experts, scholars and practitioners from academic, private and not-for-profit institutions in and outside Canada and bringing the **range of expertise required for this project**.

5   *Significance for Partners*

We propose a unique **multidisciplinary research partnership** linking academic and non-academic partners in order to co-create research knowledge with existing government and grassroots level organizations and networks so that findings can be incorporated into these organizations' work. Our partners consist of: (1) Brace Centre for Water Resources Management at McGill University (Canada); (2) the Education and Competence Studies Group at Wageningen University (The Netherlands); (3) Signature Games (the Netherlands); (4) the Games Institute at the University of Waterloo (Canada); (5) the UNEP-DHI Center for Water and Environment (Denmark); and (6) DHI Water & Environment (Canada). The diverse range of disciplines these partners bring ensures that the **required expertise in water governance (McGill), hydrological and ecosystem modeling (DHI Water & Environment), social learning (Wageningen University), serious games (Signature Games, UNEP-DHI), and their use as interactive learning tools (University of Waterloo) is represented**. The combination of academic partners and collaborators, the private sector, non-profit organizations, and independent experts allows theoretical concepts to inform and test games that are developed for use in the practitioners' work towards sustainable water governance.

This research project **will have relevance to all partners and collaborators.** The project is the next step in the applicant's ongoing research into how advanced ICT tools can support social learning (Medema *et al.* 2014) and it expands and builds on the applicant's current SSHRC Standard Research-

funded work that focuses on studying social learning and stakeholder collaboration processes and capacities in several Quebec watersheds in partnership with the Regroupement des organismes de bassins versants du Québec (ROBVQ). The research will strengthen ties between the Brace Centre at McGill and water practitioners in Quebec and the Great Lakes region (ROBVQ, NANBO) through co-development of theoretical and empirical knowledge to address real-world challenges to sustainable water governance. The project is in line with research pursued by the partners in Wageningen University and Signature Games on the study of virtual learning arrangements between different societal actors to address sustainability challenges, and the understanding, development and assessment of the competencies that emerge. The project will also inform a new course that is being developed at Wageningen University on Science Communication and Learning in the Digital Age. The University of Waterloo will similarly benefit from expanding research on players' experiences of serious games conducted under the SSHRC-funded IMMERSe project to a new field (i.e., water) for which very little knowledge currently exists. UNEP-DHI and Signature Games will benefit from the opportunity to test, study and refine their existing serious games for sustainable water governance.

6 Project duration and proposed timeline (2 years)

We will commence with an in-person kick-off meeting. Two workshops and a public/stakeholder meeting will be held in each of the study areas spread over the two-year project timeframe. Before each of the workshops and meetings, the research team will meet to discuss and evaluate progress, conduct research, develop connections between themes, and strengthen partner relationships.

Activities/ Deliverables	Year 1				Year 2			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Group meetings	▓		▓		▓		▓	
Research workshops and meetings	▓		▓		▓		▓	
Scholarly and non-academic publications			▓				▓	▓
Conferences				▓		▓		▓
Objective 1: Social learning	▓	▓	▓	▓	▓	▓	▓	▓
Objective 2: Stakeholder collaboration	▓	▓	▓	▓	▓	▓	▓	▓
Objective 3: Serious games	▓	▓	▓	▓	▓	▓	▓	▓

7 Knowledge Mobilization

Ideas, knowledge, project progress, results and findings will be disseminated primarily through an interactive project website including partner-generated content, such as: blogs, microblogs (i.e. Twitter), social sharing services (e.g. YouTube, Flickr, StumbleUpon, Last.fm), discussion forums, collaborative editing tools (e.g. wikis), serious games (e.g. AquaRepublica version), and social media (e.g. Facebook, MySpace). Appropriate ICT (e.g. through a Moodle page that is in development by the ROBVQ) will be implemented to promote the output of our research project and interact with basin organizations over the course of the project and beyond. A web conference will be organized in collaboration with NANBO (one of the collaborators) to provide ideas for basin organizations focusing on the use of advanced ICT to support social learning and collaborations for sustainable water governance. Research results will also be presented through scholarly articles, conference presentations, and public-policy projects (e.g. stakeholder and decision-maker meetings).

8 Proposed Progress Indicators

(1) Analysis of serious games completed; (2) games tested in workshops with pre- and post-game questionnaires and interviews conducted and analyzed; (3) follow-up interviews and questionnaires completed and analyzed; (4) four partnership meetings held; (5) scholarly articles/conference papers submitted to peer-reviewed journals and presented at conferences; (6) practitioner-oriented materials developed; and (7) feedback elicited from practitioners on the value and impact of serious games for addressing local water governance issues.

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Expected Outcomes Summary

Describe the potential benefits/outcomes (e.g., evolution, effects, potential learning, implications) that could emerge from the proposed research and/or other partnership activities.

This project incorporates a unique multi-disciplinary partnership between academic, non-profit and private organizations to explore the use of advanced information and communication technologies (ICT), particularly serious games, for enhancing social learning and collaboration in complex water governance settings.

The research conducted during the proposed project will benefit a range of sectors, including researchers in water governance, social learning and serious games; the private sector modelers and developers of serious games; practitioners and decision makers in water resources planning, management and policy; and the wider public, including boaters, birdwatchers, anglers and others with interest in water and the environment. The project will contribute to academic knowledge on how social learning and collaboration can be enhanced using serious games, and the added value of serious games compared to other more traditional methods. Theories related to serious games and social learning/collaboration will be tested in a specific context.

Our partnership catalyzes different strengths of the participating organizations and brings together significant multidisciplinary expertise. With our proposed partnership, we intend to develop interactions and synergies between existing, ongoing and future research and practice, including other SSHRC-funded research on water management and digital games. Our team of practitioners and researchers will co-create research findings, which will facilitate knowledge exchange and embed non-academic partner perspectives. These findings will be disseminated to the academic community, serious game developers and decision makers/water managers both in and outside the study areas. Dissemination methods will include an interactive website, academic articles, conference presentations, a policy brief, and webinars. The findings will be incorporated into instructions for the games developed by partner institutions to enhance social learning, and games will be demonstrated at water practitioner networking events. The games will also be used in training programs and at water practitioner networking events.

The knowledge generated by the project will support practitioners in enhancing social learning and collaboration to support the transition to more collaborative decision making for water governance. Practitioners, stakeholders and the public will also directly benefit from the process of conducting the research, as the games will be tested in real-world water governance contexts. Decision makers and stakeholders in the pilot areas will benefit from a greater understanding of the water governance issues in each area and from an innovative means of addressing such issues. The project will therefore contribute to public policy both in the pilot areas and at provincial/national levels. Testing games in contexts with long-standing water governance issues will benefit the private developers of such games by providing an opportunity for evaluation and refinement.

This collaborative and multi-disciplinary research project focuses on real-world water governance issues and provides a unique opportunity for student training. Student researchers in the project will benefit from being directly involved in a research topic that is unique (water and serious games) with supervision from experts in a variety of fields, while enjoying a rare opportunity to experience how research can contribute to and inform practice in the field of water governance. Active engagement of students will extend participation beyond experts from each of our partner institutions and will support new scholars in the development of their professional skills while at the same time being able to apply this new knowledge into their own research.

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Description of Formal Partnerships

This project proposes a unique collaborative and multidisciplinary research partnership between: (1) two Canadian universities, namely the Brace Centre for Water Resources Management at McGill University and the Games Institute at the University of Waterloo; (2) one European university, namely the Education and Competence Studies Group at Wageningen University (WU-DMW); (3) one European NGO, namely the UNEP-DHI Center for Water and Environment in Denmark; (4) one European private industry partner, namely Signature Games in the Netherlands and (5) another private industry partner, namely DHI Water & Environment in Canada. Several collaborators will also participate in the project, including the Regroupement des organismes de bassins versants du Québec (ROBVQ), the North American Network of Basin Organizations (NANBO), Chengzi Chew through UNEP-DHI, Patrick Delaney through DHI, Igor Mayer through Signature Games, Larry Susskind through the Consensus Building Institute, Deborah Grantham through Cornell University and two independent consultants, namely Tony Maas and Bill Werrick. Our proposed project provides significant relevance to all partners/collaborators: governments, non-profits, private enterprises, and universities.

Why a Partnership Approach is Appropriate

Achieving sustainable water governance in the face of climate change and uncertainty requires innovative visions and approaches, such as using advanced ICT, including serious games, to support social learning about complex watershed systems and collaboration to develop novel management strategies. A multi-disciplinary partnership approach is necessary for this project; a diversity of expertise, skills, experience and contacts are needed to address issues of water governance in the Great Lakes-St Lawrence basin. The study of the role and value of serious games for social learning and collaboration in the context of sustainable water governance cannot be conducted by any one participant alone. Hence, by forming our partnership, we will be able to catalyze different strengths of our partner organizations and bring together significant expertise, which will be combined to build on McGill's research on social learning and collaboration for sustainable water governance.

Through our unique partnership and proposed research, already existing poles of research and expertise will be integrated to establish a comprehensive partnership. Although each partner is responsible primarily for leading and/or contributes to specific objectives (as highlighted below), it should also be noted that there will be a direct contribution to all three of the research objectives through participation in the partnership meetings, workshops and other research activities:

McGill University (Canada) will oversee the project through the applicant Prof Adamowski - the Associate Director of the Brace Centre for Water Resources Management, and will be responsible for the intellectual direction and administration, including activity reporting. The proposed research expands on Adamowski and Medema's SSHRC-funded research (conducted through the Brace Centre) on adaptive management of water resources in Quebec by studying the role and value of serious games to contribute to social learning and collaboration processes. The research will strengthen ties between the Centre and water practitioners in Quebec and the Great Lakes region through co-developing projects that contribute to academic knowledge on the use of serious games in the water sector and allowing practitioners to use the platforms to address long-standing issues related to water governance challenges. McGill will provide expertise in the areas of integrated and adaptive water resources governance, and will be leading research objective 2 on stakeholder collaborations, while contributing to research objective 1 on social learning. McGill will coordinate activities between partners, support each leader, organize four group meetings and support the dissemination of the results and findings of our proposed research.

University of Waterloo (Canada), through the Games Institute, will provide expertise on the design and development of digital and serious games, and this project provides an opportunity to apply the findings of the SSHRC-funded IMMERSe partnership project on digital games to a new sector. Waterloo will be the leader for research objective 3 on assessing serious games. Waterloo will contribute to the first group meeting in Montreal with McGill that will focus on establishing formal collaborations

and identifying the digital games identified and assessed through the IMMERSe project that may be relevant to our proposed research. The proposed partnership will inform and benefit the IMMERSe project through the opportunity to expand research on players' experiences with serious games to a new sector (i.e. water resources) that has not been studied in any detail to date.

Wageningen University (Netherlands), through the Education and Competence Studies Group, will bring expertise in learning arrangements between different societal actors focusing on a common sustainability challenge, and the understanding, development and assessment of the sustainability capacities/competences that emerge. To capitalize on Wageningen's expertise in social learning, they will be the leader for research objective 1 on social learning while overseeing project activities under this objective. Wageningen will also provide ongoing feedback on and support the dissemination of results and findings of our proposed research. This project will inform a new program that is being developed at Wageningen University on 'Science Communication and Learning in the Digital Age'.

Signature Games (Netherlands), this NGO will provide expertise on public policy, particularly collaborative/interactive/participative policy and decision-making, and on the use of multi-player serious games to address policy issues related to sustainability. For example, they have designed and facilitated simulation games for the Port of Rotterdam and the Netherlands Institute for Spatial Research. Hence, this group will contribute particularly to research theme 3 on assessing serious games, and they will also play a key role in facilitating game-play sessions during the stakeholder workshops in the study areas.

DHI Group (Denmark and Canada), through the UNEP-DHI Center for Water and Environment and DHI's local office in Canada, has experience in developing serious games for the water sector elsewhere that can be applied to the Canadian context. The group will benefit from the proposed project through the opportunity to test and refine their existing games designed to promote sustainable water management in Canada.
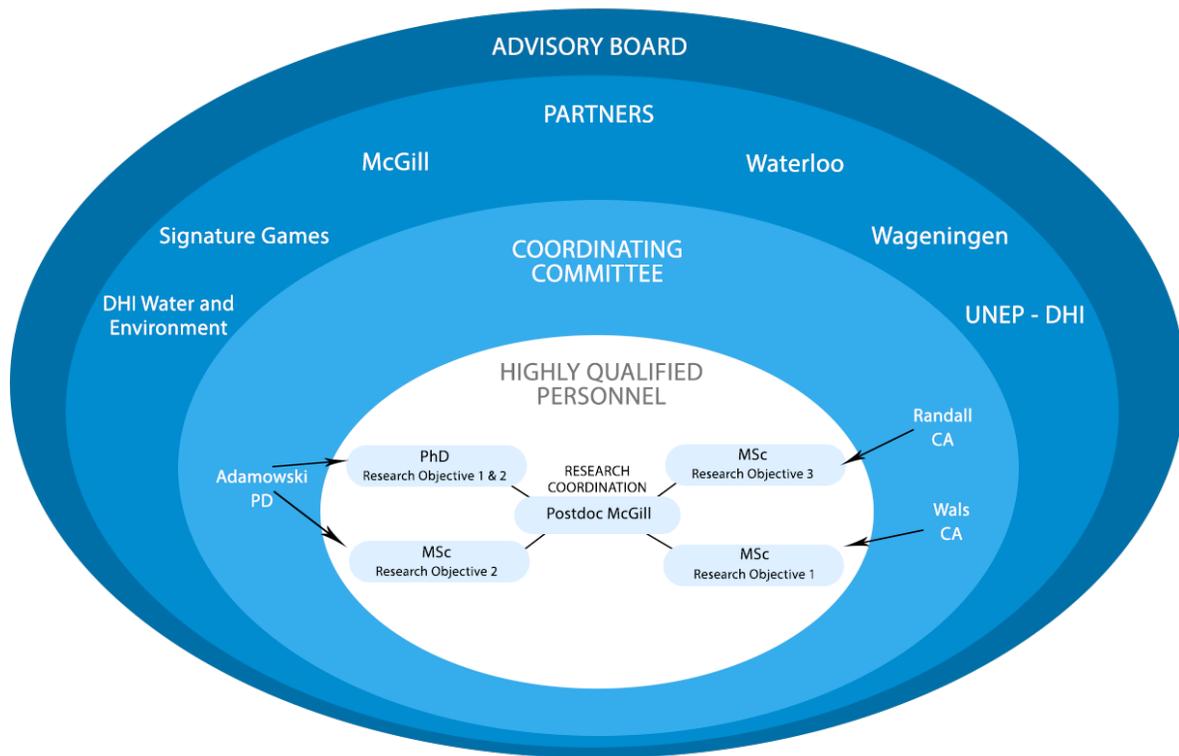
Governance Structure of Partnership

Many of the co-applicants have already collaborated in informal and formal partnerships. For example, Prof. Jan Adamowski at McGill and one of his Post-Doctoral Fellows, Dr. Wietske Medema, are working closely with Prof. Arjen Wals from Wageningen University on the subject of social learning and multi-stakeholder collaborations for sustainable water governance. One paper has been published, one paper submitted and a third in preparation by the three authors. Similarly, two of our collaborators, Chengzi Chew and Patrick Delaney, have also worked together before on developing the AquaRepublica serious game to promote sustainable water resources management. Chengzi is a member of the not-for-profit UNEP-DHI Center for Water and Environment hosted by a private consultancy (the DHI Group), of which Patrick Delaney is the president of the Canadian office. Both Wageningen and MIT in the United States (of which the Consensus Building Institute is a part) have several formal partnerships. For example, these universities proposed and are establishing the Amsterdam Institute for Advanced Metropolitan Solutions, which is planned to be a leading institute in applied urban technology.

Prof. Adamowski and Dr. Medema at McGill have also worked closely with several of the collaborators. They are conducting a research project with the ROBVQ and NANBO on adaptive management of water resources in Quebec, and both have been involved in stakeholder engagement research projects with many watershed organizations that form part of the ROBVQ. Similarly, Tony Maas and the member organizations of ROBVQ have hosted students of McGill's Integrated Water Resources Management (IWRM) MSc program, of which Prof. Adamowski is Director, as interns.

Our shared objectives, our excitement to collaborate on this proposed research and our willingness to listen and communicate with each other, will contribute to the success of our proposed partnership. The key to our success will be regular communication and interaction, openness to different viewpoints, willingness to compromise and our desire to achieve the proposed outcomes, which closely align to the organizational objectives of each partner.

Below schematic diagram visualizes our governance model:

ADVISORY BOARD

PARTNERS

McGill Waterloo

Signature Games Wageningen

COORDINATING COMMITTEE

DHI Water and Environment UNEP - DHI

HIGHLY QUALIFIED PERSONNEL

Randall CA

PhD
Research Objective 1 & 2

Adamowski PD

RESEARCH COORDINATION

MSc
Research Objective 3

Postdoc McGill

Wals CA

MSc
Research Objective 2

MSc
Research Objective 1

We will establish a project *Coordinating Committee*, which will be led by Prof. Adamowski at McGill (as the PD or Project Director), who will be supported in his role as the Applicant by one of his Post-Doctoral Fellows, Dr. Medema (who has extensive experience in social learning, multi-stakeholder collaboration processes, institutional development and capacity building in the context of sustainable water governance). The role of the Coordinating Committee will be to establish and facilitate ongoing communication/collaboration (through e.g. an interactive website, partnership meetings, and weekly video-conferencing calls); plan, coordinate and oversee research activities and reporting; and disseminate findings and results. Although the Coordinating Committee is responsible for the above-mentioned tasks, there will be regular and open communication with all other partners and collaborators to make sure their views, comments and suggestions are heard, respected and included. In other words, decisions will be made on a consensual basis.

The Coordinating Committee will include all Co-Applicants (CA) that will supervise students participating in this project, and who are therefore instrumental for the intellectual direction of the research and for student training and mentoring. The students, collectively are at the core of our project, and will conduct research projects, participate in group meetings, and disseminate results.

Our four group meetings, including workshops and working groups, will be held in the study areas and will be organized by McGill – first group meeting in July 2015, second group meeting in February 2016, third group meeting in October 2016 and fourth group meeting in April 2017 – who will be supported in the planning and organization by the Coordinating Committee. The meetings will include stakeholder workshops and working group meetings, as well as cross-objective research sessions to develop the links between objectives and allow the findings of each to inform the others. The meetings will also focus on ensuring that the research being conducted for each objective is aligned with and contributes to the project's overall goal. Each meeting will also include one or two stakeholder workshops through which stakeholders are involved in research by testing serious games.

Our high-level *Advisory Board* consists of all collaborators – Chengzi Chew (UNEP-DHI), Patrick Delaney (DHI), Igor Mayer (Signature Games), Larry Susskind (Consensus Building Institute), Deborah Grantham (Cornell), Bill Werick, Antoine Verville (ROBVQ), Marie-Ève Buist (NANBO) and Tony Maas (founding member of FLOW) – who have substantial knowledge and experience of the research

areas related to this proposed project, and of the specific water governance challenges in the selected study areas. They will be able to provide both input and guidance to the project but also some may also act as independent 'arbitrators of last resort' in the unlikely event of intra-partner conflict. Participating researchers and students will be able to contact members of the Advisory Board with any questions that arise from our collaboration on this project.

Partners' Participation in Intellectual Leadership

The project Coordinating Committee and the Advisory Board will set broad strategies for the program, both intellectually and practically. Day-to-day intellectual leadership of the partnership will come principally from the PI, Prof. Jan Adamowski at McGill, supported by his Post-Doctoral Fellow, Dr. Wietske Medema. However, all other partners and collaborators, especially those that are members of the Coordinating Committee, will also provide intellectual input. Leaders of the three research objectives (McGill, Waterloo and Wageningen) will take responsibility for the leadership of the research conducted therein and will supervise the students working on these research objectives. All members of the Coordinating Committee will also take the leading responsibility for developing dissemination materials, including scholarly articles, conference papers, a toolkit for practitioners, presentations in webinars, policy briefs, and updates on social media.

Anticipated Challenges

A distinct challenge in building this partnership will be the physical distance of our partner institutions that are spread out across two continents (North America and Europe). We will overcome this challenge through regular, structured communication and collaboration, including through (a) direct and face-to-face interaction through our group meetings (including workshops and working groups) that take place with 8 month intervals, with the first one starting at the very beginning of the project; (b) ongoing interaction and collaboration through our interactive website to share new knowledge and create a repository for our partnership's knowledge bases; and (c) progress updates and feedback on specific research activities through weekly video-conferencing calls between working group members as well as members of the Coordinating Committee, with other partners and/or collaborators.

Partner Benefit from Participation

All partners will benefit from participation in this project, since it will be the first collaboration between a unique group of universities, not-for-profits and private organizations that will work together on exploring the role and value of serious games to enhance social learning and collaboration for sustainable water governance, thus promoting synergies between existing research projects and promoting longer-term collaboration. Our proposed research partnership will help to generate a dynamic research environment around the use of serious games in the water sector within each of the academic institutions. Our non-academic partners will benefit from enhanced knowledge of existing serious games and how they can be used to address diverse water governance challenges. Our proposed partnership will lead to excellent cross-fertilization of expertise on serious games, sustainable water governance, social learning and public policy, particularly in the Canadian context. All partners will benefit from this exchange to develop research projects they would not otherwise have had the expertise to carry out, and to use serious games to enhance understanding of water management issues in their own work.

Our proposed partnership brings together significant expertise on the role and value of serious games, water resources management, social learning and public policy from all our partner organizations. The proposed research will enable us to integrate all our existing poles of research and expertise into a comprehensive collaboration. The existence of our proposed partnership will catalyze new collaborations between member researchers, and serve to leverage the creation of joint funding proposals and research projects. Active engagement of new scholars and students will extend participation beyond experts from each of our partner institutions, and support new scholars and students in the development of their skills and understanding, while at the same time being able to apply this new knowledge into their own research and practice.

Types of expertise needed to ensure the success of the partnership

  The study of the role and value of serious games to enhance social learning and collaboration for sustainable water governance requires a range of expertise. Firstly, it requires knowledge of watershed systems, including the hydrological, ecological and social processes within them, methods for managing them, including integrated and adaptive water resources management, and of the governance processes at local, regional and national levels. Secondly, it requires knowledge of the processes of social learning and collaboration, and how they can contribute to sustainable water governance through enhancing understanding of the system and resolving stakeholder conflicts around management issues. Thirdly, it requires understanding of the use of serious games for learning and conflict resolution in other contexts as well as specifically for the water sector. Therefore, a partnership approach is necessary to encompass all such skills and integrate disciplinary and interdisciplinary research to achieve a common goal.

  Below follows a description of each co-applicant and collaborator. Although each co-applicant and collaborator leads and/or contributes primarily to specifically objectives (as highlighted below), it should also be noted these participants will have involvement in all three of the research objectives through their participation in and contributions to the partnership meetings, workshops and other research activities:

Roles, Responsibilities and Contributions of the Project Director

  Project Director Prof. Jan Adamowski (McGill University, academic): Associate Professor, Department of Bioresource Engineering; Director of the Integrated Water Resources Management (IWRM) Program; Associate Director of the Brace Centre for Water Resources Management. Dr Adamowski's expertise lies in hydrological and participatory modelling, and adaptive and integrated water resources management. He will be responsible for overseeing all aspects of the project, including managing finances and directing the Coordinating Committee, and will be supported by Dr. Wietske Medema, Postdoctoral Associate, Associate Director of the IWRM Program. Dr Medema's expertise is in water governance, social learning, institutional development, capacity building and stakeholder participation. Drs Adamowski and Medema are currently collaborating on an SSHRC-funded project to research collaborative adaptive management of water resources in several watersheds in Quebec. Drs Adamowski and Medema will also lead **Research Objectives 2** and contribute to **Research Objective 1** on studying the impact of serious games to support the creation of more effective connections and interactions between actors and stakeholders across different political boundaries.

Roles, Responsibilities and Contributions of the Co-Applicants and Collaborators

Co-applicant Neil Randall (University of Waterloo, academic): Director of the Games, Dr Randall's expertise is centred in games studies, virtual worlds, game design and narratives. He is currently leading an SSHRC-funded partnership project called IMMERSe on players' experience of, immersion in and learning through digital games. He will lead **Research Objective 3** and contribute to **Research Objective 1** focusing on testing and assessing a range of existing serious games for different governance purposes.

Co-applicant Arjen Wals (Wageningen University, academic): Professor of Social Learning and Sustainable Development, UNESCO Chair in the same field and Adjunct Faculty member of the Department of Natural Resources at Cornell University. Prof Wals' expertise is in social learning and sustainable development, and hybrid learning arrangements between different societal actors focusing on common sustainability challenges. He will lead **Research Objective 1** focusing on studying the impact of serious games on enhancing social learning processes in the selected pilot areas.

Details of **collaborators to our partnership** and project are provided below, and **letters of support from each of our collaborators** are included in the Partnership Evidence section of our proposal:

- **Collaborator Deborah Grantham (Atkinson Center for a Sustainable Future at Cornell University):** As a Faculty Fellow, she works closely with educators who are providing education on water resources management across New York State. She is involved in water resources education programs for the communities along the southern shore of Lake Ontario, and thus will provide knowledge of opposition to lake level regulation changes in these communities. Her support will be primarily towards **Research Objectives 1 and 2**, and she will provide guidance as to the stakeholder issues in Lake Ontario and processes of conflict resolution.

- **Collaborator Antoine Verville (ROBVQ, non-profit):** Assistant Managing Director, ROBVQ. His expertise is in regional planning and development, and impacts of climate change on water resources. He will particularly support the delivery of **Research Objective 1 and 2,** and will act as a link to watershed organizations in Quebec.

- **Collaborator Bill Werick (independent):** Senior Planner at US Army Corps of Engineers until retirement. His expertise is in transboundary water management, water conflict resolution and shared vision planning. He will particularly support the delivery of **Research Objective 2**, and will provide guidance as to the stakeholder issues in Lake Ontario and processes of conflict resolution.

- **Collaborator Chengzi Chew (UNEP-DHI, non-profit):** Head of Serious Games, UNEP-DHI. Mr Chew's expertise is in the development of serious games simulating watershed systems, and he coordinated the development of Aqua Republica, an online serious game to promote sustainable water management. He will support Dr Randall with **Research Objective 3**, and will be particularly responsible for facilitating serious game-play focused on addressing specific governance issues.

- **Collaborator Igor Mayer (Signature Games, non-profit):** Associate Professor of Public Management and Gaming in the Faculty of Technology, Policy and Management; Director of the TU-Delft Centre for Serious Gaming; and co-founder of Signature Games. Dr Mayer's expertise is in the application of serious games and virtual worlds to policy sciences, interactive/participative/collaborative policy and decision-making, and policy-oriented learning. He will contribute mostly to **Research Objective 3**, and will facilitate workshops sessions that involve game-play through the use of some existing serious games.

- **Collaborator Larry Susskind (Consensus Building Institute, non-profit):** Founder and chief knowledge officer, teacher, trainer, mediator, and urban planner. He is one of the founders of the field of public dispute mediation having meditated fifty complex disputes in the United States and in other parts of the world. He will particularly support **Research Objective 1 and 2**, and will provide guidance on how to evaluate the extent to which science-based role-play simulations contribute to the readiness and capacity of stakeholders to undertake collaborative efforts.

- **Collaborator Marie-Eve Buist (NANBO, non-profit):** Project Manager, NANBO. She has expertise in water and climate change, particularly in relation to international issues. She will particularly support the delivery of **Research Objective 2**, and will be a link to watershed organizations outside Quebec, such as Ontario's Conservation Authorities.

- **Collaborator Patrick Delaney (DHI, private sector):** Director of DHI Water & Environment, Canada. Mr Delaney's expertise is in hydrological modelling and the development and application of water modelling technology. He will support Dr Randall with **Research Objective 3**.

- **Collaborator Tony Maas (Forum for Leadership on Water (FLOW), non-profit):** Founding member of FLOW and consultant. His expertise is in sustainable water governance and policy in Canada, particularly in relation to collaborative governance processes and the ecosystem considerations for water management. He will particularly support **Research Objectives 1 and 2**, and will provide guidance on development and implementation of regional and national policy, as well as a link to other stakeholder organizations.

TRAINING AND MENTORING

Direct participation of students/new scholars: Requested SSRHC funds for students will be used to support students at both our Canadian and European academic partners (McGill, Waterloo and Wageningen). This will provide partial funding for 4 MSc students (McGill, Waterloo and Wageningen) and 1 PhD student (McGill, supervised by Prof. Adamowski), who will undertake various aspects of the research on a part-time basis, including data gathering, data analysis, interpretation, participation in group meetings, and report writing and dissemination. The students will be supervised by Prof. Adamowski (McGill), Prof. Randall (Waterloo) and Prof. Wals (Wageningen) respectively, and co-supervised by one of the other partner institutions. The requested SSHRC funding will also provide partial funding for one post-doctoral fellow at McGill, Dr. Medema, who will be directly involved in coordinating the research network as well as coordination and synthesis of student involvement and research. Our partners also offer to partially fund student involvement through in-kind contributions. We have links with Mitacs to explore funding opportunities for student internships with our private partners DHI and Signature Games (and possibly other future industry partners).

The research activities of the students will be overseen by our Coordinating Committee, which will **ensure that all the different student research projects are closely linked to the aims of the research objectives** and that work is being conducted on all of these. All the students involved in the research will benefit from being members of the network through: (i) access to the multi-disciplinary expertise of the applicants and collaborators offering international and intersectoral opportunities; (ii) possibilities of internships in partner organizations; (iii) direct participation in research workshops, stakeholder and group meetings; (iv) student exchanges; and (v) our international collaborations. It is expected that one or more internships will be offered with our private partner DHI in Canada for one or more of the students to conduct research with funding provided by MITACS (http://www.mitacs.ca/).

Indirect participation of students/new scholars: All students will participate in McGill University's online certificate in Integrated and Adaptive Water Resources Governance taught by Prof. Adamowski. This will allow them to expand their knowledge of water governance principles and communicate the research outcomes to other international participants on the course. McGill University will also provide two paid research internships (through the Zavalkoff and Casgrain Fellowships) for two of the students, using its own funds (via the IWRM Program directed by Prof. Adamowski).

Capacity of Team Members to Provide the Proposed Training and Mentoring: Each of the professors who will formally supervise students (Adamowski, Wals and Randall) has significant experience in supervising research at the MSc, PhD and postdoctoral level. They will oversee the day-to-day research and supervise the preparation of papers and theses, according to good practice in student supervision, including regular meetings and timely feedback on work. In most cases, the MSc and PhD students are already working with these supervisors; new students will be carefully recruited if needed.

Skills Acquired: Under the supervision of faculty, students will be responsible for the design, execution and analysis of research projects, and will also be responsible for the writing of scientific manuscripts and the dissemination of results at conferences. The students will learn and develop state-of-the-art theory about the use of serious games to promote social learning and collaboration in water governance contexts, a unique research topic that has not been studied in Canada. They will understand methods for measuring social learning outcomes, and gain skills in presentations, workshop facilitation, stakeholder engagement practices, and collaborative research. Lastly, they will gain experience in modelling and game design, particularly through internships with our private sector partners DHI and Signature Games. By acquiring such a unique combination of knowledge and skills, students trained as part of this project will be competent to work in academia (e.g. in social learning, water governance and serious games), private companies (e.g. game designers), and for government and non-government agencies, and watershed management organizations in roles such as stakeholder engagement. It is envisaged that such students will have a significant impact on research and practice in water governance, serious games, social learning, stakeholder collaboration and public policy.

Knowledge Mobilization Plan

The research group includes water managers in non-governmental organizations (ROBVQ, NANBO, UNEP-DHI, Consensus Building Institute), private sector modellers and game developers (DHI and Signature Games), and universities (McGill University, University of Waterloo, Cornell University and Wageningen University) as partners and collaborators. Each brings their network of water researchers, managers and decision-makers, allowing knowledge to be disseminated easily. Stakeholders in the study areas will also contribute to the research, including shoreline residents, watershed organizations and recreation groups. An interactive website will be developed to coordinate research activities and disseminate results, and will include an online repository that can be publicly accessed. We will focus on dissemination of the research outcomes – whether game-play by stakeholders in a context of complex water policy making has the potential to enhance their social learning and collaboration – and of the research methodology, in terms of how impact of game-play on social learning and stakeholder collaboration was assessed. The key target groups for knowledge mobilization will be 1) the academic community in the fields of water governance and management, social learning, and serious games; 2) decision makers and water managers in the study areas; 3) decision makers and water managers outside the study area and at higher levels; and 4) serious games developers, particularly those specializing in games for environmental or natural resource management.

Academic community

Publication of the research results in peer-reviewed journals and presentations at conferences will contribute to debates on the impact of serious games, how stakeholder engagement processes can reach actors that do not traditionally participate in water management (such as youth), and stakeholder collaboration across political boundaries in water management.

- Four to six papers in peer-reviewed journals in the water management, social learning, and serious games fields, namely the Canadian Water Resources Journal, Ecology and Society, Simulation and Gaming, Game Studies, and the Journal of Education for Sustainable Development. Papers will be promoted on social media (Twitter, organizations' blogs, email bulletins).
- Presentations at three conferences, such as the Canadian Water Resources Association Annual General Meeting, American Geophysical Union meetings, Serious Games and Social Connect Conference, and the DevLearn Conference.
- Four group meetings to share other ongoing research from each partner institution.

Decision makers and water managers in the two study areas

Policy and decision makers with responsibility for water issues within the study areas will be a key target to ensure that increases in social learning and collaboration are maintained, and that practitioners can reach groups that do not usually participate, such as youth. Key actors in the study areas include the International Joint Commission (IJC), shoreline residents associations, and environmental NGOs. How stakeholders understand the problem, as well as their social learning and collaboration outcomes, will be the focus for dissemination, as well as how game-play should be integrated into future stakeholder engagement processes. Dissemination methods for this group include:

- Analysis of the existing serious games (i.e. serious games toolbox), and findings relating to the impact of game-based approaches to enhance water resources planning and management. This will be web-based and will include guidance for using serious games to enhance social learning and collaborations, and online versions of the games. As the language difference is a key barrier to coordination between stakeholders in the Great Lakes-St Lawrence basin, key materials will be available in both French and English.
- Guidance built into the games, which will be available on the web for future use. The 'how to play' section will include a page for water managers that will give the same guidance as in the toolkit. A discussion forum will also be linked to from the game webpage to allow players to discuss their findings (and hence increase social learning) and for practitioners to share their experiences with it.

- A results summary (in English and French) for all study participants, including practitioners, which describes the social learning/collaboration outcomes, which stakeholders participated, and how the benefits can be sustained. This will be a document circulated to all participants.
- One webinar presentation and three presentations during the partner meetings in each study area. These will be conducted by locally based partners and collaborators and will be promoted during research activities, email bulletins and social media.
- Updates and promotion via social media through relevant groups on Facebook and LinkedIn (e.g. the Water Resources Professionals LinkedIn group), partners' Facebook and Twitter, and email bulletins (e.g. The Droplet and the International Institute for Sustainable Development's Water-L).

Decision makers and water managers outside the study areas

The long-term goal of the research is to optimize the design and use of serious games to enhance social learning and collaborations for sustainable water governance in Canada, so other decision makers and water managers in Canada (outside the study areas) will be targeted. Targeted organizations will be, ROBVQ (the network of Quebec's watershed organizations and a project partner); Conservation Ontario (the network of Ontario's conservation authorities); the North American Network of Basin Organizations (a project partner); local stewardship groups; larger NGOs, such as Living Lakes Canada, WWF, and the Freshwater Alliance; and students of water management. Methods will include:

- A policy brief with advice on how games can enhance their stakeholder engagement and collaboration processes, including listing generic and freely available games and how they should be played. The brief will be distributed by email to contacts in the partners' networks, and links to an online version will be advertised via email bulletins and social media.
- The online games itself will be directly shared by NANBO to other watershed organizations so that those with similar issues can use it and discuss it in the discussion forum.
- Demonstration of the games in future NGO and practicioner networking events, such as Living Waters Rallies (an annual capacity building event for Canada's freshwater changemakers, including practitioners, NGOs and others) organized by the partners and collaborators. Event participants will play the games and be instructed in how and when to use it to maximize social learning and collaboration.
- Incorporation of the games into education and training programs for future water managers. Participants (approx. 30 in each program/year) in McGill's online professional development certificate and Master's degree in integrated water resources management will be required to play the games, assess their own learning, and discuss how it can be incorporated into their own activities.

Serious game developers

Research outcomes will be shared with serious games developers including UNEP-DHI (a project partner), Signature Games (a project partner), and the University of Virginia (UVA Bay Game), so guidance on game-play to maximize social learning and collaboration can be incorporated into the games' instructions. They will be reached via social media, articles in relevant newsletters and blogs (such as the Serious Games Blog) and via the SSHRC-funded IMMERSe project on digital games that is lead by the University of Waterloo (a partner to this proposal).

Evaluation of dissemination methods

The effectiveness of all dissemination methods will be regularly evaluated. Downloads and citations of peer-reviewed articles, as well as visitor numbers to all web-based information (e.g. the game, policy brief, toolkit), will be tracked. Reponses to social media promotion and presentations will be monitored and further promotion will be carried out where necessary. Practitioners in the study areas will complete a web-based follow-up survey to assess whether they are using the games in their stakeholder engagement activities, and how useful they think it is.