



WATERLOO INSTITUTE
for COMPLEXITY & INNOVATION

2016-2020

**PROGRESS &
RENEWAL REPORT**

SENATE GRADUATE AND RESEARCH COUNCIL

FALL 2021

EXECUTIVE SUMMARY

The Waterloo Institute for Complexity and Innovation (WICI) brings unique value to University of Waterloo complex systems researchers, in supporting high-impact research on complex systems through its activities, services and events over the past five years. Over the next five years, WICI will pursue and develop **emerging opportunities** focused on research collaborations, education and training to further synergize complex systems research at the University of Waterloo and across Canada. WICI's key initiatives and research interests maintain strong alignment of key complex systems research directions with the [University of Waterloo's Strategic Plan](#) for addressing global challenges (2020).

In this renewal report, WICI shares the key achievements of the past five years and the plans for its next five years.

- WICI core members' research is supported by a variety of sources, showing its broad relevance across disciplines and research funders. Almost half of successful complex systems-related grants won by WICI core members in the past five years (totaling over **13.2 million** dollars) were from sources other than tri-council funding agencies. Core member Dawn Parker and Associate Director Sharon Kirkpatrick are co-applicants on a successful \$4.95 million dollar grant from CIHR-NSERC-SSHRC for a Healthy Cities Research Training Platform; Waterloo's involvement in this interdisciplinary training opportunity arose directly from WICI activities. Relatedly, WICI's emergent [Canadian Network for Complex Systems](#) will improve interdisciplinary and interinstitutional networking for larger interdisciplinary funding opportunities.
- The [Mapping Canadian Complex Systems Scholarship](#) project, undertaken in 2020, reveals that WICI core members' self-reported complex systems publications represent only 6% of the active complex systems research at the University of Waterloo. The project results suggest that the value of WICI to the university is much larger than measured solely by core member activity and pave the way for continued growth of WICI's [Canadian Network for Complex Systems](#).
- WICI has hosted **5** conferences and/or symposia, **15** workshops and **47** seminars over the past five years, and the recordings continue to reach a broad viewing audience long after. Research networking events are a recently new endeavor that WICI intends to continue.
- **Two thirds** of our collaboration discussions over the past two years arose as a result of researchers contacting WICI based on our web presence, internal referrals or through our network of researchers, indicating WICI has a strong reputation as a hub for complex systems in Canada.
- WICI has grown steadily each year to a current membership of **147** members representing all six faculties, and researchers discovered through the 2020 [Mapping Canadian Complex Systems Scholarship](#) project indicate potential for substantial growth in the immediate future.
- WICI has provided nearly **\$30,000** in travel/conference funds, fellowship awards and smaller prizes for 24 graduate student members over the past five years. WICI plans to improve support for students and faculty members through educational/training workshops, research networking activities, and administrative coordination for larger interdisciplinary grants.

- **Almost a third** of respondents to the [2019 Member Survey](#) suggested WICI should strengthen its activities related to training/education opportunities. A [Proposal for Training Program](#) was developed in 2020, and in 2021 we have begun exploration of a potential [Complexity Professional Development Program](#) (Comeau, 2021), and planned workshops for both the Society of Risk Analysis (December 2021) and the Faculty of Health (Winter 2022).
- WICI's consolidation with the Waterloo Institute for Social Innovation and Resilience (WISIR) will streamline operational efficiency and bring cost savings and added value to the University.

WICI's accomplishments and activities to date have been achieved largely from member-driven support, with visionary WICI leadership, modest administrative staffing, and an annual operating budget of between **\$60-100K** from the Provost. Over the next five years, WICI requires an annual operating budget of at least **\$90K**, including core funding for an administrator, to support the priorities of its membership. While funding commitments from the faculties of Environment, Mathematics, Science, and Engineering have been secured, WICI will continue to explore alternate sources of income and resource-sharing over the next five years.

WICI has received a total of 18 **letters of support** for WICI's renewal from deans ([Appendix A](#)), members and collaborating scholars ([Appendix B](#) and [Appendix C](#)) who attest to the value WICI has brought to their research careers as well as the incredible potential of the Canadian Network for Complex Systems.

We are grateful to the Research Leaders Council and University of Waterloo Senate for taking the time to review this report, and we look forward to advancing Canadian complex systems research for another five years upon WICI's successful renewal as a senate-approved research institute.

Sincerely,



Dr. Vanessa Schweizer

Director, Waterloo Institute for Complexity and Innovation
Associate Professor and Associate Chair of Undergraduate Studies, Knowledge Integration



Dr. Dawn Parker

Core Member and Former Director, Waterloo Institute for Complexity and Innovation
Professor, School of Planning



Dr. Sharon Kirkpatrick

Associate Director, Waterloo Institute for Complexity and Innovation
Associate Professor, School of Public Health and Health Systems

TABLE OF CONTENTS

Executive Summary	2
Introduction: The Value of WICI	8
1. The Waterloo Institute for Complexity and Innovation (WICI) Background	9
1.1 Why Study Complex Systems?	9
1.2 Vision, Mission and Goals	10
1.2.1 Scientific Direction: Grand Challenges	11
1.2.2 Progress Against Strategic Goals 2016-2020	13
1.2.3 Strategic Goals and Objectives 2021-2025	15
2. Overview of Activities and Services	17
3. Research Accomplishments of the Past Five Years	19
3.1 Core Research Projects	20
3.2 Research Funding Success	23
3.3 Scholarly Publications and Outputs	27
3.3.1 WICI Occasional Papers and Briefs	28
3.3.2 Software Tools and Other Resources	28
3.4 Seed and Partnership Grants	29
3.5 WICI Sponsored Events	30
3.5.1 Conferences/Symposia and Workshops	30
3.5.2 WICI Talks/Speaker Series Seminars	31
3.5.3 Research Networking Events	31
3.6 New Collaboration Opportunities	32
3.7 Development of a Canadian Network for Complex Systems	33
4. Membership and Engagement	34
4.1 Categories of Membership	34

4.1.1 Membership By Faculty	35
4.1.2 Application for Membership.....	35
4.2 Current Member List.....	35
4.3 Student Involvement	40
4.3.1 Current Student Members.....	40
4.3.2 Student and PostDoctoral Fellow Employment	41
4.3.3 Student Awards	42
4.3.4 Working/Reading Groups	44
4.4 Member Engagement	44
4.4.1 Online Engagement	45
4.4.2 WICI 2019 Membership Survey	45
5. Governance.....	46
5.1 Consolidation with Waterloo Institute for Social Innovation & Resilience.....	46
5.2 Organization Chart.....	47
5.3 Board.....	47
5.4 Steering Committee	48
5.5 International Scientific Advisory Council	49
5.6 Administration	50
5.6.1 Director	50
5.6.2 Associate Director	51
5.6.3 Staff.....	51
5.7 External Node Coordinators	52
6. Financials.....	52
6.1 Detailed Financial Report 2016-2021	52
6.2 Projected Budget 2021-2025	53

6.3 Metrics for Success	55
7. Conclusion: Supporting the University of Waterloo Strategic Plan	56
References	57
Appendix A: Letters of Support from University of Waterloo Faculty Deans	58
Appendix B: Letters of Support from WICI Members and Collaborating Scholars	66
Appendix C: Letter of Support and Collaboration From The Problem Lab.....	87
Appendix D: Progress Against WICI’s Yearly Goals 2015-2020 (Full Report)	88
Appendix E: Core Member Complex Systems Publications 2016-2020*	95
Appendix F: Student Travel Grants Awarded 2016-2020	108
Appendix G: WICI 2019 Members’ Survey Report	109

List of Tables

<i>Table 1: Complex Systems Society-Environment-Health Questions that Support UW Research Alignments</i> _____	12
<i>Table 2: WICI Core Member Grants Obtaining Funding</i> _____	24
<i>Table 3: Core Member Scholarly Publications/Outputs</i> _____	27
<i>Table 4: Scholarly Complex Systems Publications in Scopus up to 2019</i> _____	28
<i>Table 5: WICI Seed and Partnership Grant Recipients</i> _____	29
<i>Table 6: WICI Conferences/Symposia</i> _____	30
<i>Table 7: WICI Member Workshops 2016-2020</i> _____	31
<i>Table 8: WICI 2020 Membership List by Faculty and Affiliation</i> _____	36
<i>Table 9: WICI 2020 Student Members</i> _____	40
<i>Table 10: Graduate Students Employed for WICI Institutional Projects</i> _____	42
<i>Table 11: Postdoctoral Fellows Employed on WICI Research Projects</i> _____	42
<i>Table 12: WICI 2017 Student Fellowship Awards</i> _____	43
<i>Table 13: WICI 2019 Complex Systems Student Project Symposium Awards</i> _____	43
<i>Table 14: WICI 2020 Board Members</i> _____	48
<i>Table 15: WICI 2020 Steering Committee Members</i> _____	49
<i>Table 16: WICI 2020 International Scientific Advisory Committee Members</i> _____	49
<i>Table 17: Financial Statement 2015-2021</i> _____	52
<i>Table 18: Projected Budget 2021-2025</i> _____	54

List of Figures

<i>Figure 1: WICI at the Intersection of Society, Environment and Health</i>	11
<i>Figure 2: WICI-Related External Funding</i>	23
<i>Figure 3: Non Tri-Council WICI-Related Funding</i>	24
<i>Figure 4: Emerging Nodes of a Canadian Network for Complex Systems (CNCS)</i>	33
<i>Figure 5: WICI Membership by Category</i>	34
<i>Figure 6: WICI Membership by University of Waterloo Faculty</i>	35
<i>Figure 7: Yearly WICI Membership Growth</i>	35
<i>Figure 8: WICI Student Membership by Faculty</i>	40
<i>Figure 9: WICI Online Engagement</i>	45
<i>Figure 10: WICI's Governance Structure</i>	47
<i>Figure 11: WICI Director Achievements of the Past Five Years</i>	51

Prepared by:

Brenda Panasiak
Administrative Coordinator
Waterloo Institute for Complexity and Innovation

Dawn Parker
Core Member and former Director
Waterloo Institute for Complexity and Innovation

Vanessa Schweizer
Director
Waterloo Institute for Complexity and Innovation

August 2021

Acknowledgements:

Special thanks to the WICI core, student and affiliate members who have contributed productivity reports, project reports and/or updates, and other information to support the development of this document.

Cover image by Gerd Altmann (2020) Retrieved from <https://pixabay.com/illustrations/wave-concentric-waves-circles-water-3732123/>

INTRODUCTION: THE VALUE OF WICI

The Waterloo Institute for Complexity and Innovation (WICI) recognizes that the field of [complex systems](#) is inherently transdisciplinary. Complex systems researchers often see themselves as doing basic science, investigating the question of what complex systems are and what makes them similar across living and non-living systems. These investigations provide important insights for policy-relevant applications, for example, in environmental resource management, disease transmission, or human resources within a large firm. In short, advances in basic complex systems science support policy-relevant complex systems applications. Complexity scientists are very open to the idea that insights generated in one discipline, for example, physics, might be applicable to another, such as biology. Thus the field of complex systems advances most effectively through interdisciplinary networking and collaboration, with a dual focus on basic and applied science.

For these reasons, WICI has focused on building interdisciplinary networks and activities that bring members together over the past eleven years. With core funding support from the University of Waterloo, WICI has grown to a team of **147** members across the globe. WICI has worked to **highlight and support complex systems research** at the University of Waterloo through various member-led and member-driven initiatives, including WICI seminars, workshops and conferences, student competitions and symposia, working/reading groups, support for grant development, and the development of a national network for complex systems researchers. [Section 1](#) of this report covers WICI's vision, mission and goals, and outlines the strategic directions for WICI's next five years. [Section 2](#) overviews the activities and services WICI has provided, as well as the new activities that will be an added focus for the next five years. In [Section 3](#), the current complex systems research of WICI's core members are outlined, and the research accomplishments WICI has achieved and plans to continue are detailed, including publications and outputs, grant support, sponsored events, and a [Canadian Network for Complex Systems](#). A breakdown of WICI's membership categories and a [list of members](#) are provided in [Section 4](#), including an overview of student involvement and member engagement. [Section 5](#) summarizes WICI governance and organizational structure, and addresses the planned adoption of the Waterloo Institute for Social Innovation and Resilience (WISIR) as a sub-centre of WICI. Our financial statements from the past five years and projected budget over the next five years are covered in [Section 6](#), as well as a discussion of possibilities for future metrics for success.

Looking to the future, WICI is prepared to pioneer new and exciting opportunities: namely **Canadian complex systems education and training, a national network for complex systems research, and innovative research programs around grand complex challenges that are relevant to the University of Waterloo's research priorities over the next decade.**

Overall, this document illustrates the unique value that WICI brings to researchers at the University of Waterloo and beyond, through recognition, development and advancement of Canadian contributions to complex systems research. WICI supports the University's goal to "use its disciplinary and interdisciplinary strengths to solve increasingly complex, real-world problems", while bringing tremendous potential for the University of Waterloo to advance complex systems research, training and education in modern academia.

1. THE WATERLOO INSTITUTE FOR COMPLEXITY AND INNOVATION (WICI) BACKGROUND

“WICI provides incredible networking and capacity for trainees to engage in complex systems science training that fits their level of knowledge and discipline.”

- Amanda Raffoul, WICI Affiliate Member & Postdoctoral Fellow at Harvard STRIPED

1.1 WHY STUDY COMPLEX SYSTEMS?

Complex systems are all around us. They are seen in the natural world, for example, in the ways birds organize themselves into flocking formations and ants communicate to forage. They are also seen in the social world, for example, in social networks and patterns of communication. They are seen in the structures of plants, landslides, and galaxies, as well as patterns of wealth and income distribution, stock market fluctuations, population distributions between cities, and patterns of urban development. Complex systems, whether natural or anthropogenic, are often referred to as “wholes that are more than the sum of their parts,” wholes whose behaviour cannot be understood without looking at the interactions among individual components.

Complex behaviour arises from the interplay, in densely interconnected systems, among multiplicative feedbacks. A signature of such systems is radically disproportional causation (i.e., small causes do not always produce small effects) or what is often called “nonlinearity.” Nonlinear systems can undergo sudden flips between stable states, or equilibria. A second signature is the “emergence” of structured macroscopic patterns that are the outcome of the independent microscopic interactions of the entities in the system. These macroscopic patterns—be they hurricanes in Earth’s atmosphere or boom-bust cycles in global financial markets—often have enormous causal power (e.g., the butterfly effect).

The formal study of complex systems began in the mid-20th century in mathematics, physics, computer science, systems engineering (including cybernetics) and meteorology. More recently, ecology, social science and cognitive science have made important contributions. Researchers now apply the insights of complexity theory to the behaviour of systems as diverse as pathogen transmission, fresh-water lakes, mammalian immune systems, financial markets, social networks, the Internet, the power grid, urban environments, and meta-cognition.

WICI members across the natural and physical sciences, engineering, mathematics, social sciences, and the humanities study the formal aspects of complex systems, harnessing both quantitative and qualitative approaches. We investigate questions such as: What processes and structures define complex systems and characterize their outcomes? How might theoretical or methodological insights in one application-area of complexity science be transferable to another? How can complex systems be modeled and their implications understood? What real-world problems are best represented by complex systems, and what new insights are gained from a complex-systems lens? Most importantly, how can our understanding of complexity help us better address the world’s most intractable problems?

“Complex systems research narrows the gap between fundamental research and its application to problems.”

*-Roger White
WICI External Core Member
Memorial University*

By bringing together scholars, practitioners, and policy makers working on theoretical and applied complex-systems problems, **WICI is one of the top Institutes at the University of Waterloo for connecting researchers and students from multiple faculties.** WICI helps researchers and students across departments and faculties and beyond create a shared understanding of complexity concepts, theories, and methods, and to connect with stakeholders interested in these ideas. Beyond the immediate geographic scope of Southern Ontario, WICI disseminates its findings and engages vigorously with complexity researchers around Canada and the world.

By establishing the University of Waterloo as a leader in the use of complex-systems ideas to solve important problems, the Institute furthers the university's goal to "use its disciplinary and interdisciplinary strengths to solve increasingly complex, real-world problems." (University of Waterloo's Strategic Plan 2020-2025, p.16).

1.2 VISION, MISSION AND GOALS

Since its inception, WICI's **vision** has been to create an interdisciplinary institute that integrates complex systems knowledge from the university's faculties, departments, centres and schools, and that draws complex systems expertise from around the world to address the most pressing problems of the 21st century. WICI's **mission** has been to facilitate and undertake rigorous, transdisciplinary, collaborative research that promotes innovation and resilience within the complex adaptive systems at the core of human well-being in the 21st century.

"WICI's mandate is vital to innovation, and its basic methodology is indispensable to a thorough understanding of any complex problem."

– Larry Smith, Former Director of the Problem Lab

WICI will continue to support and enable cross-faculty, cross-institutional, transdisciplinary collaborations in complex systems research and education in Canada. With the establishment of the [Canadian Network of Complex Systems](#) and a renewed focus on education and training in complex systems, WICI aims to improve access to interinstitutional funding opportunities and to attract top complex systems scholars to the University of Waterloo. For the next five years, WICI has refined its vision and mission statements to reflect an added focus on complexity education and training initiatives (as identified through WICI's 2015 and 2019 Member Surveys).

WICI's Vision 2021-2025: Supporting transdisciplinary collaborations in Canadian complex systems research and education for global impact in addressing society's most pressing complex challenges.

WICI's Mission 2021-2025: Facilitate complex systems collaboration, research and education within University of Waterloo and across Canada to equip students and professionals to address complex challenges at the intersection of society, environment and health.

1.2.1 SCIENTIFIC DIRECTION: GRAND CHALLENGES

As noted by incoming President Goel, Waterloo is more than just a technical university. It has deep strength in the environmental, social, and health sciences, and is well positioned to address major societal challenges in these areas. In the [University of Waterloo 2020-2025 Strategic Plan](#), the University commits to align its research strengths to address the following important global challenges:

Quantum science, nanotechnology, connectivity and telecommunications

Water, energy and climate: sustainability, security, infrastructure

Information technology and its impact, including intelligent systems, human–machine interfaces, cybersecurity, privacy and data science

Robotics and advanced manufacturing

Health technologies

Each of these global challenges involves cross-scale and networked interactions within human–environment systems, thus, each is inherently a **complex systems challenge**. We believe complex systems science should be viewed as one of the University of Waterloo’s research strengths, a strength that provides the core scientific foundations for investigations into each of these thematic areas. WICI has strong and/or developing connections with complex systems researchers in all of these areas.

In its interdisciplinarity, WICI’s thematic research foci can be very broad. Branding WICI’s foci around grand challenges at the intersection of **society, environment and health** encompasses the majority of our existing and desired research foci while providing clarity of purpose and function and aligning closely with the global challenges of the University of Waterloo Strategic Plan through 2025.

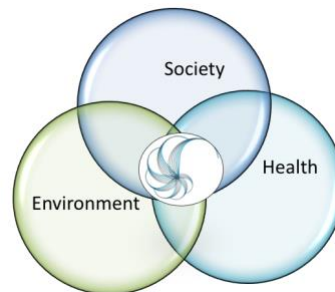


Figure 1: WICI at the Intersection of Society, Environment and Health

Some examples of current and future areas of exploration that both support the University of Waterloo’s research alignments **and** fall under the umbrella of society-environment-health challenges are summarized in Table 1 on the next page (this is not an exhaustive list).

Table 1: Complex Systems Society-Environment-Health Questions that Support UW Research Alignments

<i>UW Research Strength Alignments</i>	Examples of past/current WICI research priorities that both support UW research alignments <i>and</i> intersect with society-environment-health	Examples of potential complex systems questions that both support UW research alignments <i>and</i> intersect with society-environment-health
<i>Water, energy and climate: sustainability, security, infrastructure</i>	<ul style="list-style-type: none"> • Building a circular Bioeconomy to ensure sustainable Cradle-to-Cradle Biomass Value Chains (T. Charles) • Identifying leverage points to address global systemic risks (T. Homer-Dixon, V. Schweizer) • Implementation science to create healthy cities, with a focus on food (D.C. Parker, S. Kirkpatrick) • Nutrition and its intersections with equity, health, and sustainability (S. Kirkpatrick); • Housing innovations for sustainable cities (D.C. Parker); • Collaborative social innovation, financing and design to support sustainable development (S. Geobey) • Solving complex societal-technological-environmental issues using innovative systems thinking methods (K. Hipel, V. Schweizer) 	<ul style="list-style-type: none"> • Structural economic inequality and economic instability • Green finance innovations to support a sustainability transition
<i>Information technology and its impact, including intelligent systems, human-machine interfaces, cybersecurity, privacy and data science</i>		<ul style="list-style-type: none"> • Ensuring equitable and affordable access to computing technology • Balancing attention demands vs. productivity enhancement of a digitally enabled world • Reimagining human-computer interaction for an aging population
<i>Health technologies</i>	<ul style="list-style-type: none"> • Policy interventions to control pandemic disease spread (C. Bauch) 	<ul style="list-style-type: none"> • Addressing structural inequalities in health service access • Reimagining human-computer interaction for an aging population

1.2.2 PROGRESS AGAINST STRATEGIC GOALS 2016-2020

Upon renewal in 2015, WICI established its strategic goals and objectives through 2020, and has monitored and modified its objectives through annual reporting to its Board and regular Steering Committee meetings. Progress toward its goals and objectives are described below:

1. Strengthen core networks.

- a. Continue to actively support current core projects and members through grant writing assistance and complementary activities, such as talks, workshops, and working groups.
- b. Leverage existing opportunities on campus to expand core membership in the areas of network science, human-environment interactions, expanding conventional economics, complexity and non-rational drivers of behavioural change, psychological dynamics of catastrophic dehumanization; rapid ideological change/ideological conflict; and embodied cognition.
- c. Work with faculty units and deans to identify opportunities for new hires whose research has a complex systems focus.
- d. Seek out opportunities to establish core WICI members in under-represented faculties (namely Health and Science).

Progress to date: Since 2015, membership has doubled. WICI has initiated connections with Canadian complex systems researchers and institutions through a Canadian Network for Complex Systems initiative, expanded into areas of lower representation (namely Health and Science) and continued to deliver high-profile WICI seminars and conferences attracting the attention of national and international scholars and prospective partners.

2. Facilitate interdisciplinary research.

- a. Host seminars and workshops, striving to maintain a balance between bringing in global leaders in complex systems and highlighting local complex systems scholarship.
- b. Support working groups, allowing their focus and scope to evolve with the interests and needs of membership.
- c. Offer support for grant development.

Progress to date: WICI core members have collectively developed over **75** successful complex-systems-themed grant applications in collaboration with other researchers (and countless more applied to that were not successful). WICI core members have supervised over **50** graduate students, employed at least **9** postdoctoral fellows to work specifically on WICI core research projects, and have attracted speakers from a diverse disciplinary span to UW to present their work and meet with local researchers for networking discussions and opportunities.

3. Enhance public engagement.

- a. Improve WICI's web and social media presence, including the development of web pages for WICI core research projects and a set of introductory "What are complex systems?" materials.
- b. Highlight WICI work through press releases and actively engage the media when opportunities arise.
- c. Increase public events in the community.
- d. Continue informal receptions before seminars to encourage networking and collaboration opportunities.

Progress to date: As of December 2020, WICI seminars have reached **7,997** viewers, our website has been visited over **41,000** times, our email subscribers have increased nearly 50% from 400

to **591**, and we have built a following of **724** Twitter accounts, **582** Facebook users and **114** LinkedIn members.

4. Enhance WICI's resource base and long-term viability.

- a. Prioritize efforts to obtain higher-level, external support to establish and support initiatives such as a staffed resource lab; funding for a graduate fellowship program; a competitive post-doctoral scholar program; and funding for short-term (sabbatical or study leave) positions for more senior complex systems scholars.

Progress to date: Plans toward long-term viability initially centered around the goal of running grants and contracts through the centre and receiving a portion of the research support funds or overhead. As a clearly cross-faculty, interdisciplinary centre, with a broad disciplinary scope and strong reputation, WICI anticipated application for University Centre status. In light of a review of University Centres and Institutes and a possible shift in the overall structure of research centres at UW, WICI has decided not to pursue University Centre status at this time. In 2018 and 2019 WICI initiated extensive discussions with the Office of Research, deans, other Waterloo research centres, and external complex systems hubs in France (Île de France) and the United States (Santa Fe Institute) regarding alternative budget models that WICI could consider. A one-year extension of the mandate was granted in 2020.

Development plans for an alternative model continued in 2020/21, with further consultation with the Office of Research, Waterloo Institute for Social Innovation and Resilience (WISIR), Professional Development and the Problem Lab. WICI's best near-term strategies toward an alternate funding model now include consolidation with existing small centres (e.g. WISIR), partnership(s) with Advancement office(s) at UW to search for donor and foundation funding, and consideration of professional development offerings on topics such as leadership and problem-solving in a complex world. WICI continues consultation with the Aspen Institute, Cascade Institute, Problem Lab, WISIR and Balsillie School of International Affairs, with all parties anticipating high demand for training in a variety of potential markets including professionals, government and non-profit agencies, commercial businesses and students.

In addition, collaborations with members of a new Canadian Network for Complex Systems, which WICI established, have led to a number of new grant applications in the past year, including a CIHR-SSHRC-NSERC training grant for \$4.95 million. Our next five-year plan includes direct support for similar future applications. WICI has also consulted with Steering Committee members regarding possible fee-for-service offerings and "donation" type models for events. WICI continues to develop a business model and business plan for long-term financial viability going forward. This will be a top strategic priority for the near term.

5. Raise WICI's profile.

- a. Focus on academic and media outreach to highlight WICI's unique contributions on a national and global scale.

Progress to date: WICI's "What are Complex Systems?" videos have been viewed nearly **3,000** times and are sought out and referenced by external members in their own complex systems teachings. WICI is currently sought out by prospective students asking, "How can I register for a PhD in complexity at UW?" and researchers asking, "Can you partner with us on grants?", "How can I become a member?" and "How can you help industry partners solve their own complex

problems?”. Chris Bauch’s modelling of pandemic spread in classrooms and Igor Grossmann’s work on “World After Covid” have received national and global attention this past year alone.

In each of [WICI’s Annual Reports](#), WICI has thoroughly detailed how our yearly activities have impacted our goals. A full report of the progress against our strategic goals from 2015-2020 is included in [Appendix D: Progress Against WICI’s Yearly Goals 2015-2020](#).

1.2.3 STRATEGIC GOALS AND OBJECTIVES 2021-2025

To fulfill our new mission, WICI will prioritize the most impactful resources and services we can offer in the areas where it is most needed. Below, we elaborate on how we will facilitate interdisciplinary research and deliver education and training for students and community members. To accomplish these goals, WICI must also establish a viable long-term resource base.

1. Facilitate Interdisciplinary Complex Systems Research at the Intersection of Society, Environment, and Health

Research in complex systems is inherently interdisciplinary and is well aligned to large interdisciplinary grants, especially those associated with grand challenges at the intersection of society, environment, and health. Our growing network of experienced senior research collaborators across Canada will enable us to succeed in such grant competitions. WICI will continue to support and enhance our current network of complex systems researchers, while providing services and activities that promote research collaboration and networking.

a) Continue to support new and ongoing core complex systems research projects.

There is a high amount of interdisciplinary collaboration energy and potential across existing WICI and WISIR core research projects. WICI will offer grant-writing assistance, in-kind support and matching grant opportunities when applicable, in support of these and other large shared complex systems research projects, to facilitate their success.

b) Continue to develop and grow a Canadian Network for Complex Systems.

Over its next five years, WICI will continue its development and growth of a Canadian Network for Complex Systems, enabling complex systems researchers at the University of Waterloo to expand their inter-institutional collaborative network across Canada. As noted in letters of support from WICI members and collaborating scholars in [Appendix B](#), this network has tremendous potential to enhance research capacity for inter-university and international collaboration as well as training/employment opportunities for students.

c) Provide and support interdisciplinary networking opportunities and activities, including a bi-annual conference to bring researchers together around grand challenge themes.

WICI will continue to offer informal networking opportunities, such as ‘mixers’, ‘open house’ events and seminar receptions. We will build on the successes of previous conferences and branch out to our growing Canadian Network for Complex Systems to host biennial conferences on relevant research themes as an opportunity to highlight the revolutionary complex systems research our members are engaged in and bring our diverse complex systems researchers together for networking and collaboration opportunities.

- d) [Actively promote current work and member achievements through regular seminars, WICI newsletters, social media, and media outreach.](#)
WICI will continue to host relevant seminars, distribute bi-weekly newsletters, and engage with social media followers and local media to highlight the impact of ongoing member research, strengthen existing connections, and raise the profile of both WICI and University of Waterloo.
- e) [Utilize dynamic web-based content to facilitate searching and connecting with complex systems researchers across all disciplines.](#)
WICI will seek to integrate an interactive member database, such as AirTable, with our existing website, to enable user-friendly member and research topic searches that facilitate impactful, high-caliber collaborations to strategically respond to funding opportunities.

2. Prioritize Complex Systems Education Initiatives

WICI members have made it clear that a substantive focus on complex-systems training in the science behind complex systems targeted to students, research staff, and faculty is a missing piece on campus. Both internal members and external partners are requesting training in systems thinking and methods. As the University of Waterloo looks to support flexible education pathways (University of Waterloo Strategic Plan 2020-2025, p.4), WICI will prioritize initiatives targeted to highly qualified personnel in complex systems applications.

- a) [Explore professional development offering\(s\) in collaboration with Professional Development, Co-operative Education and the Problem Lab.](#)
Building on the recommendations in WICI's [Proposal for Training Program](#) (Dordi, 2020) and [Business Plan Notes for WICI's Complexity Professional Development Program](#) (Comeau, 2021), WICI will work with Professional Development, the Problem Lab, Co-operative Education, as well as faculties and deans to implement a professional development course and/or micro-credentialing program, with the aim of engaging workforce professionals in solving relevant, applied complex problems, while exploring opportunities to promote University of Waterloo talent to the workforce.
- b) [Pursue collaborative training grants around interdisciplinary complex systems training.](#)
Due to its inherent interdisciplinarity and growing membership of top complex systems researchers in Canada, WICI is uniquely positioned to apply for strong interinstitutional training funds. In addition to the funded CIHR-NSERC-SSHRC Healthy Cities Research Training Platform, there is potential for a strong NSERC-CREATE application around modelling and simulation of coupled human-natural systems.
- c) [Host regular WICI workshops and support working groups that bring complex systems researchers together from multiple disciplines.](#)
WICI supports working groups that enable students and faculty to actively engage with a larger network, while learning relevant complex systems content. Following successful workshops offered in previous years, WICI will organize annual workshops with a focus on skill development and collaboration.
- d) [Work with University of Waterloo and/or potential partner institutions to develop graduate and/or undergraduate complex systems programming by 2025.](#)
Building on exploratory discussions in 2020, WICI will engage University of Waterloo faculties and departments as well as partner institutions in discussions and plans to leverage its existing curricula and resources, identified in WICI's [Proposal for Training Program](#) (Dordi, 2020), to

develop formalized cross-faculty complex systems programming for graduate and/or undergraduate students.

3. Establish a Viable, Long-Term Resource Base

During its next five years, WICI will develop a business plan working with the faculties, the University and our internal and external partners to pursue hybrid funding options that will allow us to establish and support the activities, services and complex systems research integral to WICI and to the University of Waterloo.

a) **Identify and harness potential revenue through Professional Development offering(s).**

WICI has begun and will continue to explore the market for applied complex systems education, working with University partners such as WatsPEED and potential community partners to determine what revenue opportunities exist in this area. A professional workshop with scale-up potential proposed for the 2021 Annual Meeting of the Society for Risk Analysis has been accepted.

b) **Partner with faculty and university advancement offices to identify potential sources of endowment funds for WICI.**

WICI will actively engage with advancement offices at both the University and faculty levels to identify promising sources for WICI Institutional support.

c) **Seek regular opportunities for collaboration and/or resource-sharing with deans, departments and other research centres and institutes, as well as external nodes of a Canadian Network for Complex Systems.**

As the University streamlines its vision for university research centres, WICI will seek to collaborate with deans, departments, and other research centres to find creative ways of sharing resources and improving cost efficiencies.

2. OVERVIEW OF ACTIVITIES AND SERVICES

Over the past five years, WICI has offered the following programs and activities to University of Waterloo faculty and students, as well as external researchers and the public:

Direct support for cross-faculty collaborative research:

- Supporting and promoting the work of several distinct core research programs;
- Publishing an occasional paper series;
- Creating and disseminating software tools for analysis of complex systems through core research projects and challenges;
- Curating a list of complexity readings and complexity-related courses on our website;
- Committing in-kind and financial contributions to WICI core members' grant applications;
- Contributing to the training of highly qualified personnel through our core research projects;
- Hosting research, networking, and grant development workshops.

Development of a network of complex systems researchers on campus and beyond:

- Identifying and connecting scholars working in complementary areas;
- Facilitating and hosting working/reading groups at University of Waterloo;
- Engaging the community through a WICI mailing list and social media accounts;

- Hosting a Speakers Series that brings experts in their field to the university and allows University of Waterloo scholars working in the field to share their work;
- Organizing workshops, symposiums, and research networking events.

Over the next five years, WICI plans to continue offering the activities and services our members value, with an added focus on Canadian complex systems education and training, growth of a national network for complex systems research, and innovative research programs and supports for grand complex challenges that are relevant to the University of Waterloo’s research priorities over the next decade:

Canadian complex systems education and training

There is increasing, immediate interest in professional training in the area of applied complex systems, and WICI has already begun considerable collaboration with university partners, namely Problem Lab, to develop material and content in this pursuit. We anticipate that WICI can explore this potential source of external funding while promoting University of Waterloo’s professional development, cooperative education and top-level education programs. WICI student member and general assistant Christina Comeau has prepared [Business Plan Notes for WICI’s Complexity Development Program](#) (2021), and Dr. Larry Smith of the Problem Lab indicated in his letter of support ([Appendix C](#)) that through WICI’s developing connection with the Problem Lab, WICI has the potential “to serve external players in their thoughtful pursuit of innovation.”

In preparation of a [Proposal for Training Program](#), WICI student member and graduate research assistant Truzaar Dordi conducted an inventory of current complex systems offerings at University of Waterloo in 2020. Results show capacity for teaching and supporting complex systems research at the University of Waterloo, but this capacity could be made more accessible to students across a variety of programs. WICI proposes to support the University to leverage its existing curricula and resources to develop formalized training programs. Such programs may attract top students and scholars to the University of Waterloo to learn about and advance the field of complex systems.

Canadian Network for Complex Systems Research

In WICI student member and graduate research assistant Jinelle Piereder’s recent report, [Mapping Canadian Complex Systems Scholarship](#) (2020), we learned complex systems research at University of Waterloo is much more robust than WICI membership alone suggests. WICI’s name and reputation have achieved international recognition, and WICI believes that continued efforts to promote complex systems research at University of Waterloo will enable continued growth, increased member engagement, and effective interdisciplinary research collaborations across campus.

“WICI has become the most predominant networking hub for complex systems research in Canada”

- Keith Hipel, Adjunct University Professor, O.C.

WICI established the [Canadian Network for Complex Systems](#), which uniquely connects top complexity science researchers across Canada to create collaborations on large research projects. Several external members are already on board, with support from their respective institutions, to develop and grow this network.

Enclosed letters of support from external core members ([Appendix B](#)) illustrate the need for a Canada-specific complex systems network, and highlight WICI's effective national leadership in complex systems. As Dr. Mary O'Connor indicates, international complex systems centres in the United States (e.g. Santa Fe Institute) and Europe may be unable to adequately address Canada's most complex problems. Our unique culture, geography, history and biodiversity require an application and understanding of complex systems that is relevant to Canadians and indigenous populations. Dr. Raja Sengupta agrees that WICI fulfills a lacunae in complex systems research and training that exists in Canadian context. Dr. Laurette Dubé and Dr. James Shelley assert in their letters that for the University of Waterloo to strengthen the impact of its interdisciplinary, collaborative work toward the complex problems of the world, Waterloo should leverage its existing reputation and foundation of complex systems researchers that WICI has built and is extending through the emerging Network. Dubé contends that complex systems research is fundamental to connect across faculty and institutional barriers, and Dr. Roger White argues complex systems approaches enable true functional integration between fundamental research and practical applications. At the Cascade Institute, Dr. Thomas Homer-Dixon expresses his enthusiasm to continue multiple lines of collaboration with WICI, especially around complexity education, in coming years.

Innovative and relevant research programs around grand complex challenges

“A particular strength of WICI is that it focuses on the interaction of human and natural systems, and is thus inherently interdisciplinary”

– Roger White, Honorary Research Professor, Memorial University of Newfoundland

By focusing on grand challenges at the intersection of health, society and environment, consistent with the University of Waterloo's research priorities and identified in its [2020-2025 Strategic Plan: Connecting Imagination with Impact](#), WICI will leverage its existing membership and networks to continue building partnerships across Canada and internationally.

The complex systems work of WICI core members has secured more than **\$13.2 million** dollars in successful research funding over the past five years. However, measuring the impact of WICI by examining productivity metrics of WICI's core membership alone reveals only the tip of a much larger complexity iceberg at the University of Waterloo. As WICI administration has consisted of mainly voluntary and part-time roles, the contributions of non-core WICI members has not been tracked by WICI previously. Knowing that WICI core members currently represent about 8 percent of WICI's full membership, and that WICI core member publications represent only 6.3 percent of the complex systems research being done at University of Waterloo (Piereder, 2020), it is clear that there is untapped potential to better coordinate these research activities in complex systems to bring significant external funds to the University of Waterloo through interdisciplinary research in complexity science. Within the shifting institutional environment for research centres at the University of Waterloo, now is the time to redefine WICI's path to supporting and facilitating complex systems scholarship at UW to best capture this funding potential.

3. RESEARCH ACCOMPLISHMENTS OF THE PAST FIVE YEARS

The following section focuses on WICI's achievements during its past five years of operation in the areas of core research projects and funding, scholarly outputs and resources, and support and growth of a network of complex systems researchers. Membership and network engagement will be discussed in [Section 4](#).

3.1 CORE RESEARCH PROJECTS

Over the past five years, there have been a wide variety of research projects led by WICI core members. Many of these have developed additional related projects and research groups, and all of them have supported a number of graduate students and postdoctoral fellows in their research while attracting external funding. Progress updates for each active core research program are provided in our Annual Reports each year and are posted on our website.

[ALGEBRAIC INTELLIGENCE AND COMPUTATION \(2018-\)](#)

Professor Chrystopher Nehaniv founded the Waterloo Algebraic Intelligence and Computation lab at University of Waterloo, which develops new tools and methods for STEM areas including Neuroscience, Biochemical and Biological Networks, and contributes to computational algebraic methods for Neuroscience algorithm development and data analysis.

[ARTIFICIAL INTELLIGENCE-BASED TOOLS FOR FRESH PRODUCE PROCUREMENT PRICE DECISIONS IN CANADIAN DISTRIBUTION CENTERS \(2020-\)](#)

In this research supported by Loblaws and a Natural Sciences and Engineering Research Council (NSERC) Collaborative Research and Development Grant, Fahkri Karray's research team, which includes WICI member Dawn Parker, proposes a deep learning model application to forecast fresh produce yield and prices and enhance decision support by fresh produce procurers.

[ASSESSMENT OF AGRICULTURAL BEST MANAGEMENT PRACTICES \(2018-\)](#)

Peter Deadman's research group is using hydrological models (SWAT) to simulate the impact of the frequency and spatial distribution of BMPs on key water quality parameters (nitrogen and phosphorus) in agricultural watersheds. The work includes the use of agent-based models to simulate farmer decision making around the selection and implementation of BMPs.

[AUGMENTING DECISION-MAKING IN COMPLEX AND SAFETY-CRITICAL DOMAINS \(2018-\)](#)

This project, led by Assistant Professor Mark Crowley, uses deep neural networks, reinforcement learning and game theory focusing on problems of prediction and control in the areas of forest fire management, medical imaging and autonomous driving. This project involves collaborations with researchers in applied fields such as sustainable forest management, ecology, automotive technology and medical imaging.

[BLUE-GREEN INFRASTRUCTURE ON PRIVATE LANDS \(2019-\)](#)

Green infrastructure (GI) for stormwater management (SWM) on private land (such as rain barrels, rain gardens, and permeable paving) is potentially part of a hybrid system solution to managing an increase of stormwater runoff due to rapid urbanization, increases in paved surfaces and extreme storm events related to climate change. Dawn Parker's research groups is working with the Cities of Kitchener and Waterloo, the non-profit REEP Green Solutions, and two consulting firms, developing an empirical agent-based model (ABM) of resident information, attitudes, knowledge, socio-economics, and social norms to explore the potential for policies and institutional supports to catalyze green infrastructure (GI) adoption for SWM on private lands.

[COMPLEX SYSTEMS SCENARIO ANALYSIS \(2016-\)](#)

Vanessa Schweizer researches complex systems methods for scenario analysis in the context of the human dimensions of climate change. Problems investigated under this project include using complex

systems methods for understanding difficult-to-imagine but high impact, or so-called ‘perfect storm’ scenarios; complex systems methods for decision support in water management, and complex systems methods for identifying strategies to achieve the Sustainable Development Goals (SDGs) both globally and at the national level.

[COMPLEXITY IN DIETARY PATTERNS, UNINTENDED CONSEQUENCES OF NUTRITION POLICIES AND PROGRAMS \(2018-\)](#)

Sharon Kirkpatrick’s research focuses on the intersections between nutrition, human and planetary health, equity, and policy, using a systems thinking lens. Much of her group’s work is aimed at improving methodologies for measuring dietary patterns to foster robust evidence on how these patterns influence human and planetary health and how to promote healthy and sustainable eating practices. For example, trainees are examining intersectionality in social positions and identities that shape dietary patterns, as well as how deep learning may help us to understand the complexity of such patterns. Kirkpatrick’s group explores the utility of systems thinking and methods to better understand the array of factors that shape major nutrition and public health challenges and the potential intended and unintended consequences of policies and other interventions to address these challenges.

[COUPLED HUMAN-ENVIRONMENT SYSTEMS THEORY \(2016-\)](#)

Professors Chris Bauch and Madhur Anand continue to explore the dynamics of coupled human-environment systems and the implications of these dynamics for environmental health and sustainability. Questions researched under this project include COVID-19 transmission models based on complex systems principles; developing new types of early warning signals for tipping points in complex systems; spatial ecosystem mosaic dynamics; human-environment dynamics of forest pest outbreaks; human feedbacks on invasive versus native grasslands; mining social media data for clues about dynamics of climate change; the effects of globalization and interconnectedness on socio-ecological population collapse; and forest-grassland mosaics.

[DIGGING INTO DATA PROJECT/OPEN-SOURCE MODELLING \(2013-\)](#)

Building on the earlier [Digging into Data Research MIRACLE](#) project, Dawn Parker collaborates with the Network for Computational Modeling in Social and Ecological Sciences (CoMSES Net) project at Arizona State University, hosting the current CoMSES Net platform on Compute Canada via a Portals and Platforms award, and leading development of an international Open Modelling Foundation. Parker and Piereder (2020) have also been exploring new bibliometric tools in a recent project, [Mapping Canadian Complex Systems Scholarship](#), for keyword and scholar community identification, including Gargantext, an open-source tool developed and hosted through the Complex Systems Institute of Paris Ile-de-France (ISC-PIF). They have proposed to implement a Gargantext implementation through CoMSES Net, which could be available for WICI scholars for specific projects.

[ECONOMICS FOR THE ANTHROPOCENE \(2018-\)](#)

Through WICI, Stephen Quilley has been a partner on the *Economics for the Anthropocene* project – an international partnership between McGill, Vermont and York focused on improving how the social sciences and humanities connect to ecological and economic realities and challenges of the anthropocene.

[FOLK THEORIES OF SOUND JUDGEMENT \(2019-\)](#)

This project, led by Igor Grossmann, concerns exploration of a theoretical framework accommodating the notion of rationality advocated in neoclassic economics and political science with the Aristotelian notion of practical wisdom, as well as the notion of reasonable judgment discussed by legal philosophers such as Rawls. The core question is how lay people understand these concepts and whether their intuitive understanding corresponds to any of the distinct philosophical positions. Currently, the team aims to expand its framework theoretically, providing a synthesis of ideas from distinct streams of behavioral and decision sciences, and to test implications of this framework in real life.

[IMPLEMENTING SMART CITIES INTERVENTIONS TO BUILD HEALTHY CITIES \(SMART TRAINING PLATFORMS \(2021-\)\)](#)

Dawn Parker and Sharon Kirkpatrick are co-applicants on the SMART Training Platforms, funded by a CIHR-NSERC-SSHRC Training Grant. The team of collaborators from ten Canadian institutions will develop a curriculum to equip trainees across the country with the knowledge and skills to tackle many of the challenges faced in urban environments. The Platform has a thematic focus on the central place of food in healthy cities and incorporates the use of 'big data' to create smart solutions for urban environments, as well as bringing together the best knowledge, practices and tools from different fields of study to find solutions to complex problems.

[PROTOTYPING LAB PROJECT \(2018-\)](#)

Building on the ongoing work of Stephen Quilley's [ReMaker Society](#), Stephen Quilley with Marcel O'Gorman were awarded a CFI-JELF grant to support the interdisciplinary work of students and researchers who are investigating the social, psychological, and environmental impacts of contemporary technologies, and training graduate students in 3D modelling and printing, physical computing, Internet of Things design, big data analysis, and visualization.

[RAPID IDEOLOGICAL CHANGE \(RIC\) PROJECT \(2018-\)](#)

Tad Homer-Dixon's research team focuses on the development of methods for modeling the emotional content of ideologies as complex systems into practical tools for data gathering and conflict resolution.

[SOCIAL INTELLIGENCE AND ROBOTICS \(2018-\)](#)

Chrystopher Nehaniv and Kerstin Dautenhahn co-founded and co-direct the Social Intelligence and Robotics Research Lab, where research focuses on social robotics, human-robot interaction, cognitive and developmental robotics and Embodied Artificial Intelligence.

[URBAN GROWTH AND CHANGE \(RESEARCH GROUP\) \(2012-\)](#)

Dawn Parker's research group is working with local government and industry partners to conduct long-term, highly empirical research to explore interactions between residential location and transportation decisions, using Kitchener-Waterloo and the natural experiment of its light rail implementation as a living laboratory case study, with the aim of building a series of agent-based models that model these interactions.

[WISDOM OF KNOWING THE DIFFERENCE: UNPACKING KNOWLEDGE OF STRATEGY-SITUATION FIT AND ITS RELATIONSHIP TO CONTEXT-SENSITIVE META-COGNITION \(2019-\)](#)

In Igor Grossmann's ongoing research to link characteristics attributed to wise persons with knowledge of Strategy-Situation Fit (SSF) and its application in meaningful daily life situations, he develops tools to assess knowledge of Strategy-Situation Fit, with a focus on cognitive, emotional, motivational and

behavioural strategies across different situations; explores the utility of Strategy-Situation Fit knowledge for performance in daily life; and examines how wise meta-cognition and SSF influence each other over

WORLD AFTER COVID (2020-)

Igor Grossmann's multimedia outreach project uses innovate discourse analyses, natural language processing, and interactive visualization (<https://www.igorGrossmann.com/wac>) to identify and illustrate core themes from the reflections of world leading behavioural and social scientists on the possible societal and psychological outcomes of the pandemic, and wisdom needed to master it.

3.2 RESEARCH FUNDING SUCCESS

Historically, all WICI related grants have been submitted by core members acting as Principal Investigators, Co-investigators, or Co-applicants through their home units. WICI has supported these applications by providing direct administrative support to assist with grant preparation, offering in-kind and financial matching contributions, and facilitating connections between researchers working in complex systems, through its various events over the years.

As illustrated in Figures 2 and 3, WICI core member research projects have demonstrated increasing success in obtaining complex-systems related external research funding, both from Tri-Council Funding Agencies and from other funding sources. More than **49%** of the over **\$13.2 million dollars** of funding that have been obtained over the past five years were from sources other than Tri-Council Funding Agencies.

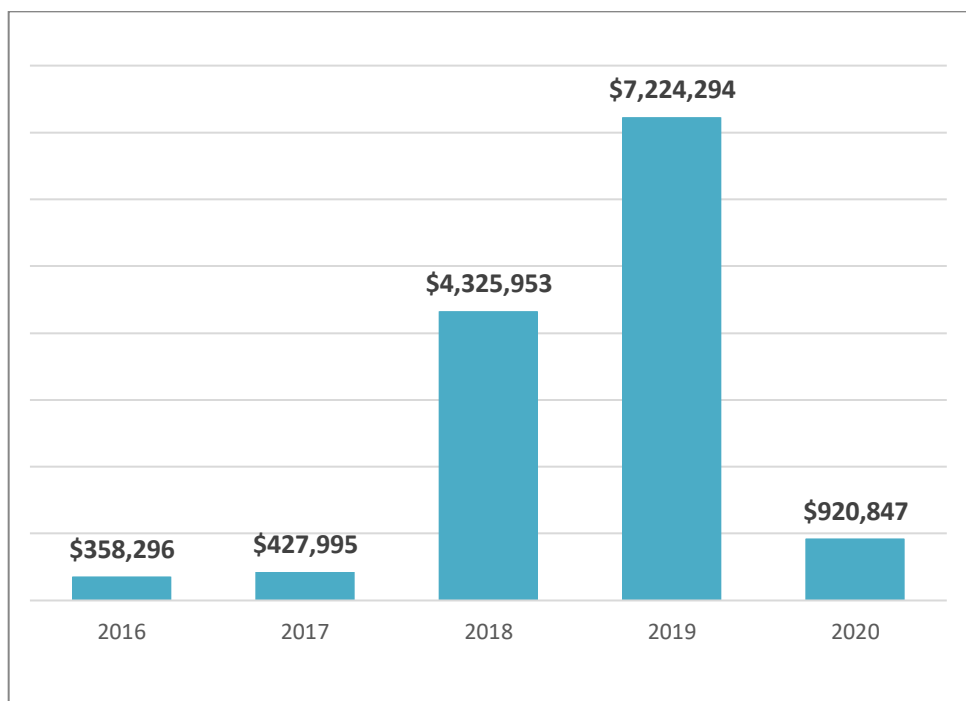


Figure 2: WICI-Related External Funding

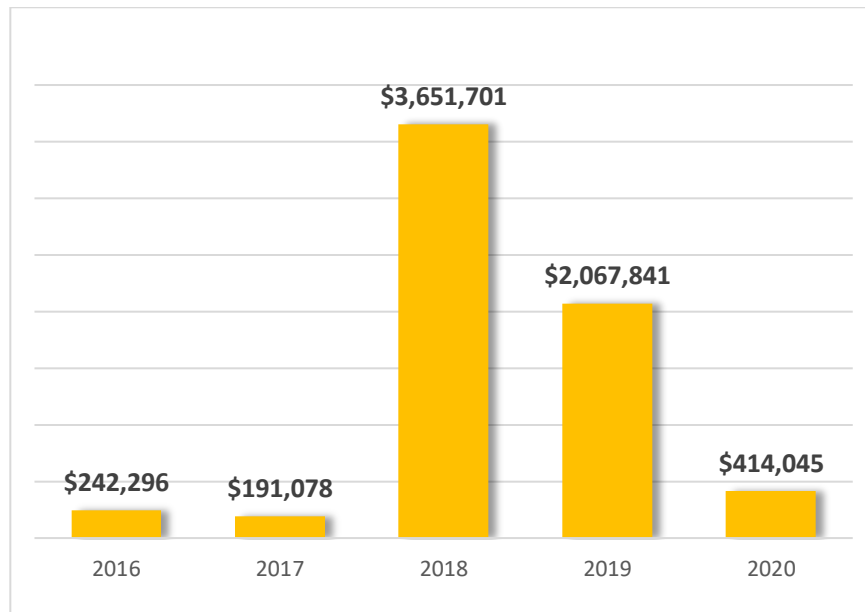


Figure 3: Non Tri-Council WICI-Related Funding

The funding successes WICI’s core members have obtained demonstrate broader national and international collaborations, and success in network and capacity building over the years. Table 2 below features a list of the successful complex-systems related grants reported by WICI core members. Some of these successes are directly attributed to partnerships formed through WICI-sponsored seminars, conferences or networking events; others through mentorship of more senior WICI members; and some through small matching funds provided by WICI.

Table 2: WICI Core Member Grants Obtaining Funding

COMPLEX-SYSTEMS GRANTS OBTAINING FUNDING BY WICI CORE MEMBERS 2016-2020

2016

- *Funding for Resilience Conference*: \$4,000 from Fields Institute
- UW Seed Grant for SSHRC Insight Development Grant: \$4,000 (50% of grant) for “*Revisiting Nature Conservation in Canada for the ‘Human Age’*” (Schweizer)
- *Coupled Human-Environment Systems - Mathematical modelling of human-environment interactions*: \$50,000 (yearly to a total of \$250,000 over 5 years) from NSERC Individual Discovery Grant for “*Dynamics of coupled human-environment systems*” (Bauch)
- *Coupled Human-Environment Systems* Canadian Foundation for Innovation-John R. Evans Leaders Fund (CFI-JELF) \$234,296 for “*Coupled human-and-natural systems laboratory.*” (Bauch)
- NSERC Discovery Grant - \$37,000 for “*Transitions and thresholds in global ecological changes of forest ecosystems*” (Anand)
- NSERC Discovery Grant – \$25,000 (yearly to a total of \$125,000 over 5 years) for “*Uncovering ‘perfect storms’ among possible events affecting complex systems*” (Schweizer)

2017

- *Urban Growth and Change* -UW IPRG Grant: \$20,000 for “*Modelling Urban Complexity*” (Parker)
- Canadian Foundation for Innovation-John R. Evans Leaders Fund (CFI-JELF): \$40,000 for “*Critical Media Prototyping Suite*” (Quilley)
- Balsillie Seed Grant: \$2,230 (Schweizer)
- UW/SSHRC Seed Grant: \$7,000 (Schweizer)
- Global Water Futures Program: \$120,000 for “*Agricultural Water Futures in Canada: Stressors and Solutions*” (Deadman)

COMPLEX-SYSTEMS GRANTS OBTAINING FUNDING BY WICI CORE MEMBERS 2016-2020

- University of Guelph: \$848 for *WICI Conference*
- Canadian Institutes of Health Research: \$20,000 for *“Improving population health in an era of social-ecological instability and economic contraction”*(Quilley)
- *MIRACLE (DiD)* – Resource allocation from Compute Canada for the CoMSES Net Community Web Portal \$8,000 (Parker)
- *Coupled Human-Environment Systems - Mathematical modelling of human-environment interactions: \$50,000* (yearly to a total of \$250,000 over 5 years) from NSERC Individual Discovery Grant for *“Dynamics of coupled human-environment systems”* (Bauch)
- NSERC Discovery Grant - \$37,000 for *“Transitions and thresholds in global ecological changes of forest ecosystems”* (Anand)
- NSERC Discovery Grant: \$29,000 (yearly to a new total of \$145,000 over 5 years) for *“Uncovering ‘perfect storms’ among possible events affecting complex systems”* (Schweizer)
- CIHR Planning and Dissemination Grant, Institute of Population & Public Health: \$19,917 for *“Improving population health in an era of social-ecological instability and economic contraction”* (Quilley)
- SSHRC Postdoctoral Fellowships Program: \$81,000 for Mark Hathaway & *Transformative Ecological Learning in Permaculture* (Quilley)

2018

- NSERC Discovery Grant - \$37,000 for *“Transitions and thresholds in global ecological changes of forest ecosystems”* (Anand)
- *Urban Growth and Change*: Municipal Property Assessment Corporation - \$300,000 in-kind for *“Interpreting housing market dynamics in Kitchener-Waterloo, and investigating relationships between housing demand and demographics from housing survey”* (Parker)
- *Urban Growth and Change*: Teranet - \$74,700 in-kind for *“Interpreting housing market dynamics in Kitchener-Waterloo, and investigating relationships between housing demand and demographics from housing survey”* (Parker)
- *Urban Growth and Change*: Cities of Kitchener, Waterloo, Cambridge and Region of Waterloo - \$7,051 for *“Residential Property Values and Active Transportation Infrastructure”* (Parker)
- Ontario Research Funds – Research Excellence (ORF-RE): \$465,000 for *“Computational Peer Review through Identification and Captioning of Gigapixel Digital Pathology Scans”* (2018-2024) (Crowley)
- NSERC Collaborative Research and Development (CRD) matched with funds from industry partner Magna International: \$265,000 for *“Driver Behaviour Learning”* (2018-2021) (Crowley)
- MITACS Accelerate Cluster Fund with Industry Partner Accerta Analytics Solutions: \$240,000 for *“End-of-line Testing for Safety and Quality with Machine Learning”* (2018-2021) (Crowley)
- NSERC Discovery Grant: \$140,000 for *“Towards Fully Integrated Deep Learning and Reinforcement Learning for General Spatial Domains”* (2018-2023) (Crowley)
- UW Research Incentive Fund: \$10,000 for *“Embracing complexity: Advancing our understanding of dietary patterns to inform chronic disease prevention”* (Kirkpatrick)
- Canadian Foundation for Diabetic Research Grant: \$20,000 for *“Impact of numeric and traffic light calorie labels on label use, purchasing, and intake among young adults”* (Kirkpatrick)
- Ontario Early Research Award: \$150,000 for *“Building capacity in dietary assessment”* (Kirkpatrick)
- UW Water Institute Seed Grant: \$18,500 for *“Integrated Assessment of Agricultural Best Management Practices and Phosphorus Runoff”* (Deadman)
- Global Water Futures Program: \$2,761,700 for *“Agricultural Water Futures in Canada: Stressors and Solutions”* (Deadman)
- SSHRC Partnership GRF Extension Plan fund: \$41,000 for *“Hedgelaying in the Ontario Landscape [UNIT 4 50658 10006]”* (Quilley)
- SSHRC IDG Fund: \$62,752 for *“A Pattern Language for Traditional Music and Sustainable Communities”* (Quilley)
- NSERC Discovery Grant: \$29,000 (yearly to a total of \$145,000 over 5 years) for *“Uncovering ‘perfect storms’ among possible events affecting complex systems”* (Schweizer)
- SSHRC Insight Grant: \$232,000 for *“Ideological Conflict Project (ICP)” as a component of the “Rapid Ideological Change (RIC) Project”* (Homer-Dixon)

COMPLEX-SYSTEMS GRANTS OBTAINING FUNDING BY WICI CORE MEMBERS 2016-2020

2019

- NSERC Discovery Grant - \$37,000 for *“Transitions and thresholds in global ecological changes of forest ecosystems”* (Anand)
 - Ontario Research Funds – Research Excellence (ORF-RE): \$93,000 (Total award of \$620,000 over 2018-2024) for *“Computational Peer Review through Identification and Captioning of Gigapixel Digital Pathology Scans”* (Crowley)
 - NSERC Collaborative Research and Development (CRD): \$82,000 for *“Driver Behaviour Learning”* (Total award of \$164,000 over 2018-2021) (Crowley)
 - Mitacs Globalinks Research Travel Award: \$6,000 for *“Integration of Scientific Workflows in Geoscience”* (Crowley)
 - NSERC Collaborative Research and Development (CRD): \$39,600 for *“Trace Analysis for Safety Assurance of Critical Software Systems”* (33% of total 120,000 award) (Crowley)
 - National Research Council – UW Collaboration Centre for AI/Cybersecurity/IoT: \$90,000 for *“Automated Material Synthesis Using Deep Reinforcement Learning”* (Crowley)
 - Waterloo Artificial Intelligence Institute, Microsoft, AI for Social Good \$25,000 for *“Artificial Intelligence and Wildland Fire Management”* (50% of total award of \$50,000) (Crowley)
 - Canada Foundation for Innovation & Ontario Research Fund (CFI-ORF): \$212,659 for *“GIS based virtual and augmented reality tools”* (Deadman)
 - Global Innovations in Character Development Grant from Templeton World Charity Foundation: \$299,919 for *“Measuring and developing the character strengths of wisdom in low-security contexts: Testing new approaches in Sri Lanka and the Philippines”* (Grossmann)
 - SSHRC Insight Grant: \$239,703 for *“Wisdom to know the difference: Unpacking knowledge of strategy-situation fit and its relationship to context-sensitive cognition”* (Grossmann)
 - Canadian Institutes of Health Research (CIHR): \$15,000 for *“Accelerating methods for characterizing dietary patterns”* (Kirkpatrick)
 - Canadian Institutes of Health Research (CIHR): \$914,175 for *“Measuring cardio-vascular Outcomes in Depression in referred Youth (MODIFY)”* (Kirkpatrick)
 - Canadian Institutes of Health Research (CIHR): \$2,994,975 for *“International food policy study: Evaluating the impact of food labelling, marketing, and fiscal nutrition policies”* (Kirkpatrick)
 - Australian Research Council Discovery Grants \$254,200 for *“Accuracy and cost-effectiveness of technology-assisted dietary assessment”* (Kirkpatrick)
 - US National Cancer Institute (contract): \$13,351 for *“Measurement error in self-report dietary intake data”* (Kirkpatrick)
 - NSERC Discovery Grant: \$205,000 for *“Automatic Computational Understanding and Manipulation of Finite Discrete-Event Dynamical Systems throughout Natural Sciences and Engineering”* (Nehaniv)
 - Canada Foundation For Innovation - John R. Evans Leaders Fund (CFI-JELF) and Ontario Research Fund (ORF) (with other funding source(s)): \$930,812 for *“Infrastructure for Social & Intelligent Robotics”* (Nehaniv)
 - US Air Force Office of Scientific Research (awarded via University of Hertfordshire): \$108,150 for *“Novel Computational Methods for Predicting Transitions in Spatiotemporal Neurodynamics between Attention and Mind-wandering”* (Nehaniv)
 - Natural Sciences and Engineering Research Council of Canada (NSERC) CRD: \$600,000 for *“Artificial Intelligence-based Tools for Fresh Produce Procurement Price Decisions as Applied to Canadian Distribution Centers”* (Parker)
 - Cities of Kitchener: \$18,750 for *“Residential Property Values and Active Transportation Infrastructure”* (Parker)
 - Global MITACS: \$6,000 for *“A Pattern Language for Traditional Music and Sustainable Communities”* (Quilley)
 - UW/SSHRC RIF: \$10,000 for *“Scientometric tools and complex systems modelling for solution-oriented assessment”* (Schweizer)
 - NSERC Discovery Grant: \$29,000 (yearly to a total of \$145,000 over 5 years) for *“Uncovering ‘perfect storms’ among possible events affecting complex systems”* (Schweizer)
-

COMPLEX-SYSTEMS GRANTS OBTAINING FUNDING BY WICI CORE MEMBERS 2016-2020

2020

- COVID-19 Rapid Research Fund, Ontario Ministry of Colleges and Universities: \$148,624 for “How to re-open Ontario’s economy without causing a resurgence of COVID-19” (Anand/Bauch)
- NSERC Alliance COVID-19 Grant: \$50,000 for “Public Health Interventions in the COVID-19 Endgame: Insights from Percolation Theory” (Anand/Bauch)
- New Frontiers in Research Fund (NFRF) Exploration Stream: \$125,000 for “Navigating the Climate Emergency with Coupled Human-Environment Models” (Anand/Bauch)
- Templeton World Charity Foundation: \$32,833 for “Post-pandemic kaleidoscope: Documenting social scientists’ wisdom on how to navigate the new normal” (Grossmann)
- SSHRC Connection Grant - \$15,926 for “Behavioural and Social Scientists’ Wisdom for Navigating the New Normal” (Grossmann)
- Health Canada: \$40,000 for “Developing and Validating a Screener to Assess Alignment of Intakes with Canada’s Food Guide” (Kirkpatrick)
- Public Health Ontario Locally Developed Collaborative Projects \$15,692 for “Validation of a food literacy measure for use in public health practice” (Kirkpatrick)
- US National Institutes of Health \$143,896 for “Machine Learning to Inform Dietary patterns to Promote Healthy Pregnancy Outcomes” (Kirkpatrick)
- Canadian Institutes of Health Research (CIHR): \$286,876 for “Monitoring ultra-processed food intake in Canada” (Kirkpatrick)
- AI For Good: \$25,000 for “Using deep learning to understand dietary patterns” (Kirkpatrick)
- NSERC Discovery Grant: \$29,000 for “Uncovering ‘perfect storms’ among possible events affecting complex systems” (Schweizer) (supplemental award of 1 additional year for Early Career Researchers)
- Interdisciplinary Centre on Climate Change (IC3) Seed Grant: \$8,000 for “Understanding the need and role of climate intervention strategies in Canadian climate policy” (Schweizer)

3.3 SCHOLARLY PUBLICATIONS AND OUTPUTS

The outputs listed in Table 3 are all **self-reported** by core members as being complex systems works related to their WICI core projects. When reporting this information annually, core members consider the outputs developed in relation to intangible contributions of WICI, such as work that originated through involvement with and/or partnerships made through WICI events.

Table 3: Core Member Scholarly Publications/Outputs

CORE MEMBER OUTPUT TYPE	2016	2017	2018	2019	2020
PUBLICATIONS	51	45	62	72	65
PUBLICATIONS IN PRESS	7	10	20	18	12
INVITED/KEYNOTE PRESENTATIONS	13	14	11	5	10
OTHER PRESENTATIONS	14	19	40	64	40
WORKSHOPS/CONFERENCES ORGANIZED	5	5	10	9	7
OP-EDS/MAGAZINE ARTICLES	2	1	2	2	25
OUTREACH: RADIO/PRINT INTERVIEWS	10	4	19	18	40+
HONOURS, DISTINCTIONS AND AWARDS*			5	9	10

**Notes: Data for Honours, Distinctions and Awards was not collected prior to 2018.*

A full list of self-reported WICI core member publications is included in [Appendix E: Core Member Complex Systems Publications 2016-2020](#).

Core members make up only about 8% of our total membership at this time. In her recent project, [Mapping Canadian Complex Systems Scholarship](#), WICI Graduate Research Assistant Jinelle Piereder determined our self-reported core member publications represent only about **6.3%** of complex systems research at University of Waterloo (2020). Table 4 summarizes the number of publications that Piereder analyzed in the project’s bibliometric analysis.

Table 4: Scholarly Complex Systems Publications in Scopus up to 2019

Scholarly Publications Captured in Scopus by Complex Systems Query (up to 2019)			
MEMBER STATUS	CAPTURED	NOT CAPTURED	TOTAL
Core and External Core Members, self-reported	31	202	233
Core Members, all publications	102	583	685
Core and External Core Members, all publications	150	739	889
All WICI Members (non-student) publications	356	1806	2162
University of Waterloo researchers, Complex Systems Query	3671	n/a	3671

WICI recognizes that tracking outputs of its members is challenging and may not fully reflect the true scope and impact of WICI or of complex systems research as a whole. However, such information has been collected and reported annually for core members over the past five years and thus warrants inclusion in this progress report. Piereder’s report provides compelling insight toward improved future reporting and analysis that will play a key role in defining future metrics for success, as discussed further in [Section 6.3 Metrics for Success](#).

3.3.1 WICI OCCASIONAL PAPERS AND BRIEFS

To provide a venue for dissemination of research findings for core projects and other local complex systems scholars, WICI established an [Occasional Paper Series](#) in 2012. Papers are written by both established and early-career scholars and are reviewed by WICI core members, undergo copyediting, and are posted for public download.

In 2015, WICI reported over 10,000 views of the first five Occasional Papers, and the webpage for accessing these papers continues to record average traffic of around 1,000 visits per year. This very high readership demonstrates that early career scholars associated with WICI are producing high-impact complex systems research. As of December 2020, there are five forthcoming occasional papers in development and/or review for publication.

3.3.2 SOFTWARE TOOLS AND OTHER RESOURCES

In the past, WICI has prioritized the internal creation and dissemination of software tools for analysis of complex systems. Tools such as [Empathica](#) and LUXE, have been developed through WICI core research projects. Other tools were developed for the WICI-sponsored Data Challenge competition in 2013, which was designed to improve the exploration, analysis and visualization of complex-systems data. The winner of the competition was awarded a \$10,000 prize and a symposium to disseminate the tools was organized.

WICI core member Dawn Parker is an active participant in hosting a global archive for software code via the Network for Computational Modeling in Social and Ecological Sciences, and development of an international Open Modelling Foundation, in collaboration with Arizona State University. Models for managing data related to complex systems are continually evolving and are a large part of complex

systems research, and the application of modelling frameworks and tools to real-world problems and decision making will be of continued importance to WICI over the next five years.

Other resources available through the WICI website include a list of relevant complexity courses, career opportunities, events and information from Complexity Institutes, and announcements of funding opportunities.

3.4 SEED AND PARTNERSHIP GRANTS

To enhance support for complex systems researchers at University of Waterloo, WICI has provided **\$37,150** to University of Waterloo complex systems researchers, through two grant challenges run in 2016 and in 2019. Table 5 lists the successful applicants for these awards.

In 2016, WICI invited applications for small grants to support development and submission of funding proposals to support complex systems research at the University of Waterloo (\$5,000 - \$10,000, commensurate with the scope of the developed proposal). Applications were to have a substantive complex systems focus, but could be from any academic domain, and had to clearly indicate how the work would lead to a novel direction. These funds contributed to hiring of coop students, research associates, application to larger grant opportunities (NSERC Discovery, AI for Social Good, SSHRC Insight), and successful grant awards from the Centre for Aging and Brain Health Innovation (Patel), and Global Water Futures (Deadman).

In April 2019, WICI offered another seed grant to be competitively awarded. Anna Klinkova, University of Waterloo Assistant Professor in Chemistry, was awarded a SEED grant for her project, *Assessment-guided development of electroorganic CO₂ fixation to value-added chemicals*, \$8,000. This funding was used to support a part-time postdoctoral fellow, Rachelle Choueiri, and led to a successful Trailblazer fund that allowed the team to hire a life-cycle-analysis postdoc. A publication from this project is in progress and further research funding proposals are also in development.

“Funding from WICI was used to support a part-time postdoctoral fellow and led to a successful Trailblazer fund and further research funding proposals.”

-Anna Klinkova
Assistant Professor, Chemistry
2019 WICI Seed Grant Recipient

Table 5: WICI Seed and Partnership Grant Recipients

WICI Seed and Partnership Grant Recipients				
YEAR	RECIPIENT	FACULTY	PROJECT TITLE	AMOUNT
2016	Patel, T	Science	Complexity in Medication Use: Older Adults and Capacity to Manage Medications	\$9,950
2016	Bauch, C	Math	Using Digital Social Data to Detect Early Warning Signals of Regime Shifts in Coupled Human-Environment Systems	\$10,000
2016	Deadman, P	Environment	Impact of Tank Rehabilitation on the Resilience of Rainwater Harvesting Institutions in South India	\$9,200
2019	Klinkova, A	Science	Assessment-guided development of electroorganic CO ₂ fixation to value-added chemicals	\$8,000

In recent years, it has become evident WICI researchers would value increased support in the area of networking and shepherding through the grant proposal and application process, especially for interdisciplinary research teams spanning multiple faculties pursuing large awards. Over the next five years, WICI aims to more specifically target research grant supports that address this need, in particular offering administrative coordination and cross-faculty networking events.

3.5 WICI SPONSORED EVENTS

A regular program of WICI Conferences, workshops and seminars allow us the opportunity to support, develop, and disseminate research from WICI’s core projects, as well as highlight and share other current research developments related to complex systems.

WICI averages between eight and ten events per year, including two to four talks each semester and at least one workshop every year, with a major conference or symposium every two to four years. The majority of our events have been very well attended, and represent a mix of faculty, students and community members from all faculties. In the past five years, WICI has hosted **5** conferences and/or symposia, **15** workshops and **47** seminars and/or talks.

3.5.1 CONFERENCES/SYMPOSIA AND WORKSHOPS

As summarized in our annual reports, a diverse audience of student, academic, and community members have attended and participated in these events. Feedback collected from these activities indicate that participants enjoyed the activities, workgroups and seminars, learned relevant information related to complex systems, and connected with other researchers from different disciplines and/or geographic locations. Student involvement was extensive and many of those who have attended WICI conferences and/or workshops listed in Tables 6 and 7, typically indicate they would like to continue seeing similar future events through WICI.

Table 6: WICI Conferences/Symposia

DATE	WICI CONFERENCE/SYMPOSIA EVENT	ATTENDEES
Nov 2016	Waterloo Urban Growth & Change Research Group Symposium	n/a
May 2017	Living on the Precipice: Interdisciplinary Conference on Resilience in Complex Natural and Human Systems	125+
Jun 2018	Conference on Modelling Complex Urban Environments	100+
Apr 2019	WICI Complex Systems Student Project Symposium	50+
Nov 2019	Synergies Cross-Disciplinary Design Colloquium at School of Architecture	60+

“Conference participation allowed our research team to enter into a large consortium...to make substantial progress toward our research goals...and to the application for two large international research calls.”

-Dominique Prunetti, University of Corsica,

2018 WICI Conference on Modelling Complex Urban Environments

Table 7: WICI Member Workshops 2016-2020

DATE	WICI MEMBER WORKSHOP TITLE (*WICI sponsored and/or hosted event)
2016-2017	Web-based Reproducible Data Analysis: MIRACLE
2016-2017	Field’s Institute on Human-Environment Sustainability*
2017-2018	Complex Institutional Systems and Urban Sustainability Outcomes*
2017-2018	Leveraging Systems Approaches to Improve Human and Planetary Health*
2017-2018	Development of a Code Kernel for Agent-Based Land Market Models, Part 1
2017-2018	Health in the Anthropocene
2017-2018	Analyzing Dietary Data, with a Focus on Distributions of Usual Intake
2017-2018	Assessing Diet in Intervention Studies
2017-2018	Deconstructing the Ideological Complexity of Right-Wing Populism Across Borders*
2017-2018	Qualitative Methods as Tools for Enacting a Systems Approach
2018-2019	Research Faculty Networking Event*
2018-2019	(The) State(s) of Complexity Workshop (CANSEE)*
2018-2019	Open Format Conversations on Complexity*
2018-2019	Research Networking Lunch for New Frontiers and NSERC Alliance*
2019-2020	Socio-Hydrology: Opportunities and Challenges

3.5.2 WICI TALKS/SPEAKER SERIES SEMINARS

The WICI Speaker Series brings experts in their field to University of Waterloo to speak on topics of their choice relevant to complexity science and offers local scholars a chance to showcase their work. Attendees generally include faculty and students from various departments and members of the local community and, in the case of our conferences, international scholars as well.

As mentioned above, WICI has hosted **89** seminars in its lifetime (**47** over the past five years), recordings of which have been viewed **7,997** times. A full list of recorded WICI webinars and seminars is available on the [‘Events’ page](#) of the WICI website.

“I have attended several Speaker Series organized by WICI and have always learned a great deal about complex problem solving from diverse perspectives.”

-Adrienne Mason
WICI Student Member
2019 WICI Member Survey

3.5.3 RESEARCH NETWORKING EVENTS

In 2019, WICI hosted two well-attended faculty networking events (the second of which was co-hosted with Faculty of Science) to connect faculty members across disciplines with common research interests, and to encourage interdisciplinary collaborations ahead of the New Frontiers Research Fund and/or Trailblazer grant(s). With administrative and graduate student support to collect and organize participant information, these events had strong potential for building interdisciplinary grant proposal team(s) for impactful complex systems research. Over the next five years, WICI will build a regular program of structured networking events, with strategic timing around specific collaborative grant calls, and with formal, structured coordination and follow-up activities to support development of strong interdisciplinary complex systems research grants.

3.6 NEW COLLABORATION OPPORTUNITIES

Over the past five years, two thirds of the collaborative and planning discussions that WICI has engaged in have occurred as a result of WICI being discovered either from our web presence, internal referrals or through our ever-growing network of researchers. This level of external engagement is very positive for WICI and signifies that the institute's name and reputation is appealing to a growing scientific and professional community.

The following is a list of some of the collaborative talks that WICI engaged in over the past two years, most of which were discussed more thoroughly in our 2019 and 2020 annual reports:

Aspen Institute – discussion regarding education program for community development professionals who need tools and trainees for addressing complex systems problems with Kirsten Moy

Canadian Mortgage and Housing Corporation – partnership in Open Research Area international grant application for “Exploring housing policy complexity: Cross-scale modelling of housing market drivers, interactions and impacts” and common areas of interest for future research in development of qualitative models to explore systems dynamics in housing markets

Canadian Water Network (CWN) - discussions regarding Climate Adaptation, Resilience, Innovation and Knowledge Mobilization in governance/management decisions

Cascade Institute, Royal Roads University (BC) - WICI is an Affiliated Institute of Cascade Institute, established by core member Thomas Homer-Dixon at Royal Roads University in British Columbia, as an outgrowth of WICI. Cascade Institute is hoping to collaborate on fellowships, courses and development of curricular materials on complexity at University of Waterloo.

Centre for Complexity Economics, Applied Spirituality and Public Policy at O.P. Jindal Global University – reconnected with Naresh Singh, to collaborate on a joint research paper with Vanessa Schweizer, Director of WICI

Complex Systems Institute of Paris Ile-de-France (ISC-PIF)– Strategic discussions around institutional development, Gargantext bibliographic mining program and Open Mole system for conducting sensitivity analysis for computational models

FuseForward - Mark Damm, CEO FuseForward contacted WICI to inquire about collaboration on a smart-campus model and similar projects going forward

Interdisciplinary Centre on Climate Change (IC3) - discussions regarding Climate Adaptation, Resilience, Innovation and Knowledge Mobilization in governance/management decisions

Kindred Credit Union Centre for Peace Advancement - Co-sponsorship of Map the System Challenge, student team mentoring in collaboration with Paul Heidebrecht, Director

The Problem Lab – discussions about collaboration toward a professional development offering(s) and/or industry training/cooperative education connections.

Santa Fe Institute - consultation and strategic advice regarding funding opportunities, summer schools

University of Twente - “resilient cities” meetings with Dean Toonen and dean of Environment, INTACT Centre, Canadian Water Network, Water Institute, and several University of Waterloo faculty members

Waterloo Institute for Nanotechnology (WIN) - common thematic research areas, speaker co-sponsorship

Waterloo Centre for Microbiology Research (WCMR) – areas of commonality, speaker co-sponsorship; connection with Laurette Dube with our developing Montreal node, Smart Health Cities grant development

Waterloo Data Science Institute (Proposed Institute)– synergies and joint activities outlined in a letter of support for the establishment of a Data Science Institute for computational modelling and analytics with Tamer Özsu

Waterloo Institute for Social Innovation and Resilience – discussions around collaboration, merging and/or absorption of WISIR into WICI going forward, to streamline funding and efficiencies between the centres.

3.7 DEVELOPMENT OF A CANADIAN NETWORK FOR COMPLEX SYSTEMS



Figure 4: Emerging Nodes of a Canadian Network for Complex Systems

In 2019, WICI released a [call for applications for external members](#), in exploration of the development of a Canadian Network for Complex Systems. Through this call, four major geographic nodes with potential for strong institutional support have been identified (Figure 4, above): British Columbia (University of British Columbia, Simon Fraser University, University of Victoria and the Cascade Institute), Ontario (University of Waterloo, University of Guelph and Western University), Montreal (McGill University and University of Montreal) and Newfoundland (Memorial University). Administrative leaders of these nodes will be designated “[external node coordinators](#),” and are also external core members of WICI. Currently, the network includes institutes/centres with shared research interests in complex systems.

4. MEMBERSHIP AND ENGAGEMENT

Our established network of complex systems researchers has become the cornerstone of our Institution. The following section discusses membership composition, engagement with our audience and feedback through our membership survey.

4.1 CATEGORIES OF MEMBERSHIP

WICI's membership is composed of University of Waterloo faculty, graduate students and undergraduate students, as well as external members who are leaders in the field of complexity science. Four categories of membership reflect various levels of engagement with the Institute's activities and services, and Figure 5 below illustrates the breakdown of current WICI membership by category.

CORE MEMBERS are regular, research, or adjunct university faculty who lead a long-horizon research program under the Institute's auspices. Membership lasts for the duration of the member's active research within WICI. Core members are expected to be active in submitted WICI-related research funding proposals, and are eligible to request support in grant preparation and matching contribution through WICI (when applicable). Speaker and workshop proposals that closely align with core members' research agendas are prioritized for WICI funding when possible. Core research projects are listed on the WICI website and progress of these projects is reported annually. Core members are expected to actively contribute to WICI activities, such as network-building, suggesting and recruiting high-interest WICI speakers, helping to organize WICI working groups, reviewing for WICI challenges and the Occasional Paper series, and related activities. In the development of the Canadian Network for Complex Systems, WICI has recently expanded core membership to include an external category.

AFFILIATE RESEARCHERS are regular, research, or adjunct university faculty or non-university researchers, including post-doctoral fellows, who actively participate in Institute activities, including its research projects or committees. Membership is ongoing with periodic outreach to confirm active status.

PRACTITIONER MEMBERS include individuals in government, the voluntary sector, and private sector interested in the Institute's research and findings and who actively participate in WICI meetings, workshops, and conferences open to a general audience. Membership is ongoing with periodic outreach to confirm active status.

STUDENT MEMBERS are students from the University of Waterloo or affiliated institutions working towards a degree on a topic of relevance to complexity science and innovation. Membership lasts until graduation, after which the members may transition to Practitioner or Affiliate Researcher status if applicable.

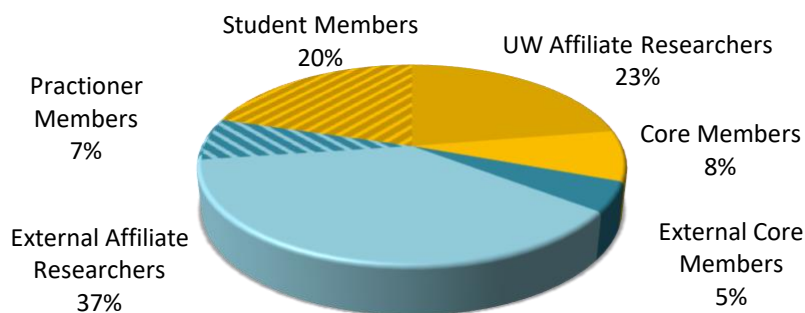


Figure 5: WICI Membership by Category

4.1.1 MEMBERSHIP BY FACULTY

WICI members represent all six University of Waterloo faculties (Figure 6), and WICI strives to maintain core membership and Steering Committee representation from each faculty. In addition, WICI strives to diversify programming and supports to engage the complex systems researchers within each faculty.

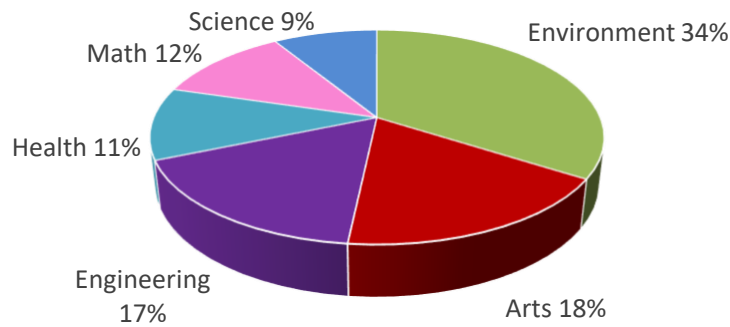


Figure 6: WICI Membership by University of Waterloo Faculty

4.1.2 APPLICATION FOR MEMBERSHIP

Interested parties can apply directly to WICI for membership through the website, by submitting a letter of inquiry and a CV, which are reviewed by WICI’s administrative leadership in consultation with the Steering Committee, to ensure their research activities reflect an active interest in complex systems science. Individuals may be invited directly to become WICI members, often once they have participated in WICI events or activities or upon the recommendation of the WICI Steering Committee or other members.

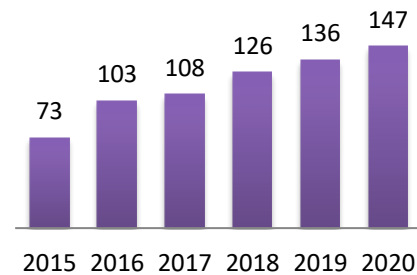


Figure 7: Yearly WICI Membership Growth

Other than core members, who are invited by the Director in consultation with the Associate Director and Steering Committee, all membership categories are designed to be open and ongoing to serve the networking goals of WICI.

Since 2015, WICI has grown steadily each year to a current membership of **147** members, as of December 31, 2020. Figure 7 illustrates the growth of WICI’s yearly membership over the past five years.

4.2 CURRENT MEMBER LIST

Table 8 lists all of the current **147** members in our database, grouped by faculty and ordered by affiliation. [Member profiles](#) are maintained on WICI’s website.

Table 8: WICI 2020 Membership List by Faculty and Affiliation

List of 147 WICI Members by Faculty and Affiliation

Faculty of Arts (9)

Igor Grossmann, Core Member, Associate Professor, Psychology
Peter Carrington, Affiliate, Professor, Department of Sociology and Legal Studies
Owen Gallupe, Affiliate, Associate Professor, Department of Sociology and Legal Studies
Michael Lawrence, Affiliate, Research Officer, Centre for International Governance Innovation
Steve Mock, Affiliate, BSIA Fellow and Lead Researcher, Ideological Change Project
Sarah Tolmie, Affiliate, Associate Professor, English Language and Literature
Clayton Dasilva, Student, Ph.D. candidate, Balsillie School of International Affairs
Scott Janzwood, Student, Ph.D. candidate, Balsillie School of International Affairs
Jinelle Piereder, Student, Ph.D. candidate, Balsillie School of International Affairs

Faculty of Engineering (18)

Mark Crowley, Core Member, Assistant Professor, Department of Electrical and Computer Engineering
Keith Hipel, Core Member, University Professor, O.C. , Systems Design Engineering
Chrystopher Nehaniv, Core Member, Professor, Systems Design Engineering
Eihab Abdel-Rahman, Affiliate, Associate Professor, Systems Design Engineering
Lisa Aultman-Hall, Affiliate, Chair, Systems Design Engineering
Kerstin Dautenhahn, Affiliate, Professor, Electrical and Computer Engineering and Canada 150 Research Chair
Paul Fieguth, Affiliate, Professor, Systems Design Engineering
Mark Hancock, Affiliate, Associate Professor, Management Sciences
Ed Jernigan, Affiliate, Professor Emeritus, Systems Design Engineering and Knowledge Integration
Ponnu Kumaraswami, Affiliate, Professor, Systems Design Engineering
Bruce MacVicar, Affiliate, Associate Professor, Civil and Environmental Engineering
Rebecca Sari, Affiliate, Assistant Professor, Civil and Environmental Engineering
Mark Weber, Affiliate, Professor, Management and Organization and Eyton Director of Conrad School of Entrepreneurship and Business
Jorge Garcia, Student, Ph.D. Candidate, Systems Design Engineering
Simon Leroux, Student, Ph.D. Candidate, School of Architecture
Ajar Sharma, Student, Ph.D. Candidate, Systems Design Engineering
Andjela Tatarovic, Student, Undergraduate Student, School of Architecture
Kirsten Wright, Student, Ph.D. Candidate, Systems Design Engineering

Faculty of Environment (27)

Peter Deadman, Core Member, Associate Professor, Geography and Environmental Management and Interim Associate Dean, Graduate Studies
Dawn Parker, Core Member, Professor, School of Planning
Stephen Quilley, Core Member, Associate Professor, School of Environment, Resources and Sustainability
Vanessa Schweizer, Director and Core Member, Associate Professor and Associate Chair, Undergraduate Studies, Knowledge Integration
Sarah Burch, Affiliate, Associate Professor, Geography & Environment Management

List of 147 WICI Members by Faculty and Affiliation

Neil Craik, Affiliate, Professor, School of Environment, Enterprise and Development (SEED) and Balsillie School of International Affairs

Sean Geobey, Affiliate, Assistant Professor, School of Environment, Enterprise and Development

Yu Huang, Affiliate, Postdoctoral Researcher, University of Waterloo

Dan McCarthy, Affiliate, Associate Professor, Environment, Resources & Sustainability (SERS)

John McLevy, Affiliate, Associate Professor, Knowledge Integration

Jeremy Pittman, Affiliate, Assistant Professor, School of Planning

Derek Robinson, Affiliate, Associate Professor, Geography and Environmental Management

Simron Singh, Affiliate, Associate Professor, School of Environment, Enterprise and Development

Hazem Ahmed, Student, Ph.D. Candidate, School of Planning

Joe Battikh, Student, Ph.D. Candidate, School of Environment, Enterprise and Development

Christina Comeau, Student, Ph.D. Candidate, School of Environment, Resources & Sustainability

Ileana Diaz, Student, Ph.D. Candidate, Geography and Environment Management

Truzaar Dordi, Student, Ph.D. Candidate, School of Environment, Enterprise and Development

Milton Friesen, Student, Ph.D. Candidate, School of Planning

Fatima Jahanmiri, Student, Ph.D. Candidate, School of Planning

Katherine Laycock, Student, Ph.D. Candidate, School of Planning

Christopher Luederitz, Student, Ph.D. Candidate, Geography and Environment Management

Adrienne Mason, Student, MSc Candidate, School of Environment, Resources & Sustainability (SERS)

Majid Mirza, Student, Ph.D. Candidate, School of Environment, Enterprise and Development

Nicholas Palaschuk, Student, Ph.D. Candidate, School of Environment, Enterprise and Development

Perin Ruttonsha, Student, Ph.D. Candidate, School of Environment, Resources & Sustainability (SERS)

Katharine Zywert, Student, Ph.D. Candidate, School of Environment, Resources & Sustainability (SERS)

Faculty of Health (7)

Sharon Kirkpatrick, Associate Director and Core Member, Associate Professor, School of Public Health Sciences

Warren Dodd, Affiliate, Assistant Professor, School of Public Health Sciences

Craig Janes, Affiliate, Professor, School of Public Health Sciences

Christopher Perlman, Affiliate, Assistant Professor, School of Public Health Sciences

Lesley Andrade, Student, PhD Candidate, School of Public Health Sciences

Julia Goyal, Student, PhD Candidate, School of Public Health Sciences and Department of Mechatronics

Kirsten Lee, Student, PhD Candidate, School of Public Health Sciences

Faculty of Mathematics (6)

Chris Bauch, Core Member, Professor, Applied Mathematics

Kathryn Fair, Affiliate, Postdoctoral Researcher, Bauch Lab

Hans de Sterck, Affiliate, Professor, Applied Mathematics

Thomas Bury, Student, Ph.D. Candidate, Applied Mathematics

Peter Jentsch, Student, Ph.D. Candidate, Applied Mathematics

John Lang, Student, Ph.D. Candidate, Applied Mathematics

List of 147 WICI Members by Faculty and Affiliation

Faculty of Science (6)

Trevor Charles, Core Member, Professor, Biology

Anna Klinkova, Affiliate, Assistant Professor, Chemistry

Tejal Patel, Affiliate, Clinical Associate Professor, School of Pharmacy

Luis Ricardez Sandoval, Affiliate, Associate Professor, Chemical Engineering

Christopher Greyson-Gaito, Student, Ph.D. Candidate, Integrative Biology

Chantal Hutchinson, Student, Ph.D. Candidate, Biology

External WICI Members (74)

Madhur Anand, External Core Member, Professor, Ecology and Environmental Sciences, University of Guelph

Laurette Dubé, External Core Member, Professor and James McGill Chair of Consumer and Lifestyle Psychology and Marketing, Director of McGill Centre for the Convergence of Health and Economics, McGill University

Liane Gabora, External Core Member, Associate Professor, Psychology, UBC Okanagan

Thomas Homer-Dixon, External Core Member, Founder and Director, Cascade Institute, Royal Roads University (cross appointed to Faculty of Env. University Research Chair)

Mary O'Connor, External Core Member, Professor, Zoology, UBC

Raja Sengupta, External Core Member, Associate Professor, Geography, McGill University

James Shelley, External Core Member, Knowledge Mobilization Coordinator, Arthur Labatt Family School of Nursing & Research Project Coordinator, Faculty of Health, Western University

Roger White, External Core Member, Professor, Geography, Memorial University

W. Brian Arthur, Affiliate, External Professor, Santa Fe Institute

Robert Axtell, Affiliate, George Mason University

Yaneer Bar-Yam, Affiliate, Founder, New England Complex Systems Institute

Michael Batty, Affiliate, Bartlett Professor of Planning, University College London and Chair, Centre for Advanced Spatial Analysis (CASA)

Marissa Beck, Affiliate, Research Director, Institute for Science, Society and Policy (ISSP)

Eric Beinhocker, Affiliate, Institute for New Economics and Said Business School, University of Oxford

Jessica Blythe, Affiliate, Assistant Professor, Environmental Sustainability Research Centre, Brock University

Teresa Branch-Smith, Affiliate, Postdoctoral Researcher, Institut Jean Nicod Epistemic Norms Lab

Virginia Capmourteres, Affiliate, Postdoctoral Researcher, University of Guelph

Monica Cojocaru, Affiliate, Professor, Department of Mathematics & Statistics, University of Guelph

Yue Dou, Affiliate, Research Associate, Environmental Geography, Vrije Universiteit Amsterdam

Niall Douglas, Affiliate, Capital Markets Platform Consultant, C++

J. Doyne Farmer, Affiliate, External Professor, Santa Fe Institute

Bill Flanik, Affiliate, Assistant Professor of Political Science - Colorado Mesa University

Carl Folke, Affiliate, Science Director, Stockholm Resilience Centre

Ian Goldin, Affiliate, Director, Oxford Martin School, Oxford University

Scott Heckbert, Affiliate, Chief Environmental Scientist, Alberta Energy Regulator, and Adjunct Assistant Professor, University of Lethbridge

Matthew Hoffmann, Affiliate, Associate Professor of Political Science, University of Toronto

Ilias Kotsireas, Affiliate, Professor, Physics and Computer Science

Jude Kurniawan, Affiliate, Researcher, Institute for Advanced Sustainability Studies

Eric Lambin, Affiliate, Professor & Senior Fellow, Woods Institute for the Environment, Stanford University

List of 147 WICI Members by Faculty and Affiliation

Anna Lawnicak, Affiliate, Professor, Mathematics & Statistics
Diana Luna-Gonzalez, Affiliate, Research Assistant, International Institute for Applied Systems Analysis
Jon Mackay, Affiliate, Lecturer, Management Sciences, University of Auckland
Hassan Masum, Affiliate, Director of Data Science, Prodigy Game
Anthony Masys, Affiliate, Associate Professor, Global Disaster Management & Homeland Security, University of South Florida
Sergey Melnik, Affiliate, Lead Data Scientist, Cara Operations
Matto Mildenerger, Affiliate, Assistant Professor, Political Science, University of California
Manjana Milkoreit, Affiliate, Assistant Professor, Political Science, Purdue University
Jukka-Pekka Onnela, Affiliate, Associate Professor, Biostatistics; Director, Health Data Science Program, Harvard School of Public Health
David A. Petrie, Affiliate, Professor and Department Head, Department of Emergency Medicine, Dalhousie University
Amanda Raffoul, Affiliate, Postdoctoral Researcher, Harvard STRIPED
Felix Reed-Tsochas, Affiliate, Director, Oxford Martin Programme on Complexity
Rob Robson, Affiliate, Principal Advisor, Institute for Healthcare Communication, Healthcare System Safety & Accountability Inc.
Sergio Rossi, Affiliate, Professor of Forest Ecology, Université du Québec
Marten Scheffer, Affiliate, Aquatic Ecology and Water Quality Management, Wageningen University
Mathias Schulze, Affiliate, Professor and Director, German, San Diego State University
Naresh Singh, Affiliate, Director, Centre for Complexity Economics, Applied Spirituality and Public Policy, O.P. Jindal Global University
Lee Smolin, Affiliate, Adjunct Professor, Physics, Perimeter Institute for Theoretical Physics
Matteo Smerlak, Affiliate, Research Group Lead, Max Planck Institute for Mathematics in the Sciences
Robert Spekkens, Affiliate, Theoretical Physicist, Perimeter Institute
Leah Stokes, Affiliate, Assistant Professor, Political Science, University of California
Shreyas Sundaram, Affiliate, Associate Professor, School of Electrical and Computer Engineering, Purdue University
William Sutherland, Affiliate, Physician & Assistant Clinical Professor, McMaster University; Founder & Director, Institute for Complexity and Connection Medicine
Isaac Tamblyn, Affiliate, Adjunct Professor, Economics, University of Ontario Institute of Technology
Mohamed Tawhid, Affiliate, Professor, Department of Mathematics and Statistics, Thompson Rivers University
Leigh Tesfatsion, Affiliate, Professor of Economics, Mathematics, and Electrical & Computer Engineering, Dept. of Economics, Iowa State
Ola Tjornbo, Affiliate, Assistant Professor, Applied Human Sciences, Archipelago Consultants
Mark Tovey, Affiliate, Adjunct Research Professor, History, University of Western
Tara Vinodrai, Affiliate, Associate Professor and Director, Master of Urban Innovation, University of Toronto
John Whalley, Affiliate, Chair in International Trade, Professor Emeritus of Economics, University of Western Ontario
Jan Wouter Vasbinder, Affiliate, Founder, Para Limes Institute, Singapore
Reza Yousefi-Nooraie, Affiliate, Postdoctoral Researcher, Institute of Health Policy, Management & Evaluation, University of Toronto
Haotian Zhang, Affiliate, Senior Research Engineer, Samsung AI Centre
Robert Babin, Practitioner, Data Analyst, Municipal Property Assessment Corporation
Kary Bheemaiah, Practitioner, Engagement Manager, Fahrenheit 212

List of 147 WICI Members by Faculty and Affiliation

Robert Cutler, Practitioner, Complex Organization and Decision Specialist, Canadian Energy Research Institute

Mark Damm, Practitioner, CEO, Fuseforward Group

Sami Houry, Practitioner, Senior Research Officer and Project Manager, Athabasca University

Xiongbing Jin, Practitioner, Senior Specialist at Canadian Mortgage and Housing Corporation

Jamie Miller, Practitioner, President, Environmental Engineering, Biomimicry Frontiers

Kirsten Moy, Practitioner, Senior Fellow, Aspen Institute

Glenn Smith, Practitioner, Director, Project Management, Communitech

Kevin Yeung, Practitioner, Transport Planning & Advisory Planner, Arup

Samuel Petrie, Student, Masters student, Spatial Determinants of Health Lab, Carleton University

Nicholas Damer, Student, Master of Arts, Political Science, Carleton University

4.3 STUDENT INVOLVEMENT

WICI is passionate about supporting students throughout their research careers. WICI core members supervise, co-supervise and graduate highly qualified personnel to the workforce with a toolbox of systems thinking competencies, as well as employ postdoctoral researchers for WICI core research projects. Many former WICI student members become practitioner and affiliate members who continue to collaborate with the wider WICI network.

The following section summarizes some of the support that has been distributed to students over the duration of WICI and some of the ways in which our student membership actively engage in WICI's events, activities and services.

"WICI has benefited me in many aspects, from providing cutting-edge knowledge on complex systems studies to offering me the chance to meet my post-doc supervisor and connect with many great professors and colleagues."

-Yu Huang

Postdoctoral Fellow and former WICI Student Member

4.3.1 CURRENT STUDENT MEMBERS

WICI student members currently make up 20% of overall membership. Figure 8 illustrates that WICI student members represent all six University of Waterloo faculties and Table 9 lists our **30** current student members, many of whom are directly supervised by WICI core and affiliate members.

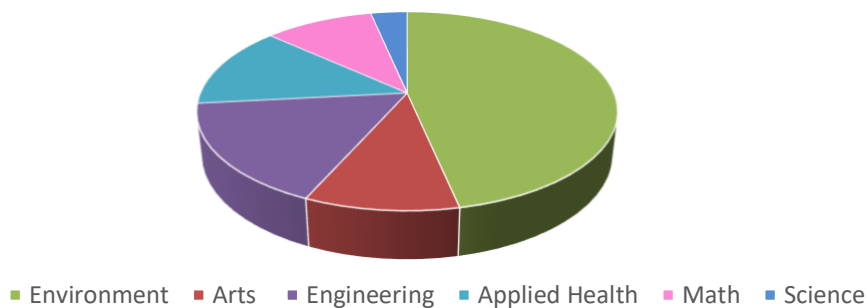


Figure 8: WICI Student Membership by Faculty

Table 9: WICI 2020 Student Members

WICI STUDENT MEMBER	DEGREE IN PROGRESS	DEPARTMENT (* = External to University of Waterloo)
Ahmed, Hazem	PhD	School of Planning
Andrade, Lesley	PhD	School of Public Health Sciences
Battikh, Joe	PhD	School of Environment, Enterprise & Development
Bury, Thomas	PhD	Applied Mathematics
Comeau, Christina	PhD	School of Environment, Resources & Sustainability
Damer, Nick	Master of Arts	Political Science *
Dasilva, Clayton	PhD	Balsillie School of International Affairs
Diaz, Ileana	PhD	Geography & Environment Management
Dordi, Truzaar	PhD	School of Environment, Enterprise & Development
Friesen, Milton	PhD	School of Planning
Garcia, Jorge	PhD	Systems Design Engineering
Goyal, Julia	PhD	School of Public Health Sciences and Mechatronics & Mechanical Engineering
Greyson-Gaito, Christopher	PhD	Integrative Biology
Jahanmiri, Fatima	PhD	School of Planning
Jentsch, Peter	PhD	Applied Mathematics
Lang, John	PhD	Applied Mathematics
Laycock, Katherine	PhD	School of Planning
Lee, Kirsten	PhD	School of Public Health Sciences
Leroux, Simon	PhD	School of Architecture
Luederitz, Christopher	PhD	Geography & Environment Management
Mason, Adrienne	MSc	School of Environment, Resources & Sustainability
Mirza, Majid	PhD	School of Environment, Enterprise & Development
Palaschuk, Nicholas	PhD	School of Environment, Enterprise & Development
Petrie, Sam	MSc	Spatial Determinants of Health*
Piereder, Jinelle	PhD	Balsillie School of International Affairs
Ruttonsha, Perin	PhD	School of Environment, Resources & Sustainability
Sharma, Ajar	PhD	Systems Design Engineering & Knowledge Integration
Tatarovic, Andjela	Undergraduate	School of Architecture
Wright, Kirsten	PhD	Systems Design Engineering
Zywert, Katharine	PhD	School of Environment, Resources & Sustainability

Through their evolving research and/or career interests after graduation, WICI student members often choose to continue their affiliation with WICI as either affiliate research or practitioner members. Currently, **20** of WICI's affiliate or practitioner members are individuals who joined WICI as student members in the past. Over WICI's lifetime, a total of **57** student members have been involved in WICI activities, and dozens more who are not active members have also attended or participated in events.

4.3.2 STUDENT AND POSTDOCTORAL FELLOW EMPLOYMENT

Since 2016, WICI has employed six Graduate Research Assistants to lead institutional development projects and conference workshops (Table 10). These projects have yielded exceptional results with a positive impact for both the institution and its members. Through 2025, WICI will continue to support and employ students in institutional development activities that support their research goals.

Table 10: Graduate Students Employed for WICI Institutional Projects

Graduate Students Employed for WICI Institutional Projects		
NAME	EMPLOYMENT TERM	WICI PROJECT
Ruttonsha, Perin	Spring 2018	Urban Growth and Change Conference
Diaz, Ileana	Summer 2018	Urban Growth and Change Conference
Wright, Kirsten	Winter 2019	Student Engagement Initiative
Piereder, Jinelle	Fall 2019	Mapping Canadian Complex Systems
Dordi, Truzaar	Summer 2020	Education Initiative
Comeau, Christina	Winter 2021	Professional Development Plan

WICI core members have also mentored a number of post-doctoral fellows (Table 11) to work on WICI core research projects. WICI continues to receive regular inquiries from highly qualified early-career scientists seeking to join WICI as post-doctoral fellows or research scientists. This interest indicates that WICI is able to attract a very strong cohort of early-career complex systems scholars.

Table 11: Postdoctoral Fellows Employed on WICI Research Projects

Postdoctoral Fellows Employed to Work on WICI Research Projects		
NAME	YEARS EMPLOYED	WICI RESEARCH GROUP AFFILIATION
Marcinow, Michelle	2016-2017	Dietary Assessment
Mock, Steven	2018-present	CAM/Ideological Conflict
Karatayev, Vadim	2019-present	Human-Environment Systems
Fair, Katharine	2020-present	Human-Environment Systems
Huang, Yu	2020-present	Urban Growth and Change

4.3.3 STUDENT AWARDS

WICI provides full-time University of Waterloo students with the opportunity to seek funding from the Institute to pursue complexity related activities that will further their own research. WICI has supported students through nearly **\$30,000** in funded travel/conference fees ([Appendix F](#)), fellowship awards and smaller prizes for 24 graduate student members.

“Without WICI’s funding, I would not have been able to attend the SIAM DS19 conference in Snowbird, Utah without significant out-of-pocket expense.”

–Kevin Church, NSERC Postdoctoral Fellow, McGill University and former WICI Student Member

In 2017, three PhD student graduate research assistantships were awarded competitively (Table 12). In February 2018, these three scholars were featured in a [WICI seminar](#) to showcase their work.

Table 12: WICI 2017 Student Fellowship Awards

WICI 2017 Student Fellowship Awards		
NAME	PROJECT	AWARD
Amanda Raffoul Public Health & Health Systems	Are we (unintentionally) doing more harm than good? Systems approaches to the prevention of eating- and weight-related disorders	\$4,000
Kevin Church Applied Mathematics	The hidden geometry of complex dynamics and how to exploit it	\$4,000
Katharine Zywert Social & Ecological Sustainability	Social-Ecological Systems Change and the Future of Human Health	\$4,000

“As a student member and recipient of the 2017 WICI Fellowship Award, I had the opportunity to seek training in complex systems concepts that served as the foundation for my dissertation research and eventual postdoctoral fellowship.”

-Amanda Raffoul, WICI Affiliate Member and Postdoctoral Fellow at Harvard STRIPED

In April 2019, WICI Graduate Research Assistant Kirsten Wright took a leadership role in organizing the WICI Complex Systems Student Project Symposium, which had over 20 participants and 10 judges from across multiple faculties. Prizes were awarded in Graduate and Undergraduate categories (Table 13).

Table 13: WICI 2019 Complex Systems Student Project Symposium Awards

WICI 2019 Complex Systems Student Project Symposium Awards		
	NAME & PROJECT	AWARD
Graduate Session		
1 st	Kathryn Fair (<i>PhD Candidate, Applied Mathematics</i>) Climate change & the future of forest-grassland mosaics	\$250
2 nd	Hazem Ahmed (<i>PhD Candidate, School of Planning</i>) Addressing barriers to adoption of source-control stormwater management practices on private residential yards in Kitchener/Waterloo	\$150
3 rd	Ajar Sharma (<i>PhD Candidate, Systems Design Engineering & Knowledge Integration</i>)	\$100
(tie)	Cauvery River: Path dependencies and feedbacks in water sharing conflicts	
3 rd	Julia Goyal (<i>PhD Candidate, Public Health and Health Systems & MME</i>)	\$100
(tie)	Navigating health and safety in Airbnb’s self-regulating system	
Undergraduate Session		
1 st	Erica J. McDonald (<i>School of Public Health and Health Systems</i>) Examining the association between marginalization and emergency room wait times in Ontario	\$250
2 nd	Amanda Pereira (<i>School of Public Health and Health Systems</i>) Quality of care for persons with concurrent substance use and mental health	\$150
3 rd	Mona Qutub (<i>School of Public Health and Health Systems</i>) Potential unintended consequences of co-operative education: Food insecurity among undergraduate students at University of Waterloo	\$100

4.3.4 WORKING/READING GROUPS

In addition to earlier working groups organized around Agent-Based Modeling, Complex Health Innovation, and Network Science, WICI has facilitated the following University of Waterloo faculty and student reading/working groups held over the past five years:

COMPLEXITY, NETWORKS AND ORGANIZATIONS WORKING GROUP: WICI Member Jon Mackay contacted WICI to establish a working group as a forum to bring graduate students and interested faculty together to share knowledge and experience around complex systems scholarship and methods. Interests of participants included ecology, sustainability, network science, new approaches to business, and economics. Meetings were organized around research presentations, journal paper discussions, and workshops around new methodologies. The group gathered to discuss how a complex systems reading/learning group might be organized and what the goals might be. Student member Jonathan Hui presented his work titled “Return of the Empires: China and the US as world ecologies” to this group on November 18, 2019.

“I got to know many graduates across the campus researching different complex systems through well-organized bi-weekly meetings.”

-Yu Huang, WICI Affiliate Member and Postdoctoral Fellow

“TOWARDS A SCIENCE OF CITIES” READING AND

WRITING GROUP:

The WICI 2018 reading and writing series, Navigating the Complexity of Urban Systems, was designed to lead into its spring conference on Modelling Complex Urban Environments and spanned four key topics: (1) cities as complex adaptive socio-ecological systems; (2) qualitative, quantitative, and design-based urban analyses; (3) networks, scale and emergence; and, (4) planning for transition. Participants reviewed, discussed and reflected on 27 readings related to the themes, and compared, critiqued and charted complexity approaches as applied to urban systems. The group also held two workshops as part of the WICI 2018 spring conference and is preparing a journal article, “A Science of Cities for Sustainable Development” (Ruttonsha, Milne, Wright et al, in preparation).

WICI DESIGN CHAPTER: In 2019-2020, WICI student member Simon Leroux organized a group of students at the University of Waterloo School of Architecture in Cambridge, Ontario. This group was able to engage both undergraduate and graduate students of the School of Architecture in complexity theory and connect them with members of WICI to organize a cross-disciplinary colloquium on design. The [colloquium event](#) was held in November, 2019 and featured graduate students from a diverse range of academic backgrounds presenting their thesis work, with moderated discussion panels, and an informal poster showcase of both undergraduate and graduate projects grounded in complexity theory and design.

4.4 MEMBER ENGAGEMENT

WICI strives to maintain effective two-way communication with its membership. Our website is actively maintained, a regular newsletter of events and information is circulated through the Mailchimp platform, and WICI actively maintains its Facebook, Twitter and LinkedIn accounts. All activity and event participants are openly encouraged to subscribe to the newsletter as an initial access point and are invited to learn more about WICI on our webpage. In addition, official member surveys have been conducted to evaluate the services and activities offered, and many informal collaborative discussions have taken place over the years.

4.4.1 ONLINE ENGAGEMENT

WICI's website continues to be the primary source for information relating to the Institute. It is used to share news about upcoming events, profile WICI members, and recruit researchers and staff. Software, tools, publications, relevant career opportunities and other resources are also available on our website. As of December 31, 2020, the WICI website has had a cumulative total of **41,413** visits.

WICI has a Mailchimp email list with **591** active subscribers, which is a growth of over 44% since our first year using this platform. Members are given the opportunity to subscribe from visiting our website and/or attending our events, and can unsubscribe any time. Events and news are also publicized using WICI's social media channels. Our [LinkedIn](#) company page, [Facebook](#) page, and [Twitter](#) account are now reaching an audience of **581**, **724**, and **114** followers respectively. Figure 9 highlights our key online engagement numbers.

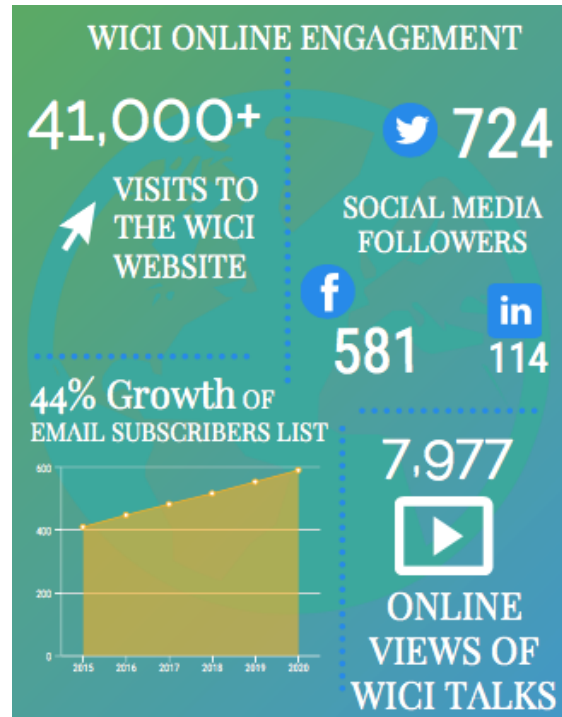


Figure 9: WICI Online Engagement

WICI records most seminars and posts the [Vimeo] video links on our website, allowing viewers from all over the world to engage with the ideas presented. As of December 31, 2020, the video recordings of core members on “[What are Complex Systems?](#)” recorded in 2018 have been viewed close to **3,000** times, and all of the WICI talks available on our website have been viewed close to **8,000** times.

The high view counts of recorded WICI talks on our Vimeo account demonstrate that in addition to capturing a significant crowd of in-person attendees, our WICI seminars are reaching an audience long after the talks have taken place. While, as expected, talks by high-profile complexity scholars (Solomon, Thagard, Eliasmith, Westley) have high view counts, many talks by early career and mid-career scholars on the University of Waterloo campus (Walker, Crowley, K. Robinson) also have high view counts, highlighting the recognized contributions of local early career scholars to complex systems science.

4.4.2 WICI 2019 MEMBERSHIP SURVEY

In fall 2019, WICI sent a survey to all current members to gauge their past interaction with the Institute and solicit their thoughts on our direction moving forward. Thirty-five people participated in the survey. This is double the number of participants who completed our 2015 member survey (discussed in the WICI 2015 Five-Year Review Report).

Respondents suggested WICI's greatest value continues to lie in sharing current research through the speakers series and/or network-building for complex systems research on campus and beyond. The next two greatest values are providing direct support for cross-faculty collaborative research and training/education opportunities through workshops, reading groups or working groups.

Thirty percent (**30%**) of respondents suggested WICI should strengthen its activities in training/education opportunities. Comments relating to training/education opportunities noted:

- “Regular trainings for students would be great”
- “Training on existing tools and methodologies: integrating approaches to complex problems”
- “More exploratory/conversational opportunities would be very interesting”
- “Best if these can include remote participation somehow”
- “Training/education opportunities could be considered that target post-docs and faculty”
- “Complex systems certificates (grad/undergrad) esp. methods classes at Waterloo”
- “Industry initiatives such as a ‘Problems solved’ seminar detailing how a company solved a problem through an analysis of complex systems” or a ‘Hard unsolved problems’ series where industry presenters seek a complex systems approach to difficult problems they face”

The full report is included as [Appendix G: WICI 2019 Member Survey Report](#).

Overall, it was determined WICI members favour a clearly defined mission and scope, which includes a continued commitment to maintaining and growing a strong local (and national) network of complex systems scholars, regular delivery of activities that include talks and/or workshops, additional training and/or education initiatives, with consideration for external members and/or partners as well as students.

5. GOVERNANCE

Given the interdisciplinary nature of WICI, administrative authority comes from the Office of Research rather than an individual faculty. WICI maintains a Steering Committee that actively advises the administrative team regarding decisions related to staffing, budget and institutional priorities. The larger WICI Board meets annually to review annual progress reports and advise on future direction. The International Scientific Advisory Committee remains available to consult with WICI and provide direction related to scientific research in complex systems. WICI strives to establish and maintain gender and ethnic diversity, as well as a diverse balance of disciplinary, research and methodological perspectives, in its oversight and membership.

5.1 CONSOLIDATION WITH WATERLOO INSTITUTE FOR SOCIAL INNOVATION & RESILIENCE

Going forward, the Waterloo Institute for Social Innovation and Resilience (WISIR) will align strategically with WICI as a sub-centre that focuses on social innovation and social resilience research. WISIR will maintain authority over its research and funding, but benefit from direct administrative support from the WICI Administrative Coordinator and continue to collaborate with WICI on core projects related to complexity, social innovation and resilience. WICI will request a member of WISIR leadership to join the Board and Steering Committee in 2021-2022.

5.2 ORGANIZATION CHART

The organization chart in Figure 10 illustrates WICI's updated Governance structure.

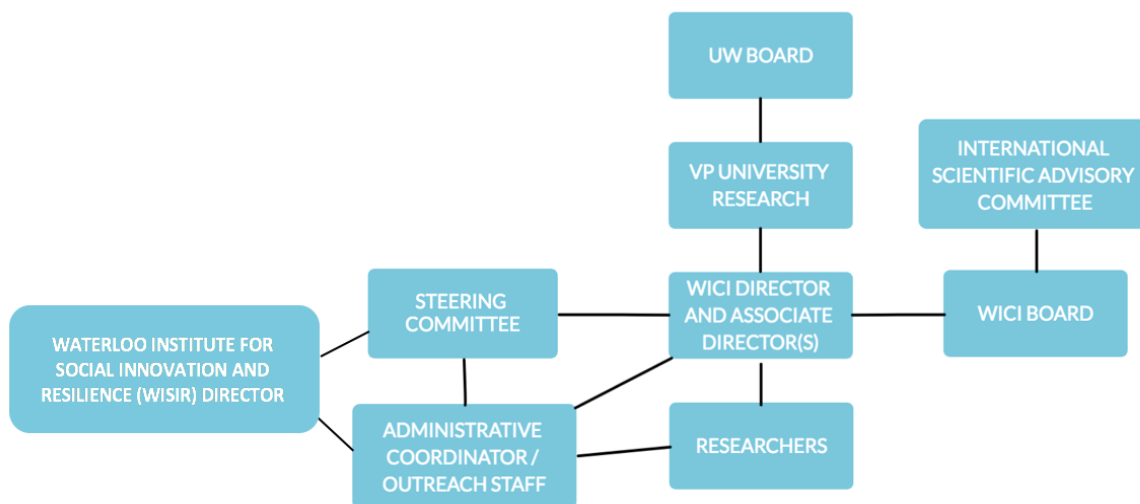


Figure 10: WICI's Governance Structure

5.3 BOARD

The Institute's Board is designed to provide advice on the general and financial management of the Institute, as well as guidance regarding the Institute's operation and research directions. The Board discusses the Institute's infrastructure needs and new initiatives, assisting WICI in identifying new areas for future growth.

Members of WICI's Board consist of:

- Vice-President Academic and Provost;
- Vice-President, University Research;
- Faculty deans or their representatives;
- WICI Director;
- WICI Associate Director;
- WISIR Director (*effective 2021*);
- Steering Committee members, other core members, or additional members drawn from university faculty, representing each of the UW faculties; and
- Three external members who are leaders in the fields of complexity science and innovation and members of the International Scientific Advisory Council, ideally selected from the Southern Ontario region.

Table 14: WICI 2020 Board Members

WICI 2020 Board Members		
James	Rush	VP, Academic and Provost (<i>or delegate</i>)
Charmaine	Dean	VP, University Research (<i>or delegate</i>)
Sheila	Ager	Dean, Arts
Lili	Liu	Dean, Health
Mary	Wells	Dean, Engineering
Jean	Andrey	Dean, Environment
Mark	Giesbrecht	Dean, Mathematics
Bob	Lemieux	Dean, Science
Vanessa	Schweizer	WICI Director
Sharon	Kirkpatrick	WICI Associate Director
Igor	Grossmann	Associate Professor, Psychology
Chrystopher	Nehaniv	Professor, Systems Design Engineering
Dawn	Parker	Professor, Planning
Trevor	Charles	Professor, Biology
Keith	Hipel	Professor, Systems Design Engineering
Sarah	Tolmie	Associate Professor, Department of English Language and Literature
Monica	Cojocar	Professor, Department of Mathematics & Statistics, University of Guelph
Anna	Lawniczak	Professor, Department of Mathematics & Statistics, University of Guelph
William	Sutherland	MD; Assistant Clinical Professor (Adjunct), Family Medicine, McMaster; Founder & Director, Institute for Complexity & Connection Medicine

5.4 STEERING COMMITTEE

WICI's Steering Committee is designed to provide advice to the Director, Associate Director, and the Vice-President, University Research on matters relating to the regular operations of WICI, including its annual budget, major activities and strategic planning. The committee is mandated to meet three or four times per year, and it may correspond more frequently as required between meetings. The Board and Steering Committee hold a joint meeting annually, for in-depth discussion of WICI activities and strategic directions.

The Steering Committee consists of:

- WICI Director;
- WICI Associate Director;
- WISIR Director (*effective 2021*);
- WICI Administrative Coordinator;
- Two or more core members representing different faculties; and
- One or two additional members drawn from the university faculty, representing participating faculties.

Table 15: WICI 2020 Steering Committee Members

WICI 2020 Steering Committee Members		
Vanessa	Schweizer	WICI Director, Associate Professor and Associate Chair of Undergraduate Studies, Knowledge Integration, University of Waterloo
Sharon	Kirkpatrick	WICI Associate Director, Associate Professor, School of Public Health Sciences, University of Waterloo
Dawn	Parker	Professor, School of Planning, University of Waterloo
Igor	Grossmann	Associate Professor, Psychology, University of Waterloo
Chrystopher	Nehaniv	Professor, Systems Design Engineering, University of Waterloo
Trevor	Charles	Professor, Biology, University of Waterloo (joined August 2020)

5.5 INTERNATIONAL SCIENTIFIC ADVISORY COUNCIL

WICI's International Scientific Advisory Council provides advice to the Board on the Institute's research priorities; it also assists WICI in establishing connections and maintaining its profile within the international complexity studies and innovation studies communities. The council is composed of outstanding complexity and innovation researchers from the university, Canada, and abroad who are core or affiliate researchers of WICI.

Table 16: WICI 2020 International Scientific Advisory Committee Members

WICI 2020 International Scientific Advisory Committee Members		
W. Brian	Arthur	External Professor, Santa Fe Institute
Robert	Axtell	Professor and Chair, Dept. of Computational Social Science, George Mason University
Yaneer	Bar-Yam	President, New England Complex Systems Institute
Michael	Batty	Professor of Planning, Director, Center of Advanced Spatial Analysis, University College London
Eric	Beinhocker	Executive Director, Institute for New Economic Thinking at the Oxford Martin School, University of Oxford
Monica	Cojocaru	Associate professor, Department of Mathematics & Statistics, University of Guelph
J. Doyne	Farmer	Professor of Mathematics and Director of Complexity Economics, Institute for New Economic Thinking at the Oxford Martin School, University of Oxford
Carl	Folke	Science Director, Stockholm Resilience Centre
Ian	Goldin	Director, Oxford Martin School, Oxford University
Matthew	Hoffman	Associate professor of political science, University of Toronto

WICI 2020 International Scientific Advisory Committee Members

Eric	Lambin	Professor, Dept. of Geography, University of Louvain; Professor, School of Earth Sciences, Stanford University
Jukka-Pekka	Onnela	Assistant Professor of Biostatistics, Department of Biostatistics, Harvard School of Public Health
Felix	Reed-Tsochas	Co-Director of the CABDyN Complexity Centre University of Oxford
Marten	Scheffer	Professor, Aquatic Ecology, Wageningen University
Lee	Smolin	Perimeter Institute; Adjunct Professor, Dept. of Physics, UW
William	Sutherland	MD, Assistant Clinical Professor (Adjunct), Family Medicine, McMaster University, and Founder and Director of the Institute for Complexity & Connection Medicine
Leigh	Tesfatsion	Professor of Economics, Mathematics, and Electrical & Computer Engineering, Dept. of Economics, Iowa State
Jan	Wouter Vasbinder	Director of the Complexity Program at the Nanyang Technological University at Singapore

5.6 ADMINISTRATION

5.6.1 DIRECTOR

WICI is led by a Director who reports to the Vice-President, University Research, and who is responsible for the management of the Institute, supervision of WICI staff members, and guiding of research and outreach agendas. **The Director is appointed by the Vice-President Academic and Provost on the recommendation of the Vice-President, University Research** for a term of up to three years, normally renewable once. The key accomplishments of WICI’s Directors over the past five years are highlighted in Figure 11 on the next page.

“The inspiration and encouragement [of the leadership of WICI] have been critical to the formation of [the Complex Adaptive Systems] group at Western. I am truly grateful for their initiative, example and vision.”

-James Shelley

Director, Complex Adaptive Systems Lab, Western University

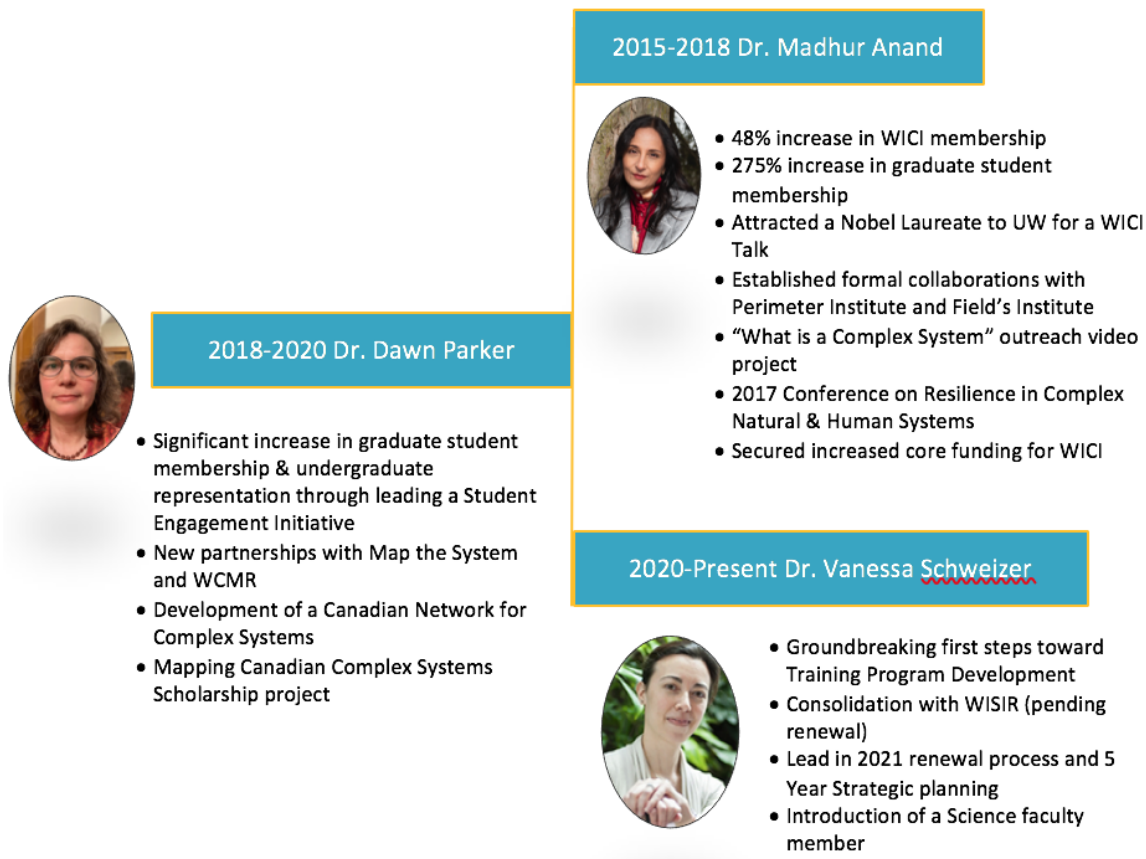


Figure 11: WICI Director Achievements of the Past Five Years

5.6.2 ASSOCIATE DIRECTOR

The WICI Director is assisted by an Associate Director. The Associate Director is appointed by the Vice-President Academic and Provost on the recommendation of the Vice-President, University Research for a term of up to three years, normally renewable once. The Associate Director assists in guidance of research and outreach agendas, and normally consults with the director regarding resource allocation decisions. The Associate Director is also expected to contribute to WICI's networking and capacity building activities. WICI's current Associate Director is Dr. Sharon Kirkpatrick. Over the past five years, the role was previously held by Dr. Vanessa Schweizer (2019), Dr. Peter Deadman (2018), and Dr. Chris Bauch (2016-2018).

5.6.3 STAFF

WICI employs an Administrative Coordinator on a part-time basis, who reports to the Director and manages general office operations. Specific responsibilities include coordinating WICI's Speaker Series, workshops and symposium; organizing travel arrangements; managing the Institute's website and member database; advertising WICI globally through the mailing list and social media accounts; and assisting with the preparation of WICI's Institutional reports. The Coordinator handles the submission of pay claims to the University of Waterloo's Finance department, maintains good records of the organization's spending and annual budget, and serves as internal liaison with University of Waterloo academic departments and administrative units.

WICI also hires Graduate Research Student Assistants to oversee and administer various institutional and outreach projects to support attainment of WICI strategic goals. A summary of Graduate Research Student Assistants employed is discussed in [Section 4.3.2 Student and Postdoctoral Fellow Employment](#).

5.7 EXTERNAL NODE COORDINATORS

As part of our development of a Canadian Network for Complex Systems, some of our external core members have indicated a desire and support to establish and lead their own ‘hubs’ of complex systems research at their respective Institutes. As such, WICI is developing a new governance category for External Node Coordinators.

EXTERNAL NODE COORDINATORS are external Canadian practitioner, affiliate or core members of WICI who take an active leadership role, with institutional support, in developing and managing external nodes. We are currently exploring the designation of three of our external members as official Node Coordinators: **James Shelley**, Director of the Complex Adaptive Systems Lab at Western University; **Mary O’Connor**, Director of the Biodiversity Research Centre at University of British Columbia; and **Raja Sengupta** of McGill University in Montreal.

6. FINANCIALS

WICI has consistently operated on a modest operating budget with our largest expenses being administrative salary and activities that support research and grant development. A financial statement for the past six years (five years of review plus an additional year of extension) and the proposed budget for the next five years are included below.

6.1 DETAILED FINANCIAL REPORT 2016-2021

Table 17 below details the itemized budget for WICI over the past six years. For a one-year extension period in 2020/21, WICI was offered interim financial support from the Office of Research and Faculty of Environment to continue operations until renewal, with the understanding the Provost would not be funding the centre. However, in 2020/21 the Office of Research was able to secure an additional full year of funding for WICI from the Provost, which resulted in a higher budget than anticipated. Restrictions to in-person activities further reduced operational expenses in 2020/21, and a substantial carryover amount has resulted, which in turn will be applied to our proposed five year budget, discussed in the next section. This investment in WICI will provided added financial stability as the institute transitions to a new funding model over the next five years.

Table 17: Financial Statement 2015-2021

Financial Report 2015-2021	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
INCOME						
Actual Carryforward from previous year	\$45,955.18	\$66,238.00	\$55,578.00	\$21,136.00	\$23,654.02	\$40,686.00
University of Waterloo Funding	\$55,000.00	\$68,000.00	\$70,000.00	\$75,000.00	\$75,000.00	\$67,500.00
Conference Registration Fees			\$4,442.48			
External Conference Support/sponsorship		\$4,000.00	\$1,848.00			
Parker 2015 Partnership Grant	\$23,000.00					
TOTAL INCOME	\$123,955.18	\$138,238.00	\$131,868.48	\$96,136.00	\$98,654.02	\$108,186.00
EXPENSES						
SALARIES						
Administrative Coordinator	\$15,600.00	\$22,379.64	\$20,971.68	\$19,638.66	\$21,942.83	\$25,423.97
Graduate Research Assistant(s)	\$5,200.02			\$7,806.69	\$10,096.30	\$16,175.02
IT Technician - Research Group Websites	\$343.20					
SPEAKERS SERIES, WORKSHOPS AND OTHER EVENTS						
Catering for Speakers Series and Meetings	\$2,193.44	\$1,630.04	\$1,390.17	\$1,079.86	\$1,442.69	
Travel, Accommodation and Meals for Speakers Series	\$3,028.13	\$8,402.82	\$6,498.42	\$3,166.11	\$3,287.29	
External Core Member Visits					\$1,869.86	\$500.00
Promotion and Marketing	\$110.34	\$469.32	\$636.74	\$532.37	\$253.66	
Sponsored Workshops	\$1,435.51		\$21,000.00			
Conference Costs		\$155.00	\$15,297.92	\$11,017.41		
GRANT SUPPORT EXPENSES						
Research Honorarium for WICI Director	\$10,000.00	\$10,000.00	\$10,000.00	\$10,000.00	\$7,500.00	\$10,000.00
WICI Partnership Grants/SEED Grants	\$14,108.00	\$236.86	\$8,892.00	\$8,000.00		
2016 Grant Challenge		\$29,150.00				
Grant Support in lieu of travel for Igor Grossmann						\$500.00
OTHER RESEARCH FUNDING						
Core Members Travel for Conferences and Networking	\$3,189.24	\$3,015.25	\$2,898.84	\$4,384.60	\$4,467.80	\$1,023.17
Additional support for SC Members						\$1,000.00
Student Research and Travel Grants	\$1,000.00	\$2,985.78	\$4,555.79	\$3,530.96	\$2,320.41	
Additional travel support for Asc. Director					\$1,812.28	
WICI Student Membership Initiative			\$3,000.00	\$1,530.05		
2017 WICI Award of Excellence			\$12,000.00			
OTHER						
IT Development and Maintenance (<i>incl. subscriptions</i>)	\$1,259.31	\$3,781.07	\$1,168.33	\$812.99	\$1,275.77	\$1,121.05
Contracted Services (<i>including editing of publications</i>)				\$263.90		
Telephone Service	\$219.49	\$241.06	\$240.64	\$239.68	\$239.38	\$239.40
Miscellaneous/Incidental	\$34.28	\$100.00	\$514.19	\$292.20	\$763.75	\$83.74
ORGANIZATIONAL DEVELOPMENT						
Institutional Development					\$1,855.87	
TOTAL EXPENSES	\$57,720.96	\$82,546.84	\$109,064.72	\$72,295.48	\$59,127.89	\$56,066.35
Projected Carryforward for the next fiscal budget	\$66,234.22	\$55,691.16	\$22,803.76	\$23,840.52	\$39,526.13	\$52,119.65

6.2 PROJECTED BUDGET 2021-2025

It is imperative that WICI has a sustainable budget model in place to fulfill the research and training objectives defined in [Section 1.2.3](#). While many WICI members have strong industry partner research portfolios, with complex systems science's strong focus on novel basic science, interdisciplinarity, and high-risk/high-gain research, industry partnership funding opportunities are not currently a primary funding source for WICI. As a shift away from central university funding is now encouraged, WICI must consider alternate options. Thus, WICI will continue exploration of partnerships, collaborations, and alternate funding models over the next five years, with the aim to develop a funding model that could also be applied to other mid-sized centres at University of Waterloo whose focus lies beyond industry contracts, but includes substantial network-building, tri-council research, and educational activities.

There is much to be determined as to how WICI may directly capture funds from external sources, such as net revenues from professional development courses and training workshops, or donor and foundation funds identified in partnership with faculty and university advancement teams. Until a viable model can be fully developed, the budget proposed in Table 18 on the next page is based primarily on faculty deans' support with augmentation from Office of Research and carryover from the 2020/21 fiscal year. Funding commitments have been confirmed from the faculties of Environment, Mathematics,

Science and Engineering ([Appendix A](#)), while the faculties of Health and Arts have indicated that they will consider financial or in-kind resource requests for specific WICI initiatives over the next five years. The WICI Steering Committee and Board will continue quarterly and annual reviews of financial statements, and annual funding requests will be adjusted (as required) as developments are made toward the goal of establishing a viable funding model.

Table 18: Projected Budget 2021-2025

Income	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026
Projected Budget Carryover from previous year	\$52,119.65	\$54,336.50	\$43,980.50	\$29,016.00	\$16,727.00
Office of Research Contributions	\$12,000.00	\$12,000.00	\$12,000.00	\$12,000.00	\$12,000.00
Faculty Funding from the Deans & Departments	\$48,000.00	\$48,000.00	\$48,000.00	\$48,000.00	\$48,000.00
Funding from Engineering Members	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00
Income from Conference Fees/Co-Sponsorships	n/a	\$5,000.00	n/a	\$5,000.00	n/a
Grant Overhead for WICI from CIHR Grant (Parker)	\$9,000.00	\$10,000.00	\$9,500.00	\$10,000.00	\$9,500.00
External Funding from Cascade Institute (Royal Roads)	\$10,000.00				
TOTAL INCOME	\$132,119.65	\$130,336.50	\$114,480.50	\$105,016.00	\$87,227.00
Expenses					
Salaries*					
Administrative Coordinator (18 h/wk)	\$25,937.00	\$26,451.00	\$27,490.00	\$28,042.00	\$28,604.00
Graduate Research Assistant (10h/wk)	\$8,300.00	\$8,465.00	\$8,634.50	\$8,807.00	\$8,983.00
Events					
Travel, Accomodation and Catering for Speaker Series	\$1,255.00	\$7,000.00	\$7,000.00	\$7,000.00	\$7,000.00
Biennial Conference		\$10,000.00		\$10,000.00	
Workshops for UW Graduate Students			\$8,700.00		\$9,000.00
Promotion and Marketing	\$600.00	\$900.00	\$600.00	\$900.00	\$600.00
Research Funding					
Stipend for WICI Director	\$9,000.00	\$9,000.00	\$9,000.00	\$9,000.00	\$9,000.00
WICI Members Research Grant Supports	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00
SC Members Research Grant Supports (up to 7 SC members @ \$500 ea)	\$3,500.00	\$3,500.00	\$3,500.00	\$3,500.00	\$3,500.00
Additional support for Associate Director	\$500.00	\$500.00	\$500.00	\$500.00	\$500.00
Additional support for Associate Director of CNCS	\$500.00	\$500.00	\$500.00	\$500.00	\$500.00
CIHR Healthy Cities Training Platform	\$9,000.00	\$10,000.00	\$9,500.00	\$10,000.00	\$9,500.00
Student Research Grants and Awards	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00
Map the System Co-Sponsorship	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00
Office Expenses					
Yearly account subscription, software, etc.	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00	\$1,000.00
Telephone Service	\$240.00	\$240.00	\$240.00	\$240.00	\$240.00
Miscellaneous/Incidentals	\$276.27	\$300.00	\$300.00	\$300.00	\$300.00
Course Funding (to be transferred out)					
(To BSIA) for Complexity Course GGOV 622	\$9,174.88				
TOTAL EXPENSES	\$77,783.15	\$86,356.00	\$85,464.50	\$88,289.00	\$87,227.00

*2% inflation year over year

A viable financial model for WICI must include core funding for administrative support, not only to manage its public-good workshops, conferences, seminars, and student activities, but also to support large core-member grants. In the next five years, the WICI Administrative Coordinator role is projected to shift priorities with a focus on management of a growing network of members, implementation of a dynamic member database, enhanced grant application support for WICI members, financial administration for consolidated research centre(s), and potentially managing external sources of funding and/or a training program if these options prove viable.

In anticipation that WICI collaboration for multidisciplinary grants will be increasing over the next five years, WICI has budgeted for research grant support (i.e., administrative support with grant preparation, matching funds where helpful) for funding applications such as the New Frontiers competitions and Waterloo Interdisciplinary Trailblazer, and others that may be applicable. Additionally, WICI has budgeted to provide qualified complex systems graduate students with opportunities to expand the impact of their research through a WICI Graduate Research Assistant (GRA) position each year, based on the significant impact GRA research projects have made for complex systems research and education over the past few years. Additional GRA positions may be funded via the conference and workshop budgets as appropriate.

6.3 METRICS FOR SUCCESS

To ensure WICI is supporting the University faculties and departments in a valuable and measurable way, a clear understanding of which metrics, and what levels thereof would constitute “success” need to be agreed upon. WICI will seek a better understanding with University of Waterloo research leaders on this matter and will work to improve its own metrics going forward. Initial ideas for enhanced metrics include:

- With modified options on cover sheets, including a “complex systems” keyword, WICI could track and attribute applications that benefited from WICI administrative or matching support and provided directly funded or in-kind WICI activities. Applications could be given additional points 1) if funded 2) if external institutions are involved 3) if the grant has international partners 4) if it includes multiple WICI members and 5) if members are in different faculties. While administrative support for grant preparation is provided within some faculties, no unit provides it for cross-faculty complex systems grants and contracts.
- The bibliometric framework provided by the [Mapping Canadian Complex Systems Scholarship](#) project (2020) provides a means to track and attribute a subset of complex systems publications (those published in Scopus). Points could be granted for (and/or) 1) Meeting the query, 2) “Complex systems” as a key word 3) Acknowledgement for WICI support and/or membership 4) Bonus for more than 1 WICI author 5) Bonus for one or more international co-authors.
- Although manual tracking of co-supervisions would be a challenge, with sufficient administrative support, this information could be tracked manually for core members and student members via WICI’s Airtable database or through a query of graduate and committee members in consultation with the Graduate Studies office, on an annual basis.
- Current metrics, including seminar attendance and views, workshop attendance, conference attendance, website views, and external contacts, could also continue.

7. CONCLUSION: SUPPORTING THE UNIVERSITY OF WATERLOO STRATEGIC PLAN

Since WICI was established in 2010, it has covered an impressive span of services and activities, and the past five years have been no exception. WICI has continued to support and grow a solid network of complex systems researchers at University of Waterloo, in Canada, and beyond. The research accomplishments of core members, as well as our strong reputation attracting national and international attention, show we have made substantive, high-impact scientific progress in the area of complex systems science.

Looking forward, WICI members have identified a need for WICI to focus more specifically on the key directions outlined in our new strategic goals. WICI's activities, network and goals are clearly aligned to support the strategic commitments of the [University of Waterloo's Strategic Plan](#) through 2025.

Specifically, Waterloo has stated a commitment to use its **disciplinary and interdisciplinary strengths to solve increasingly complex, real-world problems**. WICI is one of the University's leaders in this pursuit, not only because of our solid interdisciplinary network, but also because our research foci include the development and application of tools and knowledge in complex systems approaches to real-world problems. WICI has carefully reviewed its research priorities for the next five years and is confident that they are aligned with the University's new strategies for **advancing research for global impact**.

In conclusion, WICI's founders, leaders, and members are passionately committed to leveraging complex systems science to address global challenges. As the world shifts to an understanding of the complexity of many of its most urgent problems, the University of Waterloo is positioned to support globally impactful research through WICI's well-established local network and emerging national network of complex systems researchers. We are poised to support the University's advancement of research, to unlock key funding initiatives for grand challenges, and to continue making a name for Canadian complex systems scholarship here at Waterloo, as we all work together toward the University's mission to advance learning and knowledge through teaching and scholarship, nationally and internationally, in an environment of free expression and inquiry.

Thank you for your time and attention,



Dr. Vanessa Schweizer

Director, Waterloo Institute for Complexity and Innovation
Associate Professor and Associate Chair of Undergraduate Studies, Knowledge Integration



Dr. Dawn Parker

Core Member and Former Director, Waterloo Institute for Complexity and Innovation
Professor, School of Planning



Dr. Sharon Kirkpatrick

Associate Director, Waterloo Institute for Complexity and Innovation
Associate Professor, School of Public Health and Health Systems

REFERENCES

- Comeau, C. (2021). *Business Plan Notes for WICI's Complexity Professional Development Program*. https://uwaterloo.ca/complexity-innovation/sites/ca.complexity-innovation/files/uploads/files/notes_for_wici_business_plan_12apr21.pdf
- Dordi, T. (2020). *Proposal for Training Program*. https://uwaterloo.ca/complexity-innovation/sites/ca.complexity-innovation/files/uploads/files/08.14_td_gra_report_1.pdf
- Piereder, J. (2020). *Mapping Canadian Complex Systems Scholarship*. https://uwaterloo.ca/complexity-innovation/sites/ca.complexity-innovation/files/uploads/files/piereder_mapping_canadian_complex_systems_scholarship_wici_report_last_draft_0.pdf
- University of Waterloo (2020). *Strategic Plan 2020-2025: Connecting Imagination with Impact*. <https://uwaterloo.ca/strategic-plan/>



FACULTY OF ENVIRONMENT | Office of the Dean
 519-888-4567 | fax 519-746-2031
 uwaterloo.ca/environment

March 4, 2021

Professor Charmaine Dean
 Vice President, Research and International
 University of Waterloo

Dear Charmaine:

I write to express my support for the application of the Waterloo Institute for Complexity and Innovation (WICI) for a five-year renewal.

Since its inception, WICI has focused on the development and application of interdisciplinary approaches to scientific problem solving, which has strong congruity with the university's Strategic Plan, *Connecting Imagination with Impact*. It is thus perhaps not surprising that the 12 core members of WICI come from 12 different academic units at University of Waterloo and that a variety of research topics are investigated by its members. All core members are active researchers, who together have attracted \$7 million dollars in external research support in 2019.

WICI has a bold and broad mission: "Facilitate complex systems collaboration, research and education within University of Waterloo and across Canada to equip students and professionals to address complex challenges". Never has a systems approach to framing, understanding and solving problems been more important, as we confront the interactions of a global pandemic, climate change and geopolitical realignment. WICI has developed a thoughtful set of strategic goals and objectives through to 2025, in order to achieve its mission.

WICI has active participation from the Faculty of Environment including five of its 12 core members, 15 of its 39 students members, as well as other affiliates. WICI's focus on environmental science, social science, business and agricultural problems provides strong connections to our Faculty's strengths. Environment students, both undergraduate and graduate, are active participants in WICI events, and these events provide them with exposure to the work of global scholars.

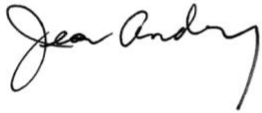
Several Environment faculty members lead WICI's core research projects. These projects have benefited from WICI-sponsored grant development workshops, administrative support for grant development, and matching support. This support has led to several substantive SSHRC projects.

WICI has facilitated the development of network connections between ENV researchers and researchers in every other Faculty on campus, as well as connections with other universities including Royal Roads and its newly formed Cascade Institute. WICI also has been instrumental in forming the Canadian Network for Complex Systems.

In all, I believe WICI continues to fill an important cross-campus niche in systems-focused scholarship, and the increased funding of its core members and strong strategic plan bode well for its future.

The Faculty of Environment is pleased to commit \$15,000 annually, for five years, to support the continuation of WICI as a Senate-approved research centre.

Sincerely,

A handwritten signature in black ink, appearing to read "Jean Andrey". The signature is fluid and cursive, with the first name "Jean" being more prominent than the last name "Andrey".

Jean Andrey,
Dean of Environment



FACULTY OF MATHEMATICS | Office of the Dean
519-888-4567, ext. 33474 | fax 519-888-4302
deanmath@uwaterloo.ca | uwaterloo.ca/math

March 9, 2021

Vanessa Schweizer
Director
Waterloo Institute for Complexity and Innovation (WICI)
University of Waterloo

Dear Ms. Schweizer,

This letter is to confirm the Faculty of Mathematics' continued support for the Waterloo Institute for Complexity and Innovation (WICI). The Faculty of Mathematics will make a contribution of \$15,000 per year, for 5 years, with an active commitment on behalf of WICI to enhance collaboration with the University of Waterloo Faculty of Mathematics and other centers of the Canadian Network for Complex Systems. This contribution is based upon the viability of WICI and continuing math involvement at current level or above.

Sincerely,

A handwritten signature in blue ink, appearing to read "Mark Giesbrecht".

Mark Giesbrecht
Dean, Faculty of Mathematics
Professor, Cheriton School of Computing Science

cc: Udaya Wettasinghe
Brenda Panasiak



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF SCIENCE | Office of the Dean
519-888-4567, ext. 30353 | fax 519-746-2543
rplemieux@uwaterloo.ca | uwaterloo.ca/science

April 13, 2021

Vanessa Schweizer
Director
Waterloo Institute for Complexity and Innovation (WICI)
University of Waterloo

Dear Ms. Schweizer,

This letter is to confirm financial support for the Waterloo Institute for Complexity and Innovation (WICI) from the Faculty of Science for the next five years. For the first two years (2021/22 and 2022/23), a contribution of \$8,000 per year will be provided, effective upon WICI's renewal in 2021. A commitment for additional funding for the next three years (2023-2026) will be determined after reviewing the level of engagement of members from the Faculty of Science with WICI over those first two years.

Sincerely,

A handwritten signature in black ink, appearing to read "R. Lemieux".

Robert P. Lemieux, PhD
Dean of Science and Professor of Chemistry



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



June 21st, 2021

Professor Charmaine Dean
Vice President, Research and International
University of Waterloo

Dear Charmaine:

The Waterloo Institute of Complexity and Innovation has the support of the Faculty of Engineering in its request for Senate renewal in 2021.

The Faculty of Engineering is pleased to provide \$10,000 annual financial support for WICI over the next five years.

Sincerely,

A handwritten signature in black ink that reads "Mary Wells".

Mary Wells
Dean of Engineering
University of Waterloo
Waterloo, Ontario, CANADA
N2L 3G1





FACULTY OF HEALTH
519-888-4567, ext. 31346 | health@uwaterloo.ca
uwaterloo.ca/health

August 4, 2021

Professor Charmaine Dean
Vice President, Research and International
University of Waterloo

Dear Professor Dean,

I am writing to express my support for the renewal of Waterloo Institute for Complexity & Innovation (WICI). WICI facilitates research that promotes innovation within the complex adaptive systems at the core of human well-being, and a complex systems lens is imperative for understanding the interplay of factors affecting human health.

In recent years, WICI has seen significant growth in membership and representation within the Faculty of Health, as well as emerging relations with other health and medical focused institutions (such as Western and McMaster University) through the Canadian Network for Complex Systems, that will undoubtedly strengthen interdisciplinary and interinstitutional collaboration over the next five years.

WICI's proposal for a workshop on "Utilizing Systems Approaches to Combat and Recover from Acute and Creeping Health Crises" aligns closely with the interests and expertise of our faculty members and I am willing to consider supporting initiatives such as this, as our budget allows, and on an as-needed basis, over the next five years.

I look forward to the continued development and growth of interdisciplinary complex systems research at the University of Waterloo through WICI's renewal and ongoing collaboration with the Faculty of Health.

Sincerely,

A handwritten signature in blue ink that reads "Lili Liu".

Lili Liu, Professor and Dean



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF ARTS
519-888-4567, ext. 38246
dean@watarts.uwaterloo.ca | uwaterloo.ca/arts

4 August 2021

Professor Charmaine Dean
VP Research and International
University of Waterloo

Dear Professor Dean,

I write to express my support for the renewal of the Waterloo Institute for Complexity & Innovation (WICI). WICI facilitates research that promotes innovation within the complex adaptive systems at the core of human well-being. Complexity science is highly interdisciplinary, and can be applied to many social science and humanities studies, including anthropology, economics, philosophy, political science, psychology, sociology, fine arts, and languages.

Traditionally the Faculty of Arts has not been broadly represented in WICI but moving forward, Director Vanessa Schweizer has shared WICI's intent to further engage with new student and faculty members within Arts. In particular, a proposal for a workshop on "Utilizing Systems Approaches to Combat and Recover from Acute and Creeping Health Crises" that is currently under development would align closely with the interests and expertise of our sociologists, psychologists studying mental health, and economists. We are excited to pursue new venues for collaboration.

While the Faculty of Arts is currently unable to commit a dedicated budgetary amount over the next five years, we are happy to work out other possibilities for support over the next five years. Resources toward the planning and hosting of WICI events, for example, can be shared on a case-by-case basis, with consideration for Faculty of Arts representation and involvement.

I look forward to the continued development and growth of interdisciplinary complex systems research at the University of Waterloo through WICI's renewal and ongoing collaboration with the Faculty of Arts.



PAS 2401, 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

Sincerely,

A handwritten signature in black ink, appearing to read "Sheila Ager". The signature is fluid and cursive, with the first name being more prominent.

Sheila Ager
Dean, Faculty of Arts

Cc: Professor Ana Ferrer, Associate Dean Research, Faculty of Arts
Professor Vanessa Schweizer, Director, WICI





THE UNIVERSITY OF BRITISH COLUMBIA

Department of Zoology
Faculty of Science
4200 - 6270 University Boulevard
Vancouver, BC V6T 1Z4

Phone 604 822 2131
Fax 604 822 2416
www.zoology.ubc.ca

March 2 2021

Dear Review Committee,

I'm writing to convey my strongest support and enthusiasm for the Waterloo Institute of Complexity Science (WICI). WICI is a truly unique institute in Canada, with a dream and a promise of creative and cross-cutting research that our country needs. I am an external core faculty, as of 2019; I will briefly share my excitement and experience with WICI and why I sincerely believe it must be renewed. As the Associate Director of the University of British Columbia's interdisciplinary Biodiversity Research Centre, and a 2020 NSERC E.W.R. Steacie Fellow, I am in a position to comment on the strengths of WICI as center and a bright spot of exciting science and innovation in Canada.

WICI is uniting scholars in Canada in a way that I sincerely believe would not be happening otherwise. This is certainly true in my experience. I am an ecologist and my research aims to understand the most likely responses of living systems to climate change (warming) in our ever-changing, complex world. This research question has led me to general scientific concepts and principles that guide research and thinking in other fields of science. During my one visit to WICI in fall 2019, I learned that these same principles are being questioned and further developed in neuroscience, computational science and computer systems. This interaction with WICI scientists following my seminar and over lunch enhanced my own research, influenced the book I am writing, and has inspired me to explore more collaboration with WICI scientists. (This conversation also led to a new paper by WICI member Paul Thagard.) This interaction would absolutely not have happened without WICI. And I say this, as a scientist who has visited the Santa Fe Institute (SFI) in the US (and I am an External Faculty there), and I also did my sabbatical in Zurich, Switzerland, and regularly joined a group of complex systems ecologists there.

It is essential that we continue to support the collaboration and networking vision that WICI offers in Canada. Local and national problems in Canada that are not going to be addressed by a complexity centre outside of Canada (e.g., SFI). Canada's culture, history, geography and natural biodiversity provide special challenges and opportunities, and only a centre in Canada for Canadian scholars can meet these challenges. WICI shares many of the successful features of the SFI model – national engagement, courses, events, promotion of complexity science, support of synthesis work. And as a research community, we can continue to use this infrastructure to benefit Canadians.

The time is right for WICI. As the world emerges from the pandemic, we are all acutely aware of the benefits of scientific collaboration and networking to find solutions to rapidly advancing problems.



WICI had momentum just before the pandemic, and I believe will realize that momentum after the pandemic. In addition to renewed attention on socio-biological problems like disease, public health and economic consequences of a pandemic, biodiversity change is emerging as a major grand challenge of the next decade. From my own experiences with NSERC and biodiversity science in Canada, WICI is going to be essential to our emerging efforts to understand problems like biodiversity change. Managing biodiversity change nationally will require both scholarly and practical work in a distributed way. This is the kind of grand challenge that WICI is already poised to approach, because of the network of scientists it has built.

Please give it another round of support, I believe the next few years will provide ample opportunities to for it to flourish and provide unique and novel perspectives and solutions to some of our greatest scientific challenges.

Sincerely,

Mary O'Connor

Mary I. O'Connor
Associate Professor, Department of Zoology
Associate Director, Biodiversity Research Centre
University of British Columbia, Vancouver, BC, Canada
604-827-5653, occonnor@zoology.ubc.ca



Department of Geography
McGill University
Burnside Hall
805 Sherbrooke Street West
Montreal, QC, Canada H3A 2K6

Département de géographie
Université McGill
Pavillon Burnside
805 ouest, rue Sherbrooke
Montréal, QC, Canada H3A 2K6

Telephone (514) 398-4111
Fax: (514) 398-7437

11th March 2021

Prof. Vanessa Schweizer
Director
Waterloo Institute for Complexity and Innovation

Dear Dr. Schweizer,

I am writing to you to indicate my strong support for the continuation of the Waterloo Institute for Complexity and Innovation (WICI), and its transformation into a pan-Canadian Institute for Complexity and Innovation.

It has been a privilege to be associated with WICI as an external member, and to be involved in several of its activities (including the seminar series). Moreover, WICI has played a fundamental role in linking my research with those of other WICI researchers. In particular, ever since I became an external member of WICI, I have increasingly partnered with your members in applying for external funding. Since 2020, WICI members and I have jointly applied for several grant applications (New Frontiers in Research Funding, CIHR-NSERC-SSHRC Healthy Cities Research Training Platform, and the Queen Elizabeth Fellows program). Needless to say, such collaborations would not have happened easily without the interactions afforded by WICI.

Moreover, WICI fulfils a lacunae in complex systems research and training that exists in the Canadian context. Interdisciplinary research in complex systems has become more important in the past two decades (as evidenced by the US National Science Foundation's "Biocomplexity in the Environment" Priority Area). Canada has now developed a critical mass of scholars who work exclusively in this area. For example, the largest number of scholars who work with Cellular Automata/Agent-Based Models within a Geospatial context now reside in Canada. Thus, initiatives like WICI are the next frontier in interdisciplinary collaboration and to harness this cohort. I personally know of great interest from individuals outside of WICI in creating a pan-Canadian network of researchers working on complex systems, whereby researchers from multiple disciplines work collaboratively on human and natural systems to study the interactions between its components. WICI can become the basis on which this future of complex systems research rests in the Canadian context. The potential to obtain an NSERC CREATE grant that trains a large cohort of Canadian graduate students in this field is a natural outcome just waiting to be implemented.

Given the rapid evolution of complex systems research in Canada and the emergence of systems and integrated thinking as a way forward, I express my strongest support for WICI and the opportunity it affords. I do hope going forward that WICI will transform itself seamlessly into the pan-Canadian Institute of Complexity and Innovation. It is but a natural path forward. Thank you,

Sincerely,

Raja Sengupta, PhD
Associate Professor
Geography & Bieler School of Environment



March 1, 2021

To Whom it may concern,

I am pleased to submit this letter to express strong support to the renewal of Waterloo Institute for Complexity & Innovation (WICI). I holds the James McGill Chair of Consumer and Lifestyle Psychology and Marketing at the Desautels Faculty of Management and am the founding Chair and Scientific Director of the McGill Centre for the Convergence of Health Economics (MCCHE). MCCHE is a unique initiative to push the boundaries of disciplinary and complexity sciences to help individuals, organizations, institutions, and policy makers to tackle, better than has been possible thus far, the most pressing challenges and possibilities facing the world at the nexus of health and economics. This work is very much in synergy with and has benefited from WICI's achievements in integrating complexity knowledge and expertise to facilitate research and innovation within the multi-layered complex adaptive systems at the core of human well-being.

I was introduced to WICI through their initiated meeting with Waterloo Centre for Microbial Research (WCMR) in 2019. It has been my priority to connect with WICI since that time, as we have been seeking partner or partners in complex systems whose research cover domains ranging from biology, to neuroscience to management and economics and that have a similar solution-oriented approach anchored into digital-powered innovation. WICI had already assembled all top Canadian researchers in that space, all performing world-leading work. I highly value access to a growing member database across Canada, as well as opportunities to learn of relevant current research and contribute ideas to addressing new challenges. Since joining as an External Core Member last year, I have facilitated the following grant applications in collaboration with WICI members from University of Waterloo and beyond:

1. Implementing Smart Cities Interventions to Build Healthy Cities (PI: D. Ma, Guelph). CIHR Training Grant: CIHR-NSERC-SSHRC Healthy Cities Research Training Platform (HCRI) - LOI \$25,000. Funded.
2. Implementing Smart Cities Interventions to Build Healthy Cities, led by Professor David Ma. CIHR-NSERC-SSHRC Healthy Cities Research Training Platform (HCRTP). \$4,950,000 (Pending)
3. Precision Convergence for Lifelong Wellness and Resilience of Individual, Organization and Society: Research Partnership for Advancing Connectional Intelligence and Real-World Navigational Support at the Human-Digital Interface (FRQSC Research Team Support Program) \$298,040 (Pending)
4. Loneliness and social isolation in the elderly: An agent-based model and digital platform for the study of multiscale determinants and simulation of post-lockdown social connectedness interventions (CIHR Operating Grant: COVID) \$579,578. Not Funded
5. Precision Retailing-Food: Navigational Pathways for Adaptive Real World Behavior and Contexts (SSHRC Insight) \$399,900 (Pending)

I feel that WICI has greatly enhanced these applications by providing initial connections with key collaborators. My connection with Professor Dawn Parker, former Director of WICI, in particular, has led me to meet Dr. Raja Sengupta and Dr. Liliana Perez, who are also WICI members based in Montreal and have collaborated with me on grant applications and strategic discussions. I was



introduced to Cascade Institute in BC to begin discussions on the potential for conceptions of the self to influence climate change action as well.

In addition, WICI administration has assisted me in promptly contacting expert researchers from WICI and University of Waterloo to recent events organized by MCCHE and WICI, including Professor Chrystopher Nehaniv (invited panelist) and Associate Professor Igor Grossmann (invited panelist), Thomas Homer-Dixon (invited panelist) and Dr. William Sutherland (speaker).

WICI's leadership have also agreed to join forces with MCCHE and Pittsburgh Supercomputing Center (a joint initiative of Carnegie Mellon and University of Pittsburgh) for launching in the coming year a new webinar series on Convergence. The CONVERGENCE webinar series will extend and bridge the scientific understanding and careful characterization of multi-scale mechanisms in biology, brain and social systems impacting real-world behavior, with the scientific understanding of the equally multi-scale mechanisms impacting organizational and institutional decision making defining the diverse and dynamics choice contexts. The vision is to enable the solution-oriented scientific study of person-centered links among innovation pipelines, delivery systems and policy-development operating within and across sectors to reimagine science, policy and innovation that better support traditional and modern economy and society in our transforming world.

It is becoming fundamental to establish research connections across faculty and institutional boundaries, and WICI has been instrumental in achieving this for much of the complex systems work I have been involved in over the past year in particular. I believe that the foundation of researchers and connections that WICI has built is imperative to the future of complex systems research and for addressing the most complex research challenges of present day.

I deeply hope that the groundbreaking value that WICI brings to the community of complex systems researchers not only at University of Waterloo but also across Canada and worldwide is recognized and served as the foundation for many years of fruitful collaboration.

Sincerely,

Laurette Dubé, PhD, MBA

Professor of Marketing, James McGill Chair of Consumer and Lifestyle Psychology and Marketing
Founding Chair and Scientific Director, McGill Centre for Convergence of Health and Economics

Laurette.dube@mcgill.ca

www.mcgill.ca/mcche



February 15, 2021

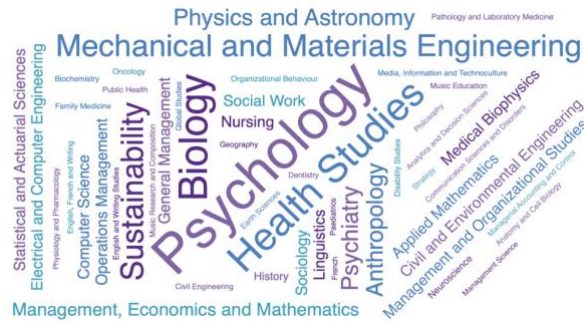
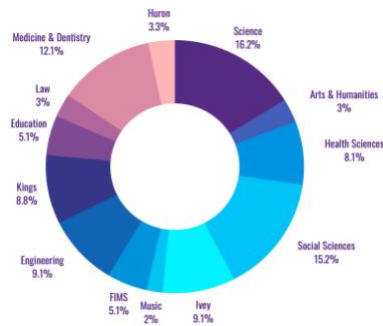
RE: Letter of support for the renewal of Waterloo Institute of Complexity and Innovation (WICI) and investment in creation of the Canadian Network for Complex Systems (CNCS)

To Whom it may concern:

I am writing in support of WICI's renewal as an institute and to support it's role in leading a national network for complex system scholarship. But first I would like to share some brief background for context.

The Complex Adaptive Systems Lab (CAS Lab) at Western University began as a small group in September 2019, inspired in no small part by WICI's July 2, 2019 call for External Core Members, with an accompanying invitation to consider the development of a national Canadian Network for Complex Systems. As a next step, we began mapping complexity scholarship here at Western, which ultimately culminated in a membership base of 90 faculty by January 2021.

Below are few images to demonstrate the disciplines, departments, and affiliate collages represented in the CAS Lab here at Western University:



I share this brief history of our lab to highlight WICI's leadership and support in galvanizing our formation as a group. WICI has, in many respects, served as both the template and the inspiration for Western's CAS Lab. But further to this point, the potential opportunity to engage a national network of complexity scholarship has served as a key impetus for the formation of the CAS Lab.

Repeatedly throughout our mapping effort, faculty members expressed concern at the difficulty of identifying and finding complex systems research collaborators in Canada. I see many indicators of the direct, mutual, and immediate value in forming a network to connect the dots of complexity scholarship across the country. Strengthening these networks of expertise and reciprocity will bear mutual dividends for all parties.

Western University, FIMS & Nursing Building (FNB) Rm. 2349 1151 Richmond St., London, ON, Canada N6A 3K7
t. 519-661-2111, ext. 89071 western.u.ca



To borrow a sporting metaphor, “the ball is in your court” to leverage the accomplishments and name recognition that WICI has achieved over the past ten years towards widening the network’s circle of influence, capacity, and leadership. Given the evident need and opportunity for interinstitutional collaboration, the University of Waterloo is uniquely positioned to build on what WICI has already accomplished.

We look forward to strengthening our relationship with WICI through the CNCS. As Western is one of six medical schools in Ontario, I also see tremendous potential collaboration opportunity for members of our group and UW’s forthcoming biomedical technology research campus in downtown Kitchener.

As COVID-19, climate change, and so many other headlines lay bare, our physical planet and social world is an array of interdependent and moving variables. The last year alone serves as a subtle reminder that the intersections of factors we experience as “the real world” do not neatly abide by our demarcation of academic disciplines. Now, more than ever, investment in systemic, interdisciplinary research and interinstitutional collaboration is crucial.

Thank you for this opportunity to express support for the renewal of WICI and for the University of Waterloo’s investment in nurturing the development of the CNCS. Finally, I would also like to extend my appreciation to the leadership of WICI over the last few years. Their inspiration and encouragement have been critical to the formation of our group here at Western. I am truly grateful for their initiative, example, and vision.

Sincerely,



James Shelley
Director, Complex Adaptive Systems (CAS) Lab – <https://cas.uwo.ca>
Research Project Coordinator, Office of the Dean, Faculty of Health Sciences
Knowledge Mobilization Coordinator, School of Nursing, Faculty of Health Sciences
Knowledge Mobilization Coordinator, Department of Geography, Faculty of Social Science
Western University
FNB (FIMS & Nursing Building) 2349
e. james.shelley@uwo.ca
t. 519.661.2111 (x89071)
c. 519.645.9169

5 March 2021

To: The evaluation committee, WICI renewal application

I am writing to express my strongest possible support for the renewal of the Waterloo Institute for Complexity and Innovation (WICI), and their continuing effort to build the Canadian Network for Complex Systems. Both of these are extremely important initiatives, and the University of Waterloo is currently the key Canadian institution in this domain.

I believe that I am well qualified to offer this support. I have been working in the area of complex systems for nearly fifty years, and on the problem of innovative systems for more than twenty, so I have witnessed the somewhat uneven development of these closely related fields for much of their history. Among others, I have worked with Ilya Prigogine, winner of the Nobel prize for his research in self-organizing complex systems, and been a visiting researcher and consultant at both the Santa Fe Institute for complex systems and Los Alamos Labs. In 1990 I was a founding researcher at the Research Institute for Knowledge Systems in the Netherlands, where we developed complexity based models of urban and regional systems, and currently I continue this work at the Flemish Institute for Technological Research in Belgium. I have authored over a hundred publications in the field, including the book *Modelling Cities and Regions as Complex Systems* (MIT press).

Historically, complex systems research in Canada has been—and continues to be—sporadic and dispersed. The field is much more strongly developed in other parts of the world, and it has therefore been more natural for Canadians to establish collaborative links with groups in other countries, especially in Europe, rather than with others in Canada.

Complex systems research depends heavily on computation—indeed simulation modelling is almost a defining characteristic of complex systems research. This has several consequences. First, the gap between fundamental research and applications to real problems is much smaller, so useful tools for practitioners in areas like urban and regional planning and ecosystem management have already been developed and are being adopted by various government agencies and corporations. But this is much more the case in Europe and Asia, where complexity research is more widespread, and more widely known. In Canada there is relatively little adoption of these tools, in part because the approach is not widely known or understood among the practitioners who would use them. This is an argument not only for strengthening the research base but also for broadening education in the area of complex systems. WICI is proposing to do this.

Another consequence of the fact that the field is simulation based is that it is relatively straightforward to integrate human and natural systems within a single formal, computational framework, so that they are treated as a single system—which in reality they are. A particular strength of WICI is that it focuses on the interaction of human and natural systems, and is thus inherently interdisciplinary. The complex systems approach is one which provides a framework for strong interdisciplinarity. In fact, it almost forces it. This is a major advantage of the approach. In contrast, in the past there have been

Finally, the computational methodology of complex systems research means that there are important synergies with Artificial Intelligence. It is ironic that Canada is a leader in AI but a laggard in complexity. One of the exciting aspects of the Waterloo Institute for Complexity and Innovation is that several of its projects are developing links with AI, and of course the University of Waterloo is the ideal location for such a research initiative.

In general, complexity research at Waterloo would be stronger if it were part of a vibrant Canadian complexity ecosystem. This is the reason that the proposal to further develop the Canadian Network for Complex Systems is vitally important, and should be supported.

I hope these points make clear the importance not only of renewing, but also of strengthening the Waterloo Institute for Complexity and Innovation.

Sincerely,

A handwritten signature in cursive script, appearing to read "Roger White".

Roger White

Honorary Research Professor
Memorial University of Newfoundland
St. John's, NL
Canada

and

Continuing Contractual Researcher
Flemish Institute for Technological Research (VITO)
Mol
Belgium



February 10, 2021

Professor Charmaine Dean
Vice President, Research
University of Waterloo

Dear Professor Dean:

I am pleased to submit this letter in support of the renewal of Waterloo Institute for Complexity & Innovation (WICI). As the founding director of the Institute in 2009, I have been delighted to see WICI grow to be the leading Canadian networking hub for complex systems research, and I am excited for WICI's further growth in coming years.

WICI's mission has been to integrate complex systems knowledge and expertise from the University of Waterloo and around the world. It facilitates research that promotes innovation within the complex adaptive systems at the core of human well-being.

This mission aligns closely with that of the Cascade Institute, which I recently founded at Royal Roads University. Indeed, the [Cascade Institute](#) is an outgrowth of WICI's activities; it would not have been created in WICI's absence. Both Institutes aim to facilitate Canadian transdisciplinary research and education to equip students and professionals with the tools they need to address the most pressing problems of the 21st century.

The Cascade Institute's work on issues related to climate change, social and economic polarization, and complexity education complements well WICI's program. Dr. Vanessa Schweizer, WICI's Director, and I communicate regularly to coordinate our activities. We aim to continue multiple lines of collaboration, especially around complexity education, in coming years. And we plan for WICI to be the future home for one or two Cascade Institute postdoctoral fellows, giving the Institute visibility and activity in central Canada.

WICI is a unique enterprise in Canada—a locus collaborative, interdisciplinary complexity research and a vital networking facilitator—at a time when complex systems science is needed more than ever in a world beset by a “polycrisis” of critical challenges. I support its renewal wholeheartedly.

Sincerely,

A handwritten signature in black ink that reads "T. Homer-Dixon".

Thomas Homer-Dixon
University Research Chair (on leave)
Faculty of Environment
University of Waterloo
Director, Cascade Institute
Royal Roads University



Letter of Support: Waterloo Institute for Complexity and Innovation (WICI)

Ottawa, 13th February, 2021.

It is my pleasure to write a letter of support for the renewal and further development of the WICI. This institute, its mission and its work have a special meaning to me. A little bit of history will help to explain. In 2001, I was the Canada Trust / Walter Bean visiting professor in the Faculty of Environment at UW. The late Prof. James Kay and I collaborated on using complex systems thinking to develop approaches to measuring sustainability. We had a small but dynamic group of people including the Dean of the Faculty of Environmental Studies, faculty and graduate students. One of my tasks as the visiting professor was to deliver an open lecture to which University and the Waterloo community were invited. At the end of my talk, I recommended the setting up of a center for the study (teaching, research and applications) of complex adaptive systems. I recall suggesting, partly in jest, that some UW alumni in the audience will have both the vision and the financial resources to make a small donation of about \$5M as an endowment to get such a center going.

In my talk I had outlined the importance of the study and use of complex systems to invigorate the highly innovative ecosystem emerging in the Kitchener-Waterloo region at the time and the importance of this work to Canada and its role in the world. (At the time I was a senior official with the UN Development Program in New York). I finished my professorship and went back to my day job in New York. But I kept in touch with both Prof. James Kay and the Dean. Imagine my surprise when I was informed a few months later an anonymous donor had indeed come forward and wanted a proposal from us. James and I worked on the proposal and completed it as I recall in a few weeks. Sadly, James got quite ill soon thereafter and passed away before long. Nevertheless, the Dean informed me afterwards that the funding did materialize but would be used as the University saw fit as neither James nor I were now affiliated with the University.

So, it was with delight that I found out from the web last year that a WICI was up and running. It had such a close resemblance of what we had in mind a while earlier! The accomplishments to date of WICI as reported in its draft progress report are commendable. Even more importantly its plans for the next 5 years are not only in the right direction, but will contribute to an area of critical need in our increasingly complex world. I am now associated with an academic center pursuing work at the public policy level to address so called wicked policy problems. I look forward to partnering with WICI. In fact, with the current director of WICI, Dr. Vanessa Schweizer, I am a co-author on a conference paper proposed for the 2021 International Conference on Public Policy. From this burgeoning collaboration, I look forward to pursuing additional opportunities that may follow. It is my ardent hope that the Institute is not only renewed but given the resources as possible to ensure its future development. Its agenda is of central importance to teaching and research in Canada and the world in the 21st century.



Naresh Singh. Ph.D.

Professor, Jindal School of Government and Public Policy, and

Director, Centre for Complexity Economics, Applied Spirituality and Public Policy.

OP Jindal Global University, Haryana. India.



Dominique Prunetti
Deputy Director of the UMR CNRS 6240 LISA
University of Corsica
Bâtiment Edmond Simeoni
Avenue Jean Nicoli
BP 52, 20250 Corte
email: prunetti@univ-corse.fr

Corte, 16 February 2021

To: Dawn Cassandra Parker, PI

Professor, School of Planning, University of Waterloo
Waterloo, Ontario, Canada

Together with Prof. Claudio Detotto, member and colleague of the UMR CNRS 6240 LISA, I attended the “Conference on Modelling Complex Urban Environments” organized by the WICI Center in Waterloo on June 21-22th, 2018. The Conference participation allowed our research team to enter into a large consortium, funded through partners’ contributions and the University of Waterloo International Research Partnership Grant, in order to develop a common code base for agent-based land market models.

The Conference on Modelling Complex Urban Environments was a fruitful atmosphere for discussions and an excellent opportunity for interactions among participants. It contributed to make substantial progress towards our research goals, as documented by our joint publications. It also represented the spark for future collaborations that has led to the application for two large international research calls (the Trans-Atlantic Platform Social Innovation Call and the Open Research Area for the Social Sciences). Both received very positive reviews.

All these reasons lead me to write in support of the Waterloo Institute for Complexity and Innovation (WICI) Renewal. The activities of this Center are indeed essential to enable further creative and effective developments in the field of agent-based land market models in Social Sciences.

Prof. Dominique Prunetti

UMR 6240 LISA – Tél. : +33 (0)6 13 34 97 88 - Email : prunetti_d@univ-corse.fr
Università di Corsica Pasquale Paoli - Bâtiment Edmond - Avenue Jean Nicoli - BP 52 - 20250 Corte
<http://umrlisa.univ-corse.fr>
www.univ-corse.fr

February 18, 2021

Dr. Bernard Duncker
Associate Vice President, Interdisciplinary Research
University of Waterloo

Dear Dr. Duncker,

I am pleased to submit this letter in support of the renewal of the Waterloo Institute for Complexity & Innovation (WICI) as I believe that WICI has become the most predominant networking hub for complex systems research in Canada.

WICI's vision and mission has been to integrate complex systems knowledge and expertise from the University of Waterloo and around the world and to facilitate research that promotes innovation within the complex adaptive systems at the core of human well-being, addressing the most pressing problems of our time.

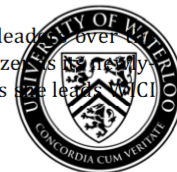
WICI is to be commended for its forward vision and mission to support Canadian transdisciplinary research and education for global impact in addressing society's grandest challenges, and for continuing to facilitate collaboration, research and education in this area. These goals are directly aligned with both the University of Waterloo's research objectives as laid out in the 2021-2025 Strategic Plan, and my own values as a complex systems researcher in the Department of Systems Design Engineering.

Many of my colleagues and I are regularly involved in WICI activities and highly value our access to a growing member database across Canada, as well as opportunities to learn about relevant current research and to contribute ideas for addressing new challenges.

In interdisciplinary fields like mine, it is important to establish research connections across faculty boundaries, and WICI is instrumental in achieving this for impactful research in the broad area of complex systems.

WICI is an important contributor to the welcoming and stimulating academic environment at the University of Waterloo in which scholarship, research and teaching can flourish. As evidenced by the receipt of the Killam Prize in Engineering and many national and international awards, my research team and I have been able to prosper as a result of this.

WICI has been fortunate to have highly talented and dedicated academics as its lead over the past several years including Prof. Dawn Parker as its previous Director and Dr. Vanessa Schweitzer as its previous appointed Director who now needs the full support of the University of Waterloo as its new lead into a promising future.



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

Most respectfully yours,



Keith W. Hipel

Adjunct University Professor, O.C.

PhD, DrHC, HDS, Killam Prize, PEng, NAE, Hon.D.WRE, FRSC, FCAE, FIEEE, FAWRA, FASCE, FINCOSE, FEIC, FAAAAS

Department of Systems Design Engineering

University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

Past President, Academy of Science, Royal Society of Canada

Senior Fellow, Centre for International Governance Innovation

Fellow, Balsillie School of International Affairs

Coordinator, Conflict Analysis Group, University of Waterloo

kwhipel@uwaterloo.ca; Tel: 1 519 888 4567 ext. 32830

Homepage: <http://www.systems.uwaterloo.ca/Faculty/Hipel/>

Conflict Analysis Group: <http://uwaterloo.ca/conflict-analysis-group/>



March 12, 2021

Re: Support for WICI renewal application

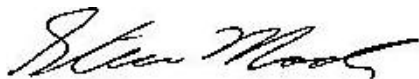
Dear reviewers,

I am pleased to support of the renewal of Waterloo Institute for Complexity & Innovation (WICI). Over the past 12 years since completing my PhD. in 2009, WICI has been instrumental in enabling me to transform my research agenda into research career, as the venue around which the Ideological Conflict Project (ICP) was established. The ICP aims to develop and apply new methods that advance understanding of the role of beliefs, ideas, and emotions in conflict behaviour, as well as the processes underlying rapid belief change. It uses concepts drawn from complexity theory to model the structure and impact of beliefs as multi-level systems involving interaction between individual minds and social institutions, thereby integrating insights from the cognitive and social sciences.

It was through WICI that the interdisciplinary research team that formed the ICP was first assembled, based at the University Waterloo but international in scope. WICI provided both the institutional structure and the theoretical tools to enable the ICP to examine the phenomenon of shared belief across the necessary disciplinary categories and levels of analysis. As Research Director of the project, I was in a position to prepare grant applications on its behalf, culminating in a 3-year SSHRC Insight Grant to develop our methods into practical tools for conflict analysis, negotiation, and resolution.

Understanding identity and ideology is increasingly recognized as crucial toward mobilizing the world's human resources around solutions to the multiple challenges faced by humanity in this century, and the ICP and WICI continue to play a critical role in ensuring that the necessary connections are made to effect such understanding. It is my sincere hope to be able to continue this work in Waterloo in collaboration with WICI over the coming years.

Sincerely,

A handwritten signature in black ink, appearing to read "Steven Mock". The signature is fluid and cursive, written in a professional style.

Dr. Steven J. Mock
Research Director, Ideological Conflict Project
Balsillie School of International Affairs



SCHOOL OF PLANNING

University of Waterloo, 200 University Avenue West, Waterloo, Canada N2L 3G1
519-888-4567, ext. 36564 Fax 519-725-2827 www.environment.uwaterloo.ca/planning

9 March 2021

Dr. Dawn Cassandra Parker
Professor, School of Planning
University of Waterloo EV3 3223
1-519-888-4567 x 3-8888
dcparker@uwaterloo.ca
<https://uwaterloo.ca/planning/people-profiles/dawn-cassandra-parker>

Dear WICI renewal and funding reviewers,

I am writing this letter in support of the renewal and provision of stable core funding for the Waterloo Institute for Complexity and Innovation. I was WICI's first associate director, helping to author WICI's first governance document and shepherd it through Faculty Senate approval. I served as WICI director first from 2013-2015, during which time I oversaw WICI's first five-year renewal, and again during 2018-2020, during which time I lead efforts to craft WICI's new direction and found the Canadian Network for Complex Systems.

It is my view that research centres serve important roles. Certainly they can help facilitate revenue-generating industry-support collaboration that results in direct consulting-style revenue streams. But they can also generate tangible and intangible connections to create applied scientific activities whose whole is greater than the sum of their parts. My letter and its call for core operating support focuses on the latter role, where WICI has made clearly documented contributions in the past, and is now poised to make higher-scale contributions in its future.

As part of our regular evaluations and now renewal, we are consistently asked to provide evidence that our scholarly and educational activities would not have occurred without WICI. Of course, even the most talented complex systems modeler cannot definitively prove a hypothetical. But for me it helps to frame this request by drawing analogy to the now ubiquitously familiar concepts of epidemic spread.

First, imagine that WICI's mission is to induce spread of a positive pandemic—dissemination of methods, applications, and interpretations of complexity science. Thus WICI succeeds by “infecting” scholars with the complexity science bug.

- Our quantitative assessment metrics, both our historical metrics and new metrics to be established in partnership with our funders, are equivalent to automatic contact tracing via a cellphone app. Our new automated query to track UW Scopus complex systems publications is an example. Expansion of a dynamic content model across campus could enable further automated contact tracing methods, such as automatic reporting of WICI-related grants and contracts and tracking of thesis committee networks.
- Anecdotes that illustrate links between WICI contacts and subsequent outputs (see many examples for me below) are analogous to manual contact tracing.
- Beyond that, we know that WICI has broader impact, for instance, when potential clients and network scholars come to us based on our broader reputation. We can see this as evidence of community spread—present and measurable but not traceable, by definition.

Just as contact tracing can attribute an infection event to a string of contacts, but can't prove that the individual would not have become infected if they had not encountered that particular infected individual, we can carefully describe a sequence of WICI contacts and their outcomes, but we cannot prove that the outcomes would not have occurred without the original contact.

A pandemic can also be considered a “public bad.” WICI provides what are called “public goods” in economics—a resource that has a positive use or enhancement of productivity, from which many can benefit, but none can be excluded. Our public lectures, also available online, are a perfect

example. When we also acknowledge that, like an epidemic, initial WICI contacts can create non-linear spread, WICI's potential public good aspects are magnified.

A well-known and compelling result in economics is that voluntary contributions will not fund public goods at the socially optimal level for two reasons. First, a potential contributor will only consider their own personal benefit, not the possibly exponential additional benefits that might accrue to others. Second, public goods funding is subject to the well-known "prisoner's dilemma," where individuals have an incentive to free-ride in the hopes that others will contribute adequately. Thus, the new funding model creates particular challenges for cross-faculty institutes such as WICI, who are asked to request core funding from all individual deans. Each dean may then under contribute, accounting only for the private benefits they see accruing to their faculty, and hoping that another dean with a higher valuation will contribute enough to keep the institute afloat.

Deans reasonably ask how WICI has benefited their individual faculty members. How have WICI contacts and activities lead to measurable positive outcomes for me? Here are representative examples of my personal WICI "manual contact tracing" history over WICI's first eleven years. The description is not exhaustive (although perhaps exhausting).

- In 2011 mathematician Monica Cojocararu from Guelph located me through the WICI website and asked me to present at the Applied Mathematics, Modeling and Computational Science (AMMCS) conference held July 25 - July 29, 2011 at Wilfred Laurier University in Waterloo, Ontario, Canada in the mini-symposium "Complex Dynamics of Population Behaviour with Impact to Socio-Economic Issues". Following this event, I presented in Dr. Cojocararu's Guelph seminar series, she presented a WICI talk (and in the process bringing some key faculty from UW, including Hans de Sterk, into the WICI community). She introduced me to Chris Bauch and Madhur Anand, both of whom also gave WICI talks. Following Dr. Bauch's move to UW, not only did he and his students interact closely with WICI, but Dr. Anand and Dr. Bauch served as WICI director and co-director for three years. Drs. Cojocararu, Anand, and Bauch helped WICI develop close ties with the Fields Institute in Toronto. For me this resulted in two invitations to speak at specialist Fields meetings. For others it has resulted in participation in several excellent co-sponsored workshops and a WICI conference. I now regularly attend the AMMCS conferences, and have located other WICI contributors, such as Dr. Jane Hefferman, a complex systems epidemiologist who also gave a WICI talk, at this conference.
- The development of my first successful tri-council grant application benefited from discussion around complexity economics and modelling markets with WICI speakers Doyne Farmer, Leigh Testfatsion, and W. Brian Arthur.
- For my second application, a SSHRC partnership development grant that ultimately had \$489,125 in municipal and industry in-kind contributions for a \$250,000 grant, we wrote a WICI funding match for about \$14k in post-doc funds.
- The post-doc from that grant, Xiongbing Jin, then collaborated with then WICI Administrative Coordinator Megan Bean, to provide administrative and managerial support for my 4-country Digging into Data grant, a highly competitive international grant program to fund computational approaches in the social sciences and humanities, which was successful.
- I subsequently organized the WICI-funded 2014 Workshop on Data Analysis and Visualization in Complex Systems, which allowed my team members the opportunity to explore the central issues in our Digging into Data grant with an international group of scholars working on similar issues across disciplines, including many non-WICI members from UW in math and science.
- The Digging into Data grant lead to longer-term collaborations with Arizona State colleagues. Currently, the international CoMSES.net organization that supports simulation modelling of coupled human-natural systems is run on Compute Canada hardware via my Platforms and Portals allocation, with software and administrative support via a US National Academies of Science grant.
- I connected with UW professor Sarah Tolmie over a shared interest in complex systems and embodied cognition. She introduced me to Benoit Charbonneau, organizer of the UW Bridges Lecture, and we gave a joint Bridges lecture called "Dancing the math of complex systems". The link is on my website, and several potential outstanding graduate students have mentioned how it caught their eye as a creative means of communicating complex systems concepts and motivated them to reach out to me as an advisor. Yesterday when I dropped a loaf of banana

bread at some friends' house, they also independently mentioned that they had just watched the video, as it came up on their You Tube feed after another documentary on chaos theory.

- In late 2017 in my role on the WICI steering committee, I took on the organization of the WICI-sponsored Conference on Modelling Complex Urban Environments. With WICI matching funds, I obtained an internal International Partnership Development grant, which funded both conference activities and two workshops, with around 45k partner matching funds for the 20k IPRG. In these workshops, building on the models developed in my first two SSHRC grants, I convened an international group of scholars to develop a common design pattern for agent-based land and housing market simulation models. To date that work has resulted in 1 publication and another in preparation.
- Following connections made at the conference and workshops, a UK collaborator lead a 6-country Transatlantic Partnership Social Innovation proposal focused on housing as a social innovation, which was recommended for funding, but not successful due to insufficient funds.
- The urban complexity conference allowed me to become more closely acquainted with Systems professor Kumaraswamy Ponnambalam, as his student organized one of our sessions, and he attended the conference. Subsequently, given my background in agricultural economics and agent-based modelling, he invited me to join himself and Professor Karray on a NSERC CERD project, funded by Loblaw's, on modelling fresh produce prices. The grant was successful, providing a partial post-doc for one of my graduating PhD students, and forming new collaborations between complex systems and AI approaches.
- In fall 2019 the Faculty of Environment arranged a campus visit from the Canadian Housing and Mortgage Corporation Housing Innovation Group. They specifically requested to meet with WICI, and as the WICI member doing housing research as well as the director of WICI, we had an extensive follow-up meeting after their campus visit. I was also connected to their research division and obtained a strong letter of collaboration for my fall 2019 international Open Research Area (social science) proposal to explore cross-scale policy interactions in land and housing markets. That proposal built directly on the team members and research frame from my workshops. Key collaborators from the UK, including Doyne Farmer, also helped us obtain letters of support from the Bank of Canada and the Bank of England. The proposal was submitted with "Complexity Science" as the main area. It received very strong reviews in the first stage (5/5/3 out of 5) and moved on to the second round, but was not funded.
- The connections with CMHC remain strong, and in particular, I'm now on the advisory committee for an Ontario implementation of the Urbanism regional economic microsimulation model, which provides direct opportunities for graduate research and will strengthen a future re-submission of the ORA grant.
- In my role as WICI director, we met with the director and staff of Waterloo Centre for Microbial Research (WCMR) to discuss synergies between our centres and explore co-sponsorship of a seminar. Their manager then met Professor Laurette Dubé from McGill, who reached out to me. Our collaborations over the last year are detailed in her support letter, but notably, they include 7 grant proposals in little over a year, including the almost 5-million-dollar CIHR/SSHRC/NSERC training proposal, which locally also includes WICI associate director Sharon Kirkpatrick, and includes many of her ideas to improve complex systems education. I know of Sharon and her work only through WICI, as she applied for and carried out a successful WICI public workshop on systems thinking.

Again, it is impossible to say which of these outputs would not have happened without WICI. However, it is notable that my multi-country international proposal that had direct WICI administrative support was funded, whereas the others, on which I had to do all the administrative work, came very close but were not funded. It is highly likely that I would not have been on the collaborative grants with Prof. Dubé without WICI, especially the CIHR training grant, and I would not have likely met Dr. Kirkpatrick.

We can also take a "difference-in-difference" approach (a statistical method for establishing causality) and look at my activity record as an assistant professor at George Mason University, where I was on-paper part of the Centre for Social Complexity, which received a portion of the overhead from my many successful NSF grants and other contracts. In that centre, the funds were controlled solely by the director (who was not me). I had no opportunity there to leverage the centre for the sorts of activities I describe above. That experience, and lost opportunity, is a

central reason why in all of my leadership roles in WICI, I have pushed for an open organization that offers many small, competitive opportunities to leverage WICI resources to further develop professional networks and opportunities.

During my George Mason years I did co-organize workshops and conferences through my role as a Global Land Project steering committee member. These did result in demonstrable impacts. For instance, current University of Waterloo Associate Professor Derek Robinson was given a lead author role from one workshop for a major overview publication as a University of Michigan post-doc, which is still one of his most cited works. And this year I reviewed a full professor promotion file for a participant in another workshop, and I was able to point to a grant and publication stream of theirs that resulted from initial contacts made at the workshop-twelve years later. But, because the activities were hosted elsewhere, other Centre for Social Complexity and broader George Mason members did not benefit from them.

The success of the Centre for Social Complexity at George Mason was in principle easy to evaluate due to the funds earned through returned overhead. But, its outputs and their public good aspects were not evaluated. In fact it would have failed any public goods test. To ensure that WICI forged a different path, I very deliberately incorporated quantitative metrics of success into the original WICI proposal, and we have tracked these metrics in every annual report. We discuss them on an annual basis with our board, which includes deans or their representatives. We responded to David Clausi's query about the extent of complex systems across UW, including WICI, by commissioning what we believe to be the first bibliometric analysis of publications under the scope of a UW centre or institute. Throughout its governance history, WICI has also worked to ensure that its activities are open and welcoming, that funds are competitively allocated, and that diversity considerations are central.

Many are asking, if WICI has received funding for ten years, why are we not self-sufficient? The answer lies at the intersection of institutional change and scale. At our five-year renewal, we had an agreement in principle (unfortunately not in writing) with George Dixon that moving forward, it would be possible for centres and institutes to submit grants through their centre and capture a percentage of the returned overhead or research support funds. We were also ensured minimal core funding, for me, a conditional of renewal. At our five-year renewal, it seemed that we had a clear path to attribute grants and contracts to WICI to demonstrate WICI's impact and fund activities beyond subsistence level. Currently, with the change in the budget model and the devolution of the majority of overhead and research support funds to the Dean's level, I fully understand that the envisioned model is no longer feasible. On that basis, I requested a one-year extension.

Now, we need to collectively and creatively design a funding model for WICI, which could be a model for other mid-sized institutions whose focus lies beyond (but also includes) industry contracts, and includes substantial network-building, tri-council research, and educational activities. In my view the key is to establish core funding with a clear path for additional revenue generation. Details of this proposal are contained in the body of the renewal report.

For such a model to support WICI renewal:

- There must be clear agreement about assessment metrics and what levels of such metrics would constitute "success" and ensure renewal of core funding.
- There must also clear articulation of pathway for WICI to generate and retain additional revenue.
- We also need to have clear agreement that the faculty and university level advancement will work with WICI to seek donor and foundation funding.

Could WICI core members fund WICI through their own funds? I do not see feasible pathways through which that could happen. Tri-council grants, including those that support external industry partnerships, cannot include funding for administration, as their expectation is that such support is provided by the institution through its received research support funds. For myself as a researcher, it is almost always beneficial to pursue a tri-council partnership grant rather than a research contract with external partners, as additional funding is brought to the project, and funds flow directly to UW and are in the control of myself as an investigator. It is within the realm of reason that during the next five years WICI may land an external non-tri-council contract that would allow inclusion of core funding for WICI administrative support, that could then be re-directed to fund WICI's public good activities. But it is not likely, as contract administrative support is generally

allocated only to support contracted activities. I personally would not have either means or rationale to participate in a member-funded WICI.

Would I be able to be as efficient or productive without WICI resources? Not quite, but I would find other channels through which to build the Canadian Network for Complex Systems. Why would I continue to do this? I have not put so much of my personal energy into WICI to further my own interests. I have done it because I'm passionate about the importance of the emerging complex system scientific paradigm, especially in relation to the existential threat of global climate change. This new scientific paradigm, with a strong focus on complex human behaviour, is our only hope to bring about a global sustainability transition. There is strong international consensus on that point. In Canada, the University of Waterloo is the right place to incubate and nurture complex systems science, especially as related to coupled human-natural systems. **We not only can be the Canadian leader, we already are.** A strong, scientific university network advocating for complex-systems foundation solutions to environmental change could make the difference for Canadian leadership on this issue. We all know that when Canada acts, the US follows! (just had to end on a little humour as a dual citizen). In fact, WICI core members are global leaders—not just Order of Canada winning core-member alums Keith Hipel and Frances Westley, but our current core members too. And we have broader strength across all faculties, including other members in Environment, Health, Mathematics and Science.

In my view, UW has experienced tangible rewards from WICI's first eleven years, and will continue to do so, especially with a path to support and attribution for grants and contracts. But most significantly, UW is now seen as the Canada-wide leader in complex systems networking. I believe it would be a strategic error to not renew WICI and offer core support, with appropriate assessment, for the next five years.

Dawn Parker



Appendix:

Dear Dr. Dawn Parker,

It is our pleasure to invite you, or supervised graduate students, to present a talk at the Applied Mathematics, Modeling and Computational Science (AMMCS) conference held July 25 - July 29, 2011 at Wilfred Laurier University in Waterloo, Ontario, Canada in the minisymposium "Complex Dynamics of Population Behaviour with Impact to Socio-Economic Issues" we plan to organize during the conference. Each talk is to be 30 minutes long including time for questions.

If you accept our invitation, please let us know no later than February 7, 2011 so that we may forward the speakers' list to the conference organizers.

For more information, you may visit the conference website at www.ammcs2011.wlu.ca.

We look forward to your reply.

Yours sincerely,

Dr. Monica Cojocar
Associate Professor
mcojocar@uoguelph.ca

Christopher Hogg
Research Associate
chogg@uoguelph.ca

Veronica Gheorghide
Ph.D. Candidate
lgheorgh@uoguelph.ca



February 9, 2021

Senate Graduate and Research Council
With respect to Review of Waterloo Institute for Complexity and Innovation

Letter of Support

I write in support of the work of the Waterloo Institute for Complexity and Innovation [WICI]. As Director of the University of Waterloo's Problem Lab, let me first note that the Lab and WICI have complementary goals and general orientation. The Lab is North America's only university-based facility whose sole mandate is to understand important problems. In order to do full justice to problem analysis, the Lab does not attempt to formulate solutions. By concentrating on problem analysis as the first step of successful innovation, our ultimate goal is to encourage high-impact solutions.

WICI's focus on both complexity and innovation are fully consistent with the Problem Lab. We both agree that innovation must be a high social priority and that rapid change is making innovation ever more challenging. The Lab's methodology emphasizes a comprehensive understanding of the problem in question. The complexity of the problem is clearly part of that understanding, as is an interdisciplinary approach.

However, even though it is generally recognized that innovation is important and difficult, many organizations do not take the time or care to fully understand the problems they are trying to solve. Both WICI and the Lab directly contribute to that deeper understanding.

The Problem Lab has found a renewed commitment by a variety of players to a more thoughtful approach to innovation. As a result, the Lab has provided problem analysis to Cisco Systems, and is currently working with Canada Mortgage and Housing Corporation, Treasury Board of Canada Secretariat and Rogers Communications. This suggests that WICI has the potential to serve external players, as do we.

In addition, we are part of the collaboration of other units of the University in order to assist all our students to become better innovators, no matter their core discipline.

We are participating in active discussions with WICI to develop professional training courses for external audiences. And we anticipate potential collaboration on other educational initiatives.

Simply put, WICI's mandate is vital to innovation, and its basic methodology is indispensable to a thorough understanding of any complex problem. We expect to be active collaborators with them on an ongoing basis.

A handwritten signature in black ink, appearing to read "Larry Smith".

Larry Smith
Director of the Problem Lab
Adjunct Associate Professor, Economics and the Conrad School

At its 2015 annual meeting, the WICI Board laid out five strategic directions for 2016-2020. The following pages are a collation of all documented WICI activities reported in support of these goals.

1. Strengthen core networks.
 - a. Continue to actively support current core projects and members through grant writing assistance and complementary activities such as talks, workshops, and working groups.
 - i. Yearly speaker series ongoing
 - ii. 2016 seed grant competition
 - iii. May 2017 WICI Conference on Resilience
 - iv. June 2018 WICI Conference on Modelling Complex Urban Environment
 - v. 2018 core member support: travel grants (8), matching grant fund for IRPG, two funded and one co-sponsored workshop organized by core members
 - vi. 2018 Other member support: One additional workshop, student travel awards (10), student fellowship awards (3), and funding for one reading group
 - vii. 2018 member-presented WICI talk (1); two WICI student visitors in spring and summer 2018
 - viii. 2019 core member support: travel grants (8), matching SEED grant for Internal Affiliate member A. Klinkova, matching grant for core member D. Parker (1)
 - ix. 2019 Other member support: student travel awards (4), other workshop funding for WICI student members (4)
 - x. Several members presented at 2019/20 WICI talks (1 core, 3 students and 1 external core member)
 - xi. 2020 core member support: matching funds for SSHRC proposal; travel grants converted
 - xii. 2020 Other member support: Map the Systems finalists sponsored for a workshop; Piereder (student member) and Sengupta featured in WICI webinars; all WICI members for remaining planned talks
 - b. Look for existing opportunities on campus to expand core membership in the areas of network science, human-environment interactions, expanding conventional economics, complexity and non-rational drivers of behavioural change, Psychological Dynamics of Catastrophic Dehumanization; Rapid Ideological Change/Ideological Conflict; and Embodied Cognition.
 - i. 2016: Vanessa Schweizer and Peter Deadman brought into core membership
 - ii. 2016: WICI formed a collaborative relationship with the Fields Institute through conference and workshop sponsorship through 2018
 - iii. 2018: New core members (2), new affiliate members (5), and new student members (10), WICI student visitors in Network Complexity Science
 - iv. 2019: New core member (1), new external core members (4), new affiliate members (2), new practitioner members (2), and new student members (6). Interactions with the Fields Institute continue; collaborations with other research institutes have been strengthened through cross-institute meetings, co-sponsored talks, and research networking sessions.
 - v. 2020: New core member (1), new external core members (2), new affiliate member (1), new practitioner members (3), and new student member (1). Collaborations with WatSPEED, The Problem Lab, WISIR, McGill Centre for Convergence in Health and Economics (MCCHE) have been in progress.

- c. Work with faculty units and deans to identify opportunities for new hires whose research has a complex systems focus.
 - i. (2017) Targeted discussions were held with chairs and deans in Engineering, Mathematics, and Environment about the possibility of a targeted complex systems hire.
 - ii. In 2018, we identified new hires in ENV and Systems who have a strong complex systems focus. A key WICI collaborator also returned to Applied Math.
 - iii. 2020: Lisa Aultman-Hall was hired as the Chair of Systems Design Engineering and has joined WICI as an Affiliate member. Conversations with Engineering and Environment chairs, and/or a proposition to the provost to hire a complex systems Assistant Professor are being considered.

- d. Seek out particular opportunities to establish core WICI members in under-represented faculties (AHS and Science).
 - i. 2016: A workshop award was granted to S. Kirkpatrick (AHS) and 2 new student members joined from AHS.
 - ii. 2017: A new affiliate member from Perimeter Institute joined, Sara Walker was invited to a WICI talk, WICI hosted a joint WICI/PI talk with Roald Hoffman.
 - iii. 2018: Kirkpatrick was promoted from affiliate to core WICI member from AHS, and joined the Steering Committee. For science, we worked with the Associate VP of Interdisciplinary Research to better reach out to the faculty. We increased poster promotion in science buildings, and we hosted our student project symposium in the Science Teaching Complex building. The Office of Research facilitated distribution of our funding calls across campus.
 - iv. 2019: core member Sharon Kirkpatrick joined WICI in 2018, and continued to advance the complex systems work in Health Sciences. Three of the judges for our Complex Systems Student Project Symposium were from AHS. In July 2019, we collaborated with the Faculty of Science to host a research networking session, and we hosted two science-focused complexity talks which both saw great turnout and engagement from the science faculty, including the most recent talk from Dr. Kate Adamala, whose visit was co-sponsored with the Waterloo Centre for Microbial Research (WCMR). An award was made to Anna Klinkova in Chemistry, who has joined WICI as an Affiliate member.
 - v. In 2020, Trevor Charles joined as a WICI core and Steering Committee member representing Science. Another representative from math and/or science is currently being approached to join as well.

- 2. Facilitate interdisciplinary research.
 - a. Host talks and workshops, striving to maintain a balance between bringing in global leaders in complex systems and highlighting local complex systems scholarship.
 - i. The 2016-17 WICI speaker series and May 2017 conference on resilience; WICI's support for graduate students through travel support; and the 2016 WICI seed grant competition helped facilitate interdisciplinary research (goals 2a-c).
 - ii. The 2017-2018 speaker series included one UW faculty member, two local scholars, and two high-profile external scholars. There was substantive overlap between the subjects of the talks and WICI's core research activities. The May 2017 WICI Conference on Resilience brought in a variety of speakers and provided presentation opportunities to local WICI members. WICI has

continued to support graduate students research through travel awards and this year's WICI student scholar competition. Also, 66% of the participants in the 2017 WICI Conference on Resilience were from outside the University of Waterloo. In 2017 an NSERC CREATE grant LOI was put forward by Kate Larson (Computer Science) which involved new collaborations between several WICI core members (Anand, Bauch & Crowley) and was successful at the institutional level.

- iii. The 2018 WICI speakers included a UW faculty member, and four high-profile external scholars. There was substantive overlap between the subjects of the talks and WICI's core research activities. WICI also co-sponsored and co-organized a highly international Field's Workshop in March 2018 on human-environment systems and subsidized student attendance. The WICI 2018 conference on Modelling Complex Urban Environments included a balance of UW, local, and international speakers and participants.
 - iv. The 2019 WICI speakers included a UW faculty member, three UW graduate students, and four high-profile external scholars, including one new WICI external core member from UBC. WICI also promoted ongoing graduate student seminars in the spring 2019 term, and an internal Systems Design and Engineering Workshop in the fall term.
 - v. While workshops and conferences were not able to be organized this year, WICI continued with a speaker series via WebEx and has worked in plans to resume a regular workshop and conference schedule over the next five years. The 2020/21 WICI speakers have included thus far an external core member from McGill University and a PhD candidate from UW's Balsillie School of International Affairs, and we have collaborated with the McGill Centre for Convergence in Health and Economics (MCCHE) on delivery of webinars as well.
- b. Support working groups, allowing their focus and scope to evolve with the interests and needs of membership.
- i. In 2017/2018, WICI awarded three workshop grants, which supported the development of the research programs of core and affiliate faculty members.
 - ii. In 2018, a WICI student member (Perin Ruttonsha) led an [interdisciplinary reading group](#) and co-authored a paper with other WICI Student members. A GRA was hired to increase the cohesiveness and identity of WICI Student members. We also actively engaged WICI members to identify existing and potential networks.
 - iii. In 2019, the working groups supported were: Open Format Complexity Conversations with Dr. Bill Sutherland (held bi-weekly from May through November 2019), Graduate Student Complexity Seminars (held monthly in spring term 2019), and Complexity Networks and Organizations group organized by an affiliate member in Fall 2019. The School of Architecture also organized a group and led a WICI-supported Design Symposium at their campus in November 2019. This was a banner year for member-led working groups and initiatives.
 - iv. In 2020, an informal working group was arranged for those interested in the ABM course that was cancelled. Active engagement continues through our existing member network as potential collaborations continue to emerge. Interdisciplinary collaboration continues as WICI connects with other research

institutes on campus (WISIR, Data Science, WCMR) as well as establish a national network of complex systems researchers.

- c. Offer support for grant development.
 - i. In 2016, WICI support facilitated several grant submissions and provided matching funds for 3 WICI workshops.
 - ii. In 2018, based on conversations with the Office of Research, WICI made targeting external partnerships funding a priority. WICI issued the challenge grant in fall 2018.
 - iii. In 2019, WICI awarded one SEED grant to A. Klinkova and promised matching funds for D. Parker's Trans-Atlantic Partnership Social Innovation grant (not funded). It was agreed that WICI would offer grant development support as needed, if requested, including mentoring, reviewing and editing support.
 - iv. In 2020, administrative and in-kind funding to support Grossmann's grant application for "World After Covid", which was successful.

3. Enhance public engagement.
 - a. Improve WICI's web and social media presence, including the development of web pages for WICI core research projects and a set of introductory "What are complex systems?" materials.
 - i. In 2016, WICI and several more of its members were added to the university's "Experts And Speakers" site, and WICI's Twitter feed and Facebook page were actively maintained. WICI's website was updated to include material which explains what complex systems are. Receptions before WICI seminars continued.
 - ii. In 2017, WICI launched its new website (<https://uwaterloo.ca/complexity-innovation/>) which was well received, and continues to gain new visitors every week. In particular, from its launch date on September 8, 2017 until the time of the Annual Report, the WICI website received 3,200 visits, with its monthly visits growing dramatically, and exceeding previous performance. WICI's Twitter feed and Facebook page were actively maintained.
 - iii. In 2018, the WICI website (<https://uwaterloo.ca/complexity-innovation/>) averaged over **1,075** visits per month, which is more than double the monthly average of 533 per month in 2017. Videos from core members on "What are complex systems?" were posted and viewed a total of 555 times in 2018; WICI's Twitter feed and Facebook page were actively maintained. Facebook events were introduced as a tool to publicize talks and workshops, that may be shared more easily via social media networks.
 - iv. In 2019, the WICI website was updated extensively to improve navigation and access to information. The website (<https://uwaterloo.ca/complexity-innovation/>) averaged over **1,194** visits per month, a 7% increase from 2018; Videos from core members on "What are complex systems?" on our website were viewed a total of **685** times in 2019 (up from 555 times viewed in 2018); and WICI's Twitter feed and Facebook page were actively maintained. Facebook events continued to be used to publicize our talks and workshops, so they may be shared more easily via social media networks. The website was updated to reflect new members, new projects, and evolving core research projects.
 - v. In 2020, the WICI website was updated to reflect current research projects, career opportunities, and the developing CNCS. The website (<https://uwaterloo.ca/complexity-innovation/>) was visited **12,996** times

between January 1 and December 31, 2020. Videos from core members on “What are complex systems?” have been viewed a total of **1792** times in 2020 (up from 685 times viewed in 2019); and WICI’s Twitter feed and Facebook page are being actively maintained. WebEx has been utilized to host and co-host webinars.

- b. Highlight WICI work through press releases and actively engage the media when opportunities arise.
 - i. In May 2016, WICI was featured prominently in a “Guelph Today” article <https://www.guelphtoday.com/columns/from-the-second-storey/from-the-second-storey-small-things-become-big-things-without-our-noticing-295879>
 - ii. In 2017, WICI core members contributed op-ed pieces to major outlets such as the Globe and Mail, and core member research projects were covered in the national and international media.
 - iii. WICI core members contributed 12 radio and print interviews in 2018
 - iv. WICI core members contributed 18 radio and print interviews in 2019
 - v. WICI Core members continued to contribute to local radio and print interviews. Chris Bauch’s work on modelling around Covid policy guidance in particular garnered a high profile in local media. Thomas Homer-Dixon and Igor Grossmann reported dozens of radio and print interviews. Overall, core members reported over 40 radio/print outreach opportunities in 2020.
 - c. Offer more public talks in the community.
 - i. In 2017, WICI continued to broaden its audience through events such as the Poetry & Complexity Readings and Conversations with high profile guests such as Roald Hoffmann, Nobel Prize-winning theoretical chemist and poet, and Rae Armantrout, Pulitzer Prize-winning poet and Guggenheim Fellow.
 - ii. The 2018 Modelling Complex Urban Environments conference keynotes were open to the public.
 - iii. In 2019, after learning that WICI and research centers are facing a climate of fiscal restraint, WICI chose to shift priority from public community talks to focused allocation of resources to activities that directly support research. All WICI talks held on campus were recorded and the videos were posted on our website to share with the community at large. Community members on our mailing list regularly attended our talks.
 - iv. In 2020 all talks have all been held virtually, thus enabling a broader participation among members of the community.
 - d. Continue informal receptions before talks with speakers and attendees.
 - i. Receptions before WICI seminars have been well attended. The fall open house is also a well-attended, effective networking event. However, all in-person activities were suspended in 2020.
4. Enhance WICI’s resource base and long-term viability.
- a. Prioritize efforts to obtain higher-level, external support to establish and support initiatives such as a staffed resource lab; funding for a graduate fellows programme; a competitive post-doctoral scholar programme; and funding for short-term (sabbatical or study leave) positions for more senior complex systems scholars.

- i. In 2016, realizing that grant acquisition is a long-term process, WICI invested in 3 grant challenge awards with promise for success. WICI was successful in an application to the Fields Institute for workshop co-sponsorship.
 - ii. In 2017, WICI acquired \$5,000 in external funding (sponsorship from The Field's Institute for Mathematical Sciences and the Canadian Applied and Industrial Mathematics Society for its 2017 Conference on Resilience, plus additional in-kind support). WICI also obtained over 20k in matching support from international partners as part of the IPRG application to support the Urban Complexity conference. Moreover, several of the sponsored workshops run in 2017 sought additional funding support from other partners. Since its inception, WICI has grown by 386%, and by 46% since its renewal in 2014, thereby building a critical mass for its long-term viability.
 - iii. In 2018, the WICI administrative team had extensive discussions with personnel in the Office of Research regarding alternative models for WICI support in its next phase. It became clear that WICI's current budget model, based on direct operating support from the Office of Research, was no longer viable moving forward, and it is also still not feasible to channel grant overhead directly to WICI to generate operating funds, as envisioned at our 2015 renewal. Alternatives considered have been 'staying small', recruiting basic operating support from several deans, or 'going big', striving to obtain University Centre status. The "go big" option would require, at a minimum, strong evidence of external partner funding relationships, and ideally, a secure external funding source such as a foundation or large tri-council operation grant. The 'go big' option was not seen as viable as of fall 2018, especially given the hold on university centers. However, it may soon be an option, following a bit more strategic assessment and planning.
 - iv. In 2019, the WICI administrative team continued discussions with the Office of Research regarding alternative models for WICI support in its next phase, and was approved for an extension to postpone our centre renewal application process by one year, therefore giving WICI until April 2021 to explore these various options to identify its next strategic goals and a path forward.
 - v. In 2020: WICI has been engaging in further strategic discussions with supporting deans, Office of Research, Steering Committee members to determine the most viable funding model for WICI. In addition, a developing Canadian Network for Complex Systems with connections at University of British Columbia, McGill University, St. John's University and Western University will provide leverage to attract substantive external funding.
5. Raise our profile.
- a. Focus on academic and media outreach to highlight WICI's unique contributions on a national and global scale.
 - i. In 2016, WICI and several of its members were added to the university's "Experts And Speakers" site, and WICI's Twitter feed and Facebook page were actively maintained. WICI core members presented at national and international conferences, notably the Sackler Colloquium at the National Academy of Sciences, USA.
 - ii. In 2017, WICI's Twitter feed and Facebook page were actively maintained. WICI launched its new website (<https://uwaterloo.ca/complexity-innovation/>) which was well received, and continues to gain new visitors every week. WICI core

member W. Hipel was elected Officer of the Order of Canada. Our activities all brought new engagement with WICI both within the University of Waterloo and externally. For example, 66% of participants in the 2017 WICI Conference on Resilience were from outside the University of Waterloo, and 13% were international.

- iii. In 2018, our core members made 12 media appearances, notably Paul Thagard's CBC Interview '[*The psychology of climate change: Why people deny the evidence*](#)' (December 2018), and Chris Bauch's CBC interview on '*Land use implications of dietary trends*' which aired on 9 CBC stations across Canada. The 2018 Conference on Modelling Complex Urban Environments attracted an international scope of participants.
- iv. In 2019, WICI core members made 18 media appearances, notably twelve of those by newest core member, Igor Grossmann. In addition, Kevin Church, a student member and fellowship awardee from Applied Mathematics, was featured on CBC Radio presenting his work on Timing of Vaccinations in Controlling Disease Outbreaks, in June 2019.
- v. In 2020, WICI continued maintaining its Twitter feed, Facebook page, and website, monitoring traffic and engagements, and optimizing outreach where possible. The website was updated to reflect new members, new projects, evolving core research projects and an emerging national network of members. Core member Chris Bauch has received a high amount of local media attention for his modelling work with Covid-19 this year. Collectively, members are reporting well over 40 separate media outreach-related activities.

APPENDIX E: CORE MEMBER COMPLEX SYSTEMS PUBLICATIONS 2016-2020*

*based on annual self-reports by WICI core members

- Chillo, V., Ojeda, R., Capmourteres, V., **Anand M.** (2016). Functional diversity loss with increasing livestock grazing intensity in drylands: the mechanisms and their consequences depend on the taxa. *Journal of Applied Ecology*.
- Galvani, A. P., Bauch, C. T., **Anand, M.**, Singer, B. H., & Levin, S. A. (2016). Human–environment interactions in population and ecosystem health. *Proceedings of the National Academy of Sciences*. 113(51): 14502–14506.
- Capmourteres, V. & **Anand, M.** (2016). Assessing ecological integrity: a multi-scale structural and functional approach using Structural Equation Modelling. *Ecological Indicators*. 71: 258-269.
- Bell, W., Lamb, E., Sharma, M., Hunt, S., **Anand, M.**, Dacosta, J., & Newmaster, S. (2016). Relative influence of climate, soils, and disturbance on plant species richness in northern temperate and boreal forests. *Forest Ecology and Management*. 381: 93-105.
- Dietrich, R., Bell, F. W., Silva, L. C., Cecile, A., Horwath, W. R., & **Anand, M.** (2016). Climatic sensitivity, water-use efficiency, and growth decline in boreal jack pine (*Pinus banksiana*) forests in Northern Ontario. *Journal of Geophysical Research: Biogeosciences*. 121(10): 2761-2774.
- Jiang, Z., Ma, K., **Anand, M.** (2016). Can the physiological tolerance hypothesis explain herb richness patterns along an elevational gradient: a trait-based analysis. *Community Ecology*. 17(1): 17-23.
- Yodzis, M., Bauch, C.T., & **Anand M.** (2016). Examining the role of social feedbacks and misperception in a model of fish-borne pollution illness. *Mathematical and Computational Approaches in Advancing Modern Science and Engineering*: 341-351.
- Anand M.** (2016). *Unified Fields: Science and Literary Form* by Janine Rogers. *University of Toronto Quarterly*. 85(3): 534-53
- Leon Cordero, R., Torchelsen, P., Overbeck, G.E., & **Anand M.** (2016). Analyzing the landscape characteristics promoting the establishment and spread of gorse (*Ulex europaeus*) along roadsides. *Ecosphere*. 7(3): e01201
- Henderson, K. A., Bauch, C. T., & **Anand, M.** (2016). Alternative stable states and the sustainability of forests, grasslands, and agriculture. *Proceedings of the National Academy of Sciences*. 113(51): 14552– 14559.
- Das, A., John, R., & **Anand M.** (2016). Does structural connectivity influence tree species distributions and abundance in a naturally discontinuous tropical forest formation? *Journal of Vegetation Science*.
- Leon Cordero, R., Torchelsen, F., Overbeck, G.E., & **Anand M.** (2016). Invasive gorse (*Ulex europaeus*, Fabaceae) changes plant community structure in subtropical forest-grassland mosaics of southern Brazil. *Biological Invasions*. 18(6): 1629-1643.
- Leon Cordero, R., Torchelsen, P., Overbeck, G.E., & **Anand M.** (2016). *Cytisus scoparius* (Fam. Fabaceae) in southern Brazil - first step of an invasion process? *Anais da Academia Brasileira das Ciências*. 88(1): 149-154.
- Capmourteres, V. & **Anand M.** (2016). "Conservation Value": a review of the concept and its quantification. *Ecosphere*. 7(10): e01476
- Ashiq, M.W. & **Anand, M.** (2016). Spatial and temporal variability in dendroclimatic response of red pine (*Pinus resinosa* Ait.) to climate in northern Ontario. *Forest Ecology and Management*. 372: 109-119.
- Salem, M., **Crowley, M.** & Fischmeister, S. (2016). "Anomaly Detection Using Inter-Arrival Curves for Real-time Systems," in *2016 28th Euromicro Conference on Real-Time Systems*. Toulouse, France, pp. 97–106.
- Salem, M., **Crowley, M.** & Fischmeister, S. (2016). "Inter-Arrival Curves for Multi-Mode and Online Anomaly Detection," in *Euromicro Conference on Real-Time Systems 2016 - Work-in-Progress Proceedings*, Toulouse, France.
- Quilley, S., Kish, K., & Hawreliak, J. (2016). Finding an Alternate Route: Towards Open, ecocyclical, and distributed production'. *Journal of Peer Production* #9. [JoPP Signal 14,5/15]
- Carlsen, H., Lempert, R., Wikman-Svahn, P., **Schweizer, V.** (2016) Choosing small sets of policy-relevant scenarios by combining vulnerability and diversity approaches, *Environmental Modelling & Software*, 84, 155-164. Virtual Special Issue on "Innovative Techniques for Quantitative Scenarios in Energy and Environmental Research," doi:10.1016/j.envsoft.2016.06.011
- Guivarch, C., Rozenberg, J., **Schweizer, V.** (2016) The diversity of socio-economic pathways and CO2 emissions scenarios: insights from the investigation of a scenarios database. *Environmental Modelling & Software*, 80, 336-353. Virtual Special Issue on "Innovative Techniques for Quantitative Scenarios in Energy and Environmental Research," doi:10.1016/j.envsoft.2016.03.006
- Schweizer, V.J.** and Morgan, M.G. (2016) Bounding US Electricity Demand in 2050. *Technological Forecasting & Social Change*, 105, 215-223, doi:10.1016/j.techfore.2015.09.001

- Schweizer, V.J.** and Kurniawan, J.H.* (2016) Systematically linking qualitative elements of scenarios across levels, scales, and sectors. *Environmental Modelling & Software*, 79, 322-333. Virtual Special Issue on "Innovative Techniques for Quantitative Scenarios in Energy and Environmental Research," doi:10.1016/j.envsoft.2015.12.014
- Tully, S.,** Cojocaru, M., **Bauch, C.T.** (2017). 'Multiplayer games and HIV transmission via casual encounters' *Mathematical Biosciences and Engineering*, **14(2)**: 359-376.
- Henderson, K., Bauch, C.T.,** & Anand, M. (2016). 'Seeing the forest for the grasslands and the people: coupled human-environment sustainability of bistable mosaic ecosystems'. *Proceedings of the National Academy of Sciences of the USA* **113**: 14552.
- Bauch, C.T., Sigdel, R., Pharaon, J.,** & Anand, M. (2016). 'Early warning signals of regime shifts in coupled human-environment systems'. *Proceedings of the National Academy of Sciences of the USA* **113**: 14560.
- Jnawali, K., Morsky, B.,** & **Bauch, C.T.** (2017). 'Strategic interactions in antiviral drug use during an influenza pandemic'. *PLOS Currents Outbreaks*, **2017 Jan 12. Edition 1**. doi: 10.1371/currents.outbreaks.602dfa010991dbe510c51d5107b02343
- Jnawali, K., Morsky, B., Poore, K.,** & **Bauch, C.T.** (2016). 'Emergence and Spread of Drug Resistant Influenza: A Two-Population Game Theoretical Model'. *Infectious Disease Modelling* **1**: 40-51.
- Morsky, B.,** & **Bauch, C.T.** (2016). 'Truncation selection, payoff distributions matrices, and the evolutionary stable state'. *Journal of theoretical biology* **404**: 383-390.
- Durham, D., Ndeffo Mbah, M.L., Skrip, L., Jones, F.K., **Bauch, C.T.,** & Galvani, A. (2016). 'The national and state level impact and cost-effectiveness of nonavalent HPV vaccination in the US'. *Proceedings of the National Academy of Sciences of the USA* **113(18)**: 5107-5112.
- Bauch, C.T.** & McElreath, R. (2016). 'Disease dynamics and costly punishment can foster socially imposed monogamy'. *Nature communications* **7**: 11219.
- Andrews, M.,** & **Bauch, C.T.** (2016). 'The impacts of simultaneous disease intervention decisions on epidemic outcomes'. *Journal of theoretical biology* **395**: 1-10.
- Yodzis, M., Bauch, C.T.,** & Anand, M. (2016). 'Coupling fishery dynamics, human health, and social learning in a model of fishborne pollution exposure.' *Sustainability science* **11(2)**: 179-192.
- Henderson, K.,** Reis, M., Blanco, C., Pillar, V.D., Printes, R., **Bauch, C.T.,** & Anand, M. (2016) 'Land-owner perceptions of the value of natural forest and natural grasslands in a mosaic ecosystem in southern Brazil'. *Sustainability science* **11(2)**: 321-330.
- Ma, J., and **Hipel, K.W.,** (2016). "Exploring Social Dimensions of Municipal Solid Waste Management around the Globe: A Systematic Literature Review", *Waste Management*, Vol. 56, pp. 3-12, 2016.
- Fiolet, J-C, Haas, C., and **Hipel, K.W.,** "Risk-chasing Behaviour in On-site Construction Decisions", *Construction Management and Economics*, Vol. 34, No. 12, pp. 845-858.
- Philpot, S., **Hipel, K.W.,** and Johnson, P.A., (2016). "Strategic Analysis of a Water Rights Conflict in the South Western United States", *Journal of Environmental Management*, DOI: 10.1016/j.jenvman.2016.05.027, available online 1 June 2016, Vol. 180, pp. 247-256, September 2016.
- He, S., Kilgour, D.M., and **Hipel, K.W.,** (2017). "A General Hierarchical Graph Model for Conflict Resolution with Application to Greenhouse, Gas Emission Disputes Between USA and China", *European Journal of Operational Research*, DOI: 10.1016/j.ejor.2016.08.014, available online since August 11, 2016, Vol. 257, No. 3, pp. 919-932, 2017.
- Xiao, Y., **Hipel, K.W.,** and Fang, L., (2016). "Incorporating Water Demand Management into a Cooperative Water Allocation Framework", *Water Resources Management*, DOI: 10.1007/s11269-016-1322, published online on 23 April, 2016, Vol. 30, No. 9 pp. 2997-3012, 2016.
- Garcia, A., Obeidi, A., and **Hipel, K.W.,** (2016). "Two Methodological Perspectives on the Energy East Pipeline Conflict", *Energy Policy*, DOI: 10.1016/j.enpol.2016.01.033, Vol. 91, pp. 397-409, 2016.
- O'Brien, N.L. and **Hipel, K.W.,** (2016). "A Strategic Analysis of the New Brunswick, Canada Fracking Controversy", *Energy Economics*, DOI: 10.1016/j.eneco.2015.12.024, Vol. 55, pp. 69-78, Vol. 55, pp. 69-78, March 2016.
- Thagard, P.** (2016). *Emotional cognition in urban planning*. In J. Portugali & E. Stolk (Eds.), *Complexity, cognition, urban planning and design* (pp. 197-213). Berlin: Springer.
- Thampi, V.A., Anand, M. & Bauch, C.T. (2018). Socio-ecological dynamics of Caribbean coral reef ecosystems and conservation opinion propagation. *Scientific Reports* **8** (1), 2597
- Sigdel, R.P., Anand, M. & Bauch, C.T. (2018). Competition between injunctive social norms and conservation priorities gives rise to complex dynamics in a model of forest growth and opinion dynamics. *Journal of theoretical biology* **432**, 132-140

- Fair, K.R., Bauch, C.T., & Anand, M. (2017). Dynamics of the Global Wheat Trade Network and Resilience to Shocks, *Scientific reports* 7 (1), 7177
- Herberich, M.M., Gayler, S., Anand, M., & Tielbörger, K. (2017). Hydrological niche segregation of plant functional traits in an individual-based model, *Ecological modelling* 356, 14-24
- Chillo, V., Ojeda, R.A., Capmourteres, V., & Anand, M. (2017). Functional diversity loss with increasing livestock grazing intensity in drylands: the mechanisms and their consequences depend on the taxa. *Journal of Applied Ecology* 54 (3), 986-996
- Das, A.A., John, R. & Anand, M. (2017). Does structural connectivity influence tree species distributions and abundance in a naturally discontinuous tropical forest formation? *Journal of Vegetation Science* 28 (1), 7-18
- Jin, X., Robinson, K., Lee, A., Polhill, J.G., Pritchard, C., and Parker, D.C. (2017). A prototype cloud-based reproducible data analysis and visualization platform for outputs of agent-based models. *Environmental Modelling and Software* 96. 172-180.
- Dou, Y.; Deadman, P., Robinson, D., Almeida, O., Rivero, S., Vogt, N., Pinedo-Vasquez, M. (2017). Impacts of cash transfer programs on rural livelihoods: a case study in the Brazilian Amazon estuary. *Human Ecology* 45(5), 697-710. DOI 10.1007/s10745-017-9934-1
- Zywert, K. & Quilley, S. (2017) 'Health systems in an era of biophysical limits: the wicked dilemmas of modernity' *Social Theory & Health*. <https://doi.org/10.1057/s41285-017-0051-4>.
- Loyal, S. and Quilley, S. (2017) 'The particularity of the universal: critical reflections on Bourdieu's theory of symbolic power and the state' *Theory and Society*, (), 1-34. 10.1007/s11186-017-9298-y.
- Kish, K. and Quilley, S. (2017) 'Wicked Dilemmas of Scale and Complexity in the Politics of Degrowth' in *Ecological Economics Volume 142*, December 2017, Pages 306-317 [Our ecological economics paper made it into the physical book (only a few chosen ones make the physical copy) <http://www.sciencedirect.com/science/article/pii/S0921800916311260>]
- Loyal, S. and Quilley, S. (2017) 'Categories of State Control: Asylum Seekers and the Direct Provision and Dispersal System in Ireland' *Social Justice* 43/4, pp69-97
- Pananos, A.D., Bury, T.M., Wang, C., Schonfeld, J., Mohanty, S.P., Nyhan, B., Salathe, M., & Bauch, C.T. (2018). 'Critical dynamics in population vaccinating behavior', *Proceedings of the National Academy of Sciences of the USA* 114(52): 13762-13767.
- Ringa, N., & Bauch, C.T. (2017). 'Spatially implicit modelling of disease-behaviour interactions in the context of non-pharmaceutical interventions'. *Mathematical Biosciences and Engineering* 15(2): 461-483.
- Tully, S., Cojocar, M., & Bauch, C.T. (2017). 'Multiplayer games and HIV transmission via casual encounters' *Mathematical Biosciences and Engineering*, 14(2): 359-376.
- Ma, J., Hipel, K.W., and Hanson, M.L., (2018). "An Evaluation of the Social Dimensions in Public Participation in Rural Domestic Waste Source-Separated Collection in Guilin, China", *Environmental Monitoring and Assessment*, DOI: 10.1007/s10661-017-6405-5, published online on December 21, 2017, 190(1): 35, 14 pp.
- Ma, J., Hipel, K.W., and Hanson, M.L., (2018). "An Analysis of Influencing Factors on Municipal Solid Waste Source-Separated Collection Behavior in Guilin, China, by Using the Theory of Planned Behavior", *Sustainable Cities and Society*, DOI: 10.1016/j.scs.2017.11.037, available online on since November 28, 2017, vol. 37, pp. 336-343.
- Philpot, S., Johnson, P.A., and Hipel, K.W., (2017). "Analysis of a Brownfield Management Conflict in Canada", *Hydrological Research Letters*, DOI: 10.3178/hrl.11.141, Vol. 11, No. 3, pp. 141-148.
- Wang, J., Hipel, K.W., and Dang, Y., (2017). "An Improved Grey Dynamic Trend Incidence Model with Application to Factors Causing Smog Weather", *Expert Systems with Applications*, DOI: 10.1016/j.eswa.2017.06.012, Vol. 86, pp. 240-251.
- Garcia, A., and Hipel, K.W., (2017). "Inverse Engineering Preferences in Simple Games", *Applied Mathematics and Computation*, DOI: 10.1016/j.amc.2017.05.016, Vol. 311, pp.184-194.
- Higo, E., Okada, N., Hipel, K.W., and Fang, L., (2017). "Cooperative Survival Principles for Underground Flooding: Vitae System Based Multi-Agent Simulation", *Expert Systems with Applications*, DOI: 10.1016/j.eswa.2017.04.034, Vol. 83, pp. 379-395.
- He, S., Hipel, K.W., and Kilgour, D.M., (2017). "Analyzing Market Competition between Airbus and Boeing using a Duo Hierarchical Model for Conflict Resolution", *Journal of Systems Science and Systems Engineering*, DOI: 10.1007/s11518-017-5351-7, 28 pp..
- Bernath Walker, S. and Hipel, K.W., (2017). "Strategy, Complexity and Cooperation: A Sino-American Climate Regime", *Group Decision and Negotiation*, DOI: 10.1007/s10726-017-9528-8, Vol. 26, No. 5, pp. 997-1027.
- Silva, M.M., Hipel, K.W., Kilgour, D.M., and Costa, A.P.C.S., (2017). "Urban Planning in Recife, Brazil: Evidence from a Conflict Analysis of the New Recife Project", *Journal of Urban Planning and Development*, DOI: 10.1061/(ASCE)UP.1943-5444.0000391, Vol. 143, No. 3, pp. 05017007-1-05017007-11.

- Talukder, B., Blay-Palmer, A., Hipel, K.W., and van Loon, G.W., (2017). "Elimination Method of Multi-Criteria Decision Analysis (MCDA): A Simple Methodological Approach for Assessing Agricultural Sustainability". *Sustainability*, DOI: 10.3390/su9020287, published online on 16 February 2017, Vol. 9(2), 287, 17 pp.
- You, H., Li, M., Hipel, K.W., Jiang, J., Ge, B., and Duan, H., (2017). "Development Trend Forecasting for Coherent Light Generator Technology based on Patent Citation Network Analysis", *Scientometrics*, DOI: 10.1007/s11192-017-2252-y, Vol.111, No.1, pp. 297-315.
- Silva, M.M., Kilgour, D.M., Hipel, K.W., and Costa, A.P.C.S., (2017). "Probabilistic Composition of Preferences in the Graph Model, with Application to the New Recife Project", *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, DOI: 10.1061/(ASCE)LA.1943-4170.0000235, Vol. 9, No. 3, pp. 05017004-1-05017004-13.
- Ma, J., Hipel, K.W., and Hanson, M.L., (2017). "Public Participation in Municipal Solid Waste Source-Separated Collection in Guilin, China: Status and Influencing Factors", *Journal of Environmental Planning and Management*, DOI: 10.1080/09640568.2017.1281798, 18 pp., published online on February 23, 2017, Vol. 60, No. 12, pp. 2174-2191.
- Zhao, S., He, D., & Bauch, C.T. (2018). 'Strategic decision-making about travel during disease outbreaks: a game theoretical approach'. *J. R. Soc. Interface*, **20180515**.
- R. Leon Cordero, Suma, M., Krishnan, S., Bauch, C.T., & Anand, M. (2018). 'Elements of indigenous socio-ecological knowledge show resilience despite ecosystem change in the forest-grassland mosaics of the Nilgiri Hills, India.' *Palgrave communications* **4**: 105.
- Rizvi, S., Pagnutti, C., Bauch, C.T., & Anand, M. (2018). 'Global land use implications of dietary trends'. *PLOS ONE*, **13(8)**: e0200781.
- Pharaon, J., Bauch, C.T. (2018). 'The influence of social behaviour on competition between virulent pathogen strains'. *Journal of Theoretical Biology* **455**: 47-53.
- Jentsch, P., Anand, M., Bauch, C.T. (2018). 'Spatial correlation as an early warning signal of regime shifts in a multiplex disease-behaviour network.' *Journal of Theoretical Biology* **448**: 17-25.
- Grimes, D.R., Bauch, C.T., & Ioannidas, J.P.A. (2018). 'Modeling science trustworthiness under publish or perish pressure'. *Royal Society Open Science* **5(1)**: 171511.
- Thampi, V., Anand, M., Bauch, C.T. (2018). 'Socio-ecological dynamics of Caribbean coral reef ecosystems and conservation opinion propagation'. *Scientific reports*, **8(1)**: 2597.
- Bauch, C.T. (2018). 'Statistical challenges and opportunities in modelling coupled behaviour-disease dynamics of vaccine refusal'. Italian Statistical Society, 2018 Annual Conference. *Book of Short Papers SIS 2018*, page 32. Eds. A. Abbruzzo, E. Brentari, M. Chiodi, D. Piacentino. Pearson Publishing.
- Menin, O., Bauch, C.T. (2018). 'Solving the patient zero inverse problem by using generalized simulated annealing'. *Physica A* **490**: 1513-1521.
- Ringa, N., Bauch, C.T. (2018). 'Spatially implicit modelling of disease-behaviour interactions in the context of non-pharmaceutical interventions'. *Mathematical Biosciences and Engineering* **15(2)**: 461-483.
- Subramanian, S.*, Crowley, M. (2018). "Using Spatial Reinforcement Learning to Build Forest Wildfire Dynamics Models from Satellite Images". *Frontiers in ICT: Environmental Informatics*. Editor: Nathaniel K. Newlands. 30 pages.
- Ganapathi Subramanian, S., Crowley, M. (2018). "Combining MCTS and A3C for Prediction of Spatially Spreading Processes in Forest Wildfire Settings". In: Bagheri E., Cheung J. (eds). *Advances in Artificial Intelligence. Canadian AI 2018 (CAI-2018)*. Lecture Notes in Computer Science, vol 10832, pp.285-291. Springer, Cham.
- Subramanian, S.*, Crowley, M. (2018). "Combining MCTS and A3C for Prediction of Spatially Spreading Processes in Forest Wildfire Settings". *The Canadian Conference on Artificial Intelligence*, Toronto.
- Subramanian, S.*, Crowley, M. (2018). "A Complementary Approach to Improve Wild Fire Prediction Systems". *AI for Social Good Workshop at the 2018 Neural Information Processing Systems (NeurIPS) conference*. 4 pages, peer reviewed workshop. Montreal.
- Zhao, Y., Andrey, J. and Deadman, P. (2018). Whether conversion and weather matter to roundabout safety. *Journal of Safety Research* (66) 151-159.
- Talukder, B., vanLoon, G., and Hipel, K.W., (2018). "Energy Efficiency of Agricultural Systems in the Southwest Coastal Zone of Bangladesh", *Ecological Indicators*, DOI: [10.1016/j.ecolind.2018.11.030](https://doi.org/10.1016/j.ecolind.2018.11.030), Vol. 98, pp. 641-648.
- Xiao, Y., Fang, L., and Hipel, K.W., (2018). "Centralized and Decentralized Approaches for Water Demand Management", *Sustainability*, DOI: [10.3390/su10103466](https://doi.org/10.3390/su10103466), Vol. 10, No. 10, 3346: pp.1-16.

- Talukder, B. and Hipel, K.W., (2018). "The PROMETHEE Framework for Comparing Sustainability of Agricultural Systems", *Resources*, DOI: [10.3390/resources7040074](https://doi.org/10.3390/resources7040074), Vol. 7, No.4, 74: pp. 1-22.
- Hipel, K.W., Fang, L., and Xiao, Y., (2018). "Managing Conflict in Aquaculture", *Marine Economics and Management*, lead article in the first issue of this newly launched journal, DOI: [10.1108/MAEM-06-2018-001](https://doi.org/10.1108/MAEM-06-2018-001), Vol. 1, No. 1, pp. 1-19.
- Han, Q., Zhu, Y., Ke, G.Y., and Hipel, K.W., (2018). "An Ordinal Classification of Brownfield Remediation Projects in China for the Allocation of Government Funding", *Land Use Planning*, DOI: [10.1016/j.landusepol.2018.05.046](https://doi.org/10.1016/j.landusepol.2018.05.046), Vol. 77, pp. 220-230.
- Aljefri, Y., Hipel, K.W., and Fang, L., (2018). "General Hypergame Analysis within the Graph Model for Conflict Analysis", *International Journal of Systems Science: Operations and Logistics*, DOI: [10.1080/23302674.2018.1476604](https://doi.org/10.1080/23302674.2018.1476604).
- Talukder, B., Hipel, K.W., and van Loon, G.W., (2018). "Using Multi-Criteria Decision Analysis for Assessing Sustainability of Agricultural Systems", *Sustainable Development*, DOI: 10.1002/SD.1848, pp. 1-19.
- Yousefi, S., Hipel, K.W., and Hegazy, T. (2018). "Attitude-Based Conflict Management for Resolving Disputes over Water Quality of the Seymareh River in Iran", *Scientia Iranica, Transactions A: Civil Engineering*, DOI: [10.24200/SCI.2018.20599](https://doi.org/10.24200/SCI.2018.20599).
- Garcia, A., Obeidi, A., and Hipel, K.W., (2018). "Strategic Advice for Decision-making under Conflict Based on Observed Behaviour", *Applied Mathematics and Computation*, DOI: 10.1016/j.amc.2018.03.031, Vol. 332, pp. 96-104.
- Wang, J., Hipel, K.W., Fang, L., and Dang, Y., (2018). "Matrix Representations of the Inverse Problem in the Graph Model for Conflict Resolution", *European Journal of Operational Research*, DOI:10.1016/j.ejor.2018.03.007, published online March 14, 2018, Vol. 270, No. 1, pp. 282-293.
- Zhu, Z., Kilgour, D.M., and Hipel, K.W., (2018). "A New Approach to Coalition Analysis within the Graph Model", *IEEE Transactions on Systems, Man, and Cybernetics: Systems, Technical Correspondence*, DOI: [10.1109/TSMC.2018.2811402](https://doi.org/10.1109/TSMC.2018.2811402).
- Ding, S., Hipel, K.W., and Dang, Y-g, (2018). "Forecasting China's Electricity Consumption using a New Grey Prediction Model", *Energy*, DOI:10.1016/j.energy.2018.01.169, Vol. 149, pp. 314-328, 2018.
- Xu, H., Hipel, K.W., Kilgour, D.M., and Fang, L., (2018). "Conflict Resolution Using the Graph Model: Strategic Interactions in Competition and Cooperation", *Studies in Systems, Decision and Control 153*, Springer, Cham, Switzerland, DOI: 10.1007/978-3-319-77670-5, ISBN 978-3-319-77669-9 (hard copy), ISBN 978-3-319-77670-5 (eBook), 436 pp.. (Book chapter).
- Kirkpatrick, S.I., Guenther, P., Douglass, D., Zimmerman, T.P., Atoloye, A., Marcinow, M.*, Kahle, L.L., Dodd, K.W., & Durward, C. The provision of assistance does not substantially impact the accuracy of 24-hour dietary recalls completed using the Automated Self-Administered 24-hour Dietary Assessment Tool among women with low incomes. *Journal of Nutrition*. Epub ahead of print. doi: 10.1093/jn/nxy207.
- Frongillo, E.A., Baranowski, T., Subar, A.F., Toozee, J.A., & Kirkpatrick, S.I. Establishing validity and cross-context equivalence of measures and indicators. *Journal of the Academy of Nutrition and Dietetics*, Epub ahead of print. doi: 10.1016/j.jand.2018.09.005.
- Vanderlee, L., Reid, J.L., White, C.M., Acton, R.B., Kirkpatrick, S.I., Ching-I, P., Rybak, M.E., & Hammond, D. (2018). Evaluation of 24-hour caffeine intake assessment compared to urinary biomarkers of caffeine intake among young adults in Canada. *Journal of the Academy of Nutrition and Dietetics*, 118(12):2245-2253. doi: 10.1016/j.jand.2018.07.016.
- Kirkpatrick, S.I. Examining the quality of foods and beverages across the food stream. *Journal of the Academy of Nutrition and Dietetics*. Epub ahead of print. doi: 10.1016/j.jand.2018.08.166.
- Gilsing, A., Mayhew, A.J., Payette, H., Shatenstein, B., Kirkpatrick, S.I., Amog, K., Griffith, L.E., Raina, P. (2018). Validity and reliability of a short diet questionnaire to estimate dietary intake in older adults in a subsample of the Canadian Longitudinal Study on Aging. *Nutrients*, 10(10):1522. doi: 10.3390/nu10101522.
- Maynard, M.*, Dean, J., Rodriguez, P.*, Sriranganathan, G.*, Qutub, M.*, & Kirkpatrick, S.I. (2018). The experience of food insecurity among immigrants: A scoping review. *Journal of Immigrant and Minority Health*. Epub ahead of print.
- Maynard, M.*, Meyer, S.B., Perlman, C., & Kirkpatrick, S.I. (2018). Experiences of food insecurity among undergraduate students: 'You can't starve yourself through school'. *Canadian Journal of Higher Education*, 48(2):1-19.
- Kirkpatrick, S.I., Reedy, J., Krebs-Smith, S.M., Pannucci, T.E., Subar, A.F., Wilson, M.M., Lerman, J., & Toozee, J.A. (2018). Applications of the Healthy Eating Index for surveillance, epidemiology, and intervention research: Considerations and caveats. *Journal of the Academy of Nutrition and Dietetics*, 118(9): 1603-1621. doi: 10.1016/j.jand.2018.05.020.
- Krebs-Smith, S.M., Pannucci, T.E., Subar, A.F., Kirkpatrick, S.I., Lerman, J., Toozee, J., Wilson, M.M., & Reedy, J. (2018). Update of the Healthy Eating Index: HEI-2015. *Journal of the Academy of Nutrition and Dietetics*, 118(9):1591-1602. doi: 10.1016/j.jand.2018.05.021.
- Reedy, J., Lerman, J., Krebs-Smith, S.M., Kirkpatrick, S.I., Pannucci, T.E., Subar, A.F., Kahle, L.L., & Toozee, J. (2018). Evaluation of the Healthy

Eating Index-2015. *Journal of the Academy of Nutrition and Dietetics*, 118(9):1622-1633. doi: 10.1016/j.jand.2018.05.019.

Kirkpatrick, S.I., Maynard, M.*, Raffoul, A.*, Lee, K.M.*, & Stapleton, J. (2018). Gaps in the evidence on population health interventions to reduce consumption of sugars: A review of reviews. *Nutrients*, 10(8), 1036; doi: 10.3390/nu10081036.

Vanderlee, L., Reid, J.L., White, C.M., Hobin, E.P., Acton, R.B., Jones, A.C., O'Neill, M., Kirkpatrick, S.I., & Hammond, D. (2018). Evaluation of the online Beverage Frequency Questionnaire (BFQ). *Nutrition Journal*, 17:73. doi: 10.1186/s12937-018-0380-8.

Kirkpatrick, S.I., Collins, C.E., Keogh, R.H., Krebs-Smith, S.M., Neuhouser, M.L., & Wallace, A. (2018). Assessing dietary outcomes in intervention studies: Pitfalls, strategies, and research needs. *Nutrients*, 10(8):1001. doi: 10.3390/nu10081001.

Wallace, A., Kirkpatrick, S.I., Darlington, G., & Haines, J. (2018). Accuracy of parental reporting of preschoolers' dietary intake using an online self-administered 24-hour recall. *Nutrients*, 10(8):187. doi: 10.3390/nu10080987.

Maynard, M.*, Andrade, L.*, Packull-McCormick, S.*, Perlman, C., Leos-Toro, C.*, & Kirkpatrick, S.I.. (2018). Food insecurity and mental health among females in high-income countries. *International Journal of Environmental Research and Public Health*, 15:1424. doi:10.3390/ijerph15071424.

Raffoul, A.*, Leatherdale, S.T., & Kirkpatrick, S.I. (2018). Weight management, weight perception, and health-compromising behaviours among adolescent girls in the COMPASS study. *Journal of Primary Prevention*, 39(4):345-360. doi: 10.1007/s10935-018-0512-0.

Pannucci, T.E., Thompson, F.E., Bailey, R.L., Dodd, K.W., Dixit-Joshi, S., Potischman, N., Kirkpatrick, S.I., Alexander, G.L., Coleman, L.A., Kushi, L.H., Groesbeck, M., Sundaram, M., Clancy, H., Zimmerman, T.P., Douglass, D., Mittl, B., George, S.M., Gahche, J.J., Kahle, L., & Subar, A.F. (2018). Comparing reported dietary supplement intakes between two 24-hour recall methods: The Automated Self-administered 24-hour recall (ASA24) and the interviewer-administered Automated Multiple-Pass Method (AMPM). *Journal of the Academy of Nutrition and Dietetics*, 118(6):1080-1086. Epub ahead of print. doi: 10.1016/j.jand.2018.02.013.

Raffoul, A.*, Leatherdale, S.T., & Kirkpatrick, S.I. (2018). Dieting predicts engagement in multiple risky behaviours among adolescent Canadian girls: A longitudinal analysis. *Canadian Journal of Public Health*, 109(1):61-69. doi: 10.17269/s41997-018-0025-x.

Ryan, C., Cooke, M., Kirkpatrick, S.I., Leatherdale, S., & Wilk P. (2018). The correlates of physical activity among adult Métis. *Ethnicity and Health*, 23(6):629-648. doi: 10.1080/13557858.2017.1294655. PubMed

Bonnell, C., Melendez-Torres, G.J. and Quilley, S. (2018) 'The potential role for sociologists in designing RCTs and of RCTs in refining sociological theory: A commentary on Deaton and Cartwright' *Social Science & Medicine*, 26 April 2018.

Kish, K., Davy, B., Quilley, S., McCarthy, D. D. P. and Murphy, S. J. (2018). Novel Psycho-Social Approaches to Restoration. *Ecology and Society*.

Davy, B. J. & Quilley, S. 2018. "Ritual Matters: Changing Ontologies, Values, and Ecological Conscience Formation" *Journal for the Study of Religion, Nature, and Culture*. 12.4.

Loyal, S. and Quilley, S., (2018). *State Power and Asylum Seekers in Ireland* (New York: Springer).

Schweizer, V. (2018) Decision Support: A Few Scenarios Still Do Not Fit All. News & Views article in *Nature Climate Change*, 8, 361–362.

Scheele, R., Kearney, N.M., Kurniawan, J.H., & **Schweizer, V.J.** (2018) What Scenarios Are You Missing? Poststructuralism for Deconstructing and Reconstructing Organizational Futures. Book chapter in H. Krämer and M. Wenzel (Eds.) *Organizing (for) the Future: How Organizations Manage Things to Come*. Palgrave Macmillan.

Thagard, P. (2018). Computational models in science and philosophy. In S. O. Hansson & V. F. Hendricks (Eds.), *Introduction to formal philosophy* (pp. 457-467). Berlin: Springer.

Thagard, P. (2018). Mind, consciousness, and free will. *Frontiers of Philosophy in China*, 12(3), 377-393.

Thagard, P. (2018). Social equality: Cognitive modeling based on emotional coherence explains attitude change. *Policy Insights from Behavioral and Brain Sciences*, 5(2), 247-256.

Thagard, P., & Larocque, L. (2018). Mental health assessment: Inference, explanation, and coherence. *Journal of Evaluation in Clinical Practice*, 24(3), 649-654.

Thampi, V.A., **Bauch, C.T.**, & Anand, M. (2019). 'Socio-ecological mechanisms for persistence of native Australian grasses under pressure from nitrogen runoff and invasive species'. *ECOLOGICAL MODELLING*, 413:108830. [\[PDF\]](#)

Fitzpatrick, M.C., **Bauch, C.T.**, Townsend, J.P., & Galvani, A.P. (2019). 'Modelling microbial infection to address global health challenges'. *NATURE MICROBIOLOGY*, 4(10):1612-1619.

Souza, P.V.S., Silva, R., Girardi, D., & **Bauch, C.T.** (2019). 'Cooperation in a generalized age-structured spatial game'. *JOURNAL OF THEORETICAL BIOLOGY*, 109995.

- Sigdel, R., Anand, M., **Bauch, C.T.** (2019). 'Convergence of socio-ecological dynamics in disparate ecological systems under strong coupling to human social systems'. *THEORETICAL ECOLOGY*, **12(3)**:285-296.
- Bury, T., **Bauch, C.T.**, Anand, M. (2019). 'Charting pathways to climate change mitigation in a coupled socio-climate model'. *PLOS COMPUTATIONAL BIOLOGY*, **15(6)**: e1007000.
- Nowack, S., **Bauch, C.T.**, Anand, M. (2019). 'A local optimization framework for addressing conservation conflicts in mosaic ecosystems'. *PLOS ONE*, **14(5)**:e0217812.
- Bhattacharyya, S., Vutha, A., & **Bauch, C.T.** (2019). 'The impact of rare but severe vaccine adverse events on behaviour-disease dynamics: a network model'. *SCIENTIFIC REPORTS*, **9(1)**: 7164.
- Andrews, M.A., **Bauch, C.T.** (2019). 'Parameterizing a dynamic influenza model using longitudinal versus age-stratified case notifications yields different predictions of vaccine impacts'. *MATHEMATICAL BIOSCIENCES AND ENGINEERING*, **16(5)**: 3753-3770.
- Morsky, B., **Bauch, C.T.** (2019). 'The impact of truncation selection and diffusion on cooperation in spatial games'. *JOURNAL OF THEORETICAL BIOLOGY*, **466**: 64-83.
- Dockstader, Z., **Bauch, C.T.**, Anand, M. (2019). 'Interconnections accelerate collapse in a socio-ecological metapopulation'. *SUSTAINABILITY*, **11(7)**: 1852.
- Bhalla, S.*, Subramanian, S.*, Crowley, M. (2019). "Training Cooperative Agents for Multi-Agent Reinforcement Learning". *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*. 9 pages. Montreal.
- Bhalla, S., Yao, M., Hickey, J.P. and Crowley, M. (2019). "Compact Representation of a Multi-dimensional Combustion Manifold Using Deep Neural Networks", *European Conference on Machine Learning (ECML-19)*. 8 pages. Wurzburg, Germany. September, 2019.
- Carrillo, J., Crowley, M., Pan, G., Fu, L. (2019). "Comparison of Deep Learning models for Determining Road Surface Condition from Roadside Camera Images and Weather Data". In *The Transportation Association of Canada and Intelligent Transportation Systems Canada Joint Conference (TAC-ITS)*. 17 pages. Halifax, Canada, July 2019.
- Ghojogh, B., Karray, F., Crowley, M.. (2019). "Locally Linear Image Structural Embedding for Image Structure Manifold Learning (LLISE)". *16th International Conference on Image Analysis and Recognition (ICIAR-19)*. 12 pages. Waterloo, Canada, August 27-29, 2019.
- Ghojogh, B., Karray, F., Crowley, M.. (2019). "Principal Component Analysis on Image Analysis and Recognition (ICIAR-19)". 12 pages. Waterloo, Canada, August 27-29, 2019.
- Ghojogh, B., Karray, F., Crowley, M.. (2019). "Image Structure Subspace Learning Using Structural Similarity Index (SSIM-M)". *16th International Conference on Image Analysis and Recognition (ICIAR-19)*. 12 pages. Waterloo, Canada, August 27-29, 2019.
- Bhalla, S., Subramanian, S.G., Crowley, M.. (2019). "Learning Multi-Agent Communication with Reinforcement Learning". In *Conference on Reinforcement Learning and Decision Making (RLDM-19)*. 4 pages. Montreal, Canada, July 2019.
- Dorfman, A., Oakes, H., Santos, H. C. & Grossmann, I. (2019). Self-distancing promotes positive emotional change after adversity: Evidence from a micro-longitudinal field experiment. *Journal of Personality*. doi: 10.1111/jopy.12534 (**3.08**)
- Na, J.*, **Grossmann, I.***, Varnum, M. E.W., Karasawa, M., Cho, Y., Kitayama, S., & Nisbett, R. E. (2019). Culture and personality revisited: Behavioral profiles and within-person stability in interdependent (vs. independent) social orientation and holistic (vs. analytic) cognitive style. *Journal of Personality*. doi: 10.1111/jopy.12536 (**3.08**) *corresponding authors
- Ferrari, M., **Grossmann, I.**, Grimm, S., & Staffel, J. (2019). A process model of wisdom from adversity. *The Journal of Value Inquiry*, **5**, 471-473. doi: 10.1007/s10790-019-09711-7.
- Grossmann, I., Oakes, H. & Santos, H. C.** (2019). Wise reasoning benefits from emotion diversity, irrespective of emotional intensity. *Journal of Experimental Psychology: General*, **148(5)**, 805-823. doi: 10.1037/xge0000543 (**5.78**)
- Huh, M., Grossmann, I., & Friedman, O. (2019). Children show reduced trust in confident advisors who are partially-informed. *Cognitive Development*, **50**, 49-55. doi: 10.1016/j.cogdev.2019.02.003 (**2.00**)
- Varnum, M. E. W. & **Grossmann, I.** (2019). The wealth→life history→innovation account of the Industrial Revolution is largely inconsistent with empirical time series data. *Behavioral and Brain Sciences*, **42**, e212. [commentary] (**14.20**) doi: 10.1017/S0140525X19000086
- Zhao, S., Xu, H., Hipel, K.W., and Fang, L., (2019). "Mixed Stabilities for Analyzing Opponents' Heterogeneous Behavior within the Graph Model for Conflict Resolution", *European Journal of Operational Research*, DOI: 10.1016/j.ejor.2019.02.043, Vol. 277, No. 2, pp. 621-632.
- Silva, M.M., Hipel, K.W., Kilgour, D.M., and Costa, A.P.C.S., (2019). "Strategic Analysis of a Regulatory Conflict Using Dempster-Shafer Theory and AHP for Preference Elicitation", *Journal of Systems Science and Systems Engineering*, DOI: [10.1007/s11518-019-5420-1](https://doi.org/10.1007/s11518-019-5420-1), Vol. 28, No. 4, pp.

415-433.

Zhao, J., Xu, H., Hipel, K.W., and Yang, B., (2019). "Theory and Implementation of Sensitivity Analyses Based on their Algebraic Representation in the Graph Model", *Journal of Systems Science and Systems Engineering*, DOI: [10.1007/s11518-019-5412-1](https://doi.org/10.1007/s11518-019-5412-1), Vol. 28, No. 5, pp. 580-601.

Aljefri, Y., Fang, L., Hipel, K.W., and Madani, K. (2019). "Strategic Analyses of the Hydropolitical Conflicts Surrounding the Grand Ethiopian Renaissance Dam", *Group Decision and Negotiation*, DOI: [10.1007/s10726-019-09612-x](https://doi.org/10.1007/s10726-019-09612-x), Vol. 28, No. 2, pp. 305-340.

Wang, J., Hipel, K.W., Fang, L., Xu, H., and Kilgour, D.M. (2019). "Behavioral Analysis in the Graph Model for Conflict Resolution", *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, DOI: [10.1109/TSMC.2017.2689004](https://doi.org/10.1109/TSMC.2017.2689004), Vol. 49, No. 5, pp. 904-916.

Garcia, A., Hipel, K.W., and Obeidi, A., (2019). "Classifying Metarational Stabilities in Conflicts", *Journal of Systems Science and Systems Engineering*, DOI: [10.1007/s11518-019-5408-x](https://doi.org/10.1007/s11518-019-5408-x), Vol. 28, No. 3, pp. 265-284.

Sabtan, B., Kilgour, D.M., and Hipel, K.W. (2019). "Assessing the Effectiveness of Economic Sanctions", *EURO Journal of Decision Processes*, DOI: [10.1007/s40070-019-00096-3](https://doi.org/10.1007/s40070-019-00096-3), Vol. 7, No.1-2, pp. 69-82.

Langenegger, T.W. and Hipel, K.W. (2019). "The Strategy of Escalation and Negotiation: The Iran Nuclear Dispute", *Journal of Systems Sciences and Systems Engineering*, DOI: [10.1007/s11518-019-542-1](https://doi.org/10.1007/s11518-019-542-1), Vol. 28, No. 4, pp. 434-448.

Aljefri, Y., Fang, L., Hipel, K.W., and Madani, K. (2019). "Strategic Analyses of the Hydropolitical Conflicts Surrounding the Grand Ethiopian Renaissance Dam", *Group Decision and Negotiation*, DOI: [10.1007/s10726-019-09612-x](https://doi.org/10.1007/s10726-019-09612-x), Vol. 28, No. 2, pp. 305-340.

Talukder, B. and Hipel, K.W. (2019). "Diagnosis of Sustainability of Trans-Boundary Water Governance in the Great Lakes Basin", *World Development*, DOI: [10.1016/j.worlddev.2019.104855](https://doi.org/10.1016/j.worlddev.2019.104855). Accepted for publication on December 18, 2019. 12 pp.

Zhang, X., Hipel, K.W., Ge, B., and Tan, Y. (2019). "A Game-theoretic Model for Resource Allocation with Deception and Defense Efforts", *Systems Engineering*, DOI: [10.1002/sys.21479](https://doi.org/10.1002/sys.21479), Vol. 22, No. 3, pp. 282-291.

de Vlieger, N.M., Weltert, M., Molenaar, A., McCaffrey, T.A., Rollo, M.E., Truby, H., Livingstone, B., **Kirkpatrick, S.I.**, Boushey, C.J., Kerr, D.A., Collins, C.E., & Bucher, T. A systematic review of recall errors associated with portion size estimation aids in children. *Appetite*, Epub ahead of print. [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Lee, K.M.*, Marcinow, M.L.*, Minaker, L.M., & **Kirkpatrick, S.I.** The healthfulness of eateries at the University of Waterloo: A comparison across two time points. *Canadian Journal of Dietetic Practice and Research*, Epub ahead of print. [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Solbak, N.M., Rajabi, A.A., Akawung, A.K., Lo Siou, G., **Kirkpatrick, S.I.**, & Robson, P.J. (2019). Strategies to address misestimation of energy intake based on self-report dietary consumption in examining associations between dietary patterns and cancer risk. *Nutrients*, 11(11). pii: E2614. doi: [10.3390/nu11112614](https://doi.org/10.3390/nu11112614). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Jones, A., **Kirkpatrick, S.I.**, & Hammond, D. (2019). Beverage consumption and energy intake among Canadians: analyses of 2004 and 2015 national dietary intake data. *Nutrition Journal*, 18(1):60. doi: [10.1186/s12937-019-0488-5](https://doi.org/10.1186/s12937-019-0488-5). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Kirkpatrick, S.I., Baranowski, T., Subar, A.F., Tooze, J.A., Frongillo, E.A. (2019). Best practices for conducting and interpreting studies to validate self-report dietary assessment methods. *Journal of the Academy of Nutrition and Dietetics*. 119(11):1801-1816. doi: [10.1016/j.jand.2019.06.010](https://doi.org/10.1016/j.jand.2019.06.010). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Kirkpatrick, S.I., Vanderlee, L., Dias, G.M., Hanning, R.M. (2019). Can food-based dietary guidelines support transformation of the food system to foster human and planetary health? *UNSCN Nutrition*. [View](https://www.unscn.org/en/nutrition).

Acton, R.B., Jones, A.C., **Kirkpatrick, S.I.**, Roberto, A.C., Hammond, D. (2019). Taxes and front-of-package labels improve the healthiness of beverage and snack purchases: A randomized experimental marketplace. *International Journal of Behavioural Nutrition and Physical Activity*. 16(1):46. [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Raffoul, A.*, Hobin, E.P., Sacco, J.E., Lee, K.M.*, Haines, J., Robson, P.J., Dodd, K.W., **Kirkpatrick, S.I.** (2019). School-age children can recall some foods and beverages consumed the prior day using the Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24) without assistance. *Journal of Nutrition*, 149(6):1019-1026. [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Kirkpatrick, S.I., Raffoul, A.*, Lee, K.M.*, Jones, A.C.. (2019). Sources of energy, sugars, sodium, and saturated fats among Canadians. *Applied Physiology, Nutrition, and Metabolism*, 44(6):650-658. doi: [10.1139/apnm-2018-0532](https://doi.org/10.1139/apnm-2018-0532). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Faught, E.L., McLaren, L., **Kirkpatrick, S.I.**, Hammond, D., Minaker, L.M., Raine, K.D., Olstad, D.L. (2019). Socioeconomic disadvantage across the life course is associated with diet quality in young adulthood. *Nutrients*, 11(2). doi: [10.3390/nu11020242](https://doi.org/10.3390/nu11020242). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

Thomas, H., Azevedo Perry, E., Manowicz, E., Slack, J., Samra, R., Petermann, L., Manofa, E., **Kirkpatrick, S.I.** (2019). Complexities in conceptualizing and measuring food literacy. *Journal of the Academy of Nutrition and Dietetics*. S2212-2672(18)30266-1. doi: [10.1016/j.jand.2018.10.015](https://doi.org/10.1016/j.jand.2018.10.015). [PubMed](https://pubmed.ncbi.nlm.nih.gov/).

- Kirkpatrick, S.I.**, Guenther, P., Douglass, D., Zimmerman, T.P., Atoloye, A., Marcinow, M.*, Kahle, L.L., Dodd, K.W., Durward, C. (2019). The provision of assistance does not substantially impact the accuracy of 24-hour dietary recalls completed using the Automated Self-Administered 24-hour Dietary Assessment Tool among women with low incomes. *Journal of Nutrition*, 149(1):114-122. doi: 10.1093/jn/nxy207. [PubMed](#).
- Förster, F., Saunders J., Lehmann, H., Nehaniv, C. (2019). 'Robots Learning to Say "No" Prohibition and Rejective Mechanisms in Acquisition of Linguistic Negation', *ACM Transactions on Human-Robot Interaction (THRI)* 8 (4), 1-26, Dec. 2019.
- Broz, F., Nehaniv, C., Kose, H., Dautenhahn, K., (2019). 'Interaction Histories and Short-Term Memory: Enactive Development of Turn-Taking Behaviours in a Childlike Humanoid Robot', *Philosophies: Special Issue Frontiers of Embodied Artificial Intelligence: The (r)-evolution of the embodied approach in AI*, 4(2), June 2019.
- Nehaniv, C. (2019). 'Constructive Biology of Emotion Systems: First-and Second-Person Methods for Grounding Adaptation in a Biological and Social World', In : *Cognitive Architectures*, Springer Verlag
- Robu, A., Salge, C., Nehaniv, C., Polani, D. (2019). 'Measuring Time with Minimal Clocks', *Artificial Life* 25(4) : 383-409. November 2019.
- Foerster, F., Nehaniv, C., Saunders, J., Lehmann, H., (2019). 'Example recordings of human-robot interactions in the rejection and prohibition experiments', University of Hertfordshire Research Archive, 29 August 2019. [Dataset]
- Frongillo, E.A., Baranowski, T., Subar, A.F., Toozee, J.A., **Kirkpatrick, S.I.** (2019). Establishing validity and cross-context equivalence of measures and indicators. *Journal of the Academy of Nutrition and Dietetics*, 119(11):1817-1830. doi: 10.1016/j.jand.2018.09.005. [PubMed](#).
- Kirkpatrick, S.I.** (2019). Examining the quality of foods and beverages across the food stream. *Journal of the Academy of Nutrition and Dietetics*, 2019, 119(1):35-38. doi: 10.1016/j.jand.2018.08.166. [PubMed](#).
- Maynard, M.*, Dean, J., Rodriguez, P.*, Sriranganathan, G.*, Qutub, M.* & **Kirkpatrick, S.I.** (2019). The experience of food insecurity among immigrants: A scoping review. *Journal of Immigrant and Minority Health*, 20(2):375-417. [View](#).
- Parker, D.C., Barton, M.J., Filatova, T., Polhill, J.G., Jin, X., Lee, A., Lee, J.S., Robinson (Wright), K., and Pritchard, C. (2019). Final white paper: MIRACLE project (Mining Relationships Among variables in large datasets from complex systems). Digging into Data grant program.
- Huang, Y., Parker, D., & Anglin, P. (2019). Identifying heterogeneous preferences of homebuyers for a new Light-Rail Transit line: Application of a two-stage hedonic model. *Presented at the 5th Canadian PhD and Early Career Workshop in Environmental and Resource Economics. University of Calgary, Calgary. June 3-4, 2019.*
- Parker, D.C., Carro, A., Detotto, C., Filatova, T., Ge, J., Huang, Y., Idda, C., Magliocca, N., Polhill, J.G., and Prunetti, D. (2019). MR POTATOHEAD: Property market edition-development of a common description template and code base for agent-based land-market models. Social Simulation conference Short Paper (peer reviewed)
- Quilley, S. and Zywert, K. (2019). 'Livelihood, market and state: What does a political economy predicated on the 'individual-in-group-in-place' actually look like?' in the 30th anniversary issue of *Ecological Economics* on the future of the discipline Ed. Kish, K. and Farley, J.
- Quilley, S. (2019). Smithsonian Reflections on the Age of Humans: A review of *Living in the Anthropocene: Earth in the Age of Humans* by Kress, W.J. and Stine, J.K. (Eds) 2017 Washington DC: Smithsonian Institute.
- Quilley, S. (2019). 'Liberty in the Near Anthropocene: State, Market and Livelihood. What the changing I/We balance means for feminism, nationalism, liberalism, socialism and conservatism' in *Liberty and the Ecological Crisis Freedom on a Finite Planet*, 1st Edition Edited by [Christopher J. Orr](#), [Kaitlin Kish](#), [Bruce Jennings](#) (London Routledge)
- Quilley, S. (2019). 'Liberty in the (Long) Anthropocene: The 'I' and the 'We' in the Longue Duree ' in *Liberty and the Ecological Crisis Freedom on a Finite Planet*, 1st Edition Edited by [Christopher J. Orr](#), [Kaitlin Kish](#), [Bruce Jennings](#) (London Routledge)
- Kish, K. and Quilley, S. (2019). 'Livelihood and the Individual: New Ecological Economic Development Goals'. In: *BSIA-10: Reflections on the Sustainable Development Goals*. By: Dalby, S. University of Toronto Press: Toronto, ON.
- Kish, K. and Quilley, S. (2019). Labour and Regenerative Production. In: *A Research Agenda for Ecological Economics*. By: Costanza, B., Farley, J., and Kubiszewski, I. Edward Elgar: New York, NY.
- Schweizer, V.** (2019) Scenarios and Decision Support for Security and Conflict Risks in the Context of Climate Change. *Current Climate Change Reports*, 5, 12-23. Part of a Topical Collection on "Climate Change and Conflict," doi:10.1007/s40641-019-00123-0
- Sharma, A.*, Hipel, K.W., **Schweizer, V.** (2019) Cauvery River Dispute: Strategic insights using Graph Model for Conflict Resolution (GMCR) with Fuzzy Preferences. In: K.W. Hipel, H. Wang, L. Fang, J. Chen and Y. Xiao (Eds.), Proceedings of the 8th International Conference on Water Resources and Environment Research, 14-18 June 2019, Nanjing, China, 284-286. 2 pp.
- Schweizer, V.** Development as a determinant of climate risk (2019). Book chapter in S. Dalby and S. Horton (Eds.), *Achieving the Sustainable Development Goals: Global Governance Challenges*, Routledge.

Kurniawan, J.H.* and **Schweizer, V.** (2019) Extending Shared Socio-economic Pathways: Developing multi-scale internally consistent scenarios for Canada's energy futures. 7th Annual Meeting of the Society for Decision Making under Deep Uncertainty, 7 November 2019, Delft, The Netherlands.

Schweizer, V., Power, A.*, Kurniawan, J.* (2019). Scientometrics for systematic review of academic literature related to the Shared Socioeconomic Pathways. Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures, 11 March 2019, Denver.

Keisler, J.M., Collier, Z.A., Ayyub, B.M., Dempwolf, C.S., MacDonald Gibson, J., Porter, A.L., **Schweizer, V.J.**, Thorisson, H., Wang, L., Ye, M. (2019). Modeling and Analytics to Identify Emerging International Innovation Partnerships. Breakout Group Report for the workshop, "Signals and Metrics Identifying Partnerships for Innovation", Washington, DC, May 2019, 18 pp.

Boonman, C.C., Beñítez-López, A., Schipper, A.M., Thuiller, W. Anand, M., Cerabolini, B.E., Cornelissen, J.H., Gonzalez-Melo, A., Hattingh, W.N., Higuchi, P. & Laughlin, D.C. (2020). Assessing the reliability of predicting plant trait distributions at the global scale. *Global Ecology and Biogeography*, 29(6), 1-18.

Herberich, M.M., Gayler, S. **Anand, M.**, & Tielbörger, K. (2020). Biomass–density relationships of plant communities deviate from the self-thinning rule due to age structure and abiotic stress. *Oikos*, 129(9), 1393-1403.

Kattge, J., Bönnisch, G., Díaz, S., Lavorel, S., Prentice, I.C., Leadley, P., Tautenhahn, S., Werner, G.D., Aakala, T., Abedi, M., Acosta, A.T., et al. (2020). TRY plant trait database - enhanced coverage and open access. *Global Change Biology*, 26(1), 119-188.

Anand, M. (2020). This Red Line Goes Straight to Your Heart. Strange Light/Penguin Random House Canada (creative non-fiction book).

Pedro, S.A., Ndjomatchoua, F.T., Jentsch, P., Tcheunche, J.M., **Anand, M.**, **Bauch, C.T.** (2020). 'Conditions for a second wave of COVID-19 due to interactions between disease dynamics and social processes'. *Frontiers in Physics*: 574514.

Karatayev, V.A., **Anand, M.**, **Bauch, C.T.** (2020). 'Local lockdowns outperform global lockdown on the far side of the COVID-19 epidemic curve'. *PNAS* **117(39)**: 24575-244580.

Jentsch, P., **Bauch, C.T.**, Yemshanov, D., **Anand, M.** (2020). 'Go big or go home: a model-based assessment of policies to slow the spread of forest pests via infested firewood'. *PLOS ONE* **15(9)**: e0238979.

Infarahbakhsh, I., **Bauch, C.T.**, **Anand, M.** (2020). 'Best response dynamics improve sustainability and equity outcomes in common-pool resources problems, compared to imitation dynamics'. *Journal of Theoretical Biology*: 110476.

Bury, T., **Bauch, C.T.**, **Anand, M.** (2020). 'Detecting and distinguishing tipping points using spectral early warning signals'. *Interface* **17(170)**: 20200482.

Fair, K., **Anand, M.**, **Bauch, C.T.** (2020). 'Spatial Structure in Protected Forest-Grassland Mosaics: Exploring Futures Under Climate Change.' *Global Change Biology* **26**: 6097–6115.

Wang, Z., Jusup, M., Guo, H., Shi, L., Gecek, S., **Anand, M.**, Perc, M., **Bauch, C.T.**, Kurths, J., Boccaletti, S., Schellnhuber, H.J. (2020). 'Communicating sentiment and outlook reverses inaction against collective risk'. *PNAS* **117(30)**: 17650-17655.

Bauch, C.T., **Anand, M.** (2020). 'COVID-19: When should quarantine be enforced?'. *The Lancet Infectious Diseases* **20(9)**: 994-995.

Phillips, B., **Anand, M.**, **Bauch, C.T.** (2020). 'Spatial early warning signals of social and epidemiological tipping points in a coupled behaviour-disease network'. *Scientific reports* **10(1)**: 1-12.

Pharaon, J., **Bauch, C.T.** (2020). The Impact of Pre-exposure Prophylaxis for Human Immunodeficiency Virus on Gonorrhoea Prevalence. *Bulletin of Mathematical Biology* **82(7)**: 1-19.

Wells, C.R., Huppert, A., Fitzpatrick, M.C., Pandey, A., Velan, B., Singer, B.H., **Bauch, C.T.**, Galvani, A. (2020). 'Prosocial vaccination in Israel'. *PNAS* **117(23)**: 13138-13144.

Horrocks, J., **Bauch, C.T.** (2020). 'Algorithmic discovery of dynamic models from infectious disease data'. *Scientific reports* **10(1)**: 1-18.

Souza, P.V.S., Silva, R., **Bauch, C.T.**, Girardi, D. (2020). 'Cooperation in a generalized age-structured spatial game'. *Journal of Theoretical Biology* **484**: 109995.

Grossmann, I., Eibach, R. P., Koyama, J., & Sahi, Q. (2020). Folk standards of sound judgment: Rationality vs. Reasonableness. *Science Advances*, 6(2), eaaz0289. doi: 10.1126/sciadv.aaz0289 (**12.80**)

Grossmann, I., Dorfman, A., & Oakes, H. (2020). Wisdom is a social-ecological rather than person-centric phenomenon. *Current Opinion in Psychology*, 20, 66-71. doi: 10.1016/j.copsyc.2019.07.010 (**SJR 1.61**)

Huynh, A. C. & **Grossmann, I.** (2020). A pathway to wisdom-focused education. *Journal of Moral Education*, 49, 9-29. doi: 10.1080/03057240.2018.1496903 (**1.02**)

Ko, A., Pick, C., Kwon, J. Y., Barlev, M., Krems, J. A., Varnum, M. E. W., Neel, R., Peysha, M., Boonyasiriwat, W., Brandstätter, E., Vasquez, J. E. C., Galindo, O., Pereira de Felipe, R., Crispim, A. C., Fetvadjiiev, V. H., Fischer, R., Karl, J., David, D., Galdi, S., Gomez-Jacinto, L., **Grossmann, I.** ... & Kenrick, D. T. (2020). Family Matters: Rethinking the Psychology of Human Social Motivation. *Perspectives on Psychological Science*, 15, 173-201. doi: 10.1177/1745691619872986 (7.51)

Jayawickreme, E., Infurna, F. J., Alajak, K., Blackie, L. E. R., Chopik, W. J., Chung, J. M., Dorfman, A., Fleeson, W., Forgeard, M. J. C., Frazier, P., Furr, R. M., **Grossmann, I.**, ... & Zonneveld, R. (2020). Post-Traumatic Growth as Positive Personality Change: Challenges, Opportunities and Recommendations. *Journal of Personality*. (3.08)

Grossmann, I., Dorfman, A., & Oakes, H. (2020). Wisdom is a social-ecological rather than person-centric phenomenon. *Current Opinion in Psychology*, 20, 66-71. doi: 10.1016/j.copsy.2019.07.010 (SJR 1.61)

Grossmann, I. & Eibach, R. E. (2020). Reasonable bounds on rationality. *Mind & Society*. doi: 10.1007/s11299-020-00267-9.

Grossmann, I., Eibach, R. P., Koyama, J., & Sahi, Q. (2020). Folk standards of sound judgment: Rationality versus reasonableness. *Science Advances*, 6(2), eaaz0289. doi: 10.1126/sciadv.aaz0289 (12.80)

Grossmann, I., Weststrate, N. M., Ardelt, M., Brienza, J. P., Dong, M., Ferrari, M., Fournier, M. A., Hu, C. S., Nusbaum, H. C. & Vervaeke, J. (2020). The science of wisdom in a polarized world: Knowns and unknowns. *Psychological Inquiry*, 31(2), 103-133. doi: 10.1080/1047840X.2020.1750917 [target article] (10.27)

Grossmann, I., Weststrate, N. M., Ferrari, M., & Brienza, J. P. (2020). A common model is essential for a cumulative science of wisdom. *Psychological Inquiry*, 31(2), 185-194. doi: 10.1080/1047840X.2020.1750920 [reply to commentaries] (10.27)

Huynh, A. C. & **Grossmann, I.** (2020). Rising ethnic diversity in the United States accompanies shifts toward an individualistic culture. *Social Psychological and Personality Science*. (4.39)

Huynh, A. C. & **Grossmann, I.** (2020). A pathway to wisdom-focused education. *Journal of Moral Education*, 49, 9-29. doi: 10.1080/03057240.2018.1496903 (1.02)

Ko, A., Pick, C., Kwon, J. Y., Barlev, M., Krems, J. A., Varnum, M. E. W., Neel, R., Peysha, M., Boonyasiriwat, W., Brandstätter, E., Vasquez, J. E. C., Galindo, O., Pereira de Felipe, R., Crispim, A. C., Fetvadjiiev, V. H., Fischer, R., Karl, J., David, D., Galdi, S., Gomez-Jacinto, L., **Grossmann, I.** ... & Kenrick, D. T. (2020). Family matters: Rethinking the psychology of human social motivation. *Perspectives on Psychological Science*, 15, 173-201. doi: 10.1177/1745691619872986 (7.51)

Na, J.*, **Grossmann, I.***, Varnum, M. E.W., Karasawa, M., Cho, Y., Kitayama, S., & Nisbett, R. E. (2020). Culture and personality revisited: Behavioral profiles and within-person stability in interdependent (vs. independent) social orientation and holistic (vs. analytic) cognitive style. *Journal of Personality*, 88(5), 908-924. doi: 10.1111/jopy.12536 (3.08) *corresponding authors

Peetz, J. & **Grossmann, I.** (2020). Wise reasoning about the future is associated with adaptive interpersonal feelings after relational challenges. *Social Psychological and Personality Science*. doi: 10.1177/1948550620931985 (4.39)

Prentice, L., Klackl, J., Agroskin, D., **Grossmann, I.**, Alexandrov, Y., Apanovich, V., Bezdenezhnykh, B., & Jonas, E. (2020). Reaction to norm transgressions and Islamization threat in culturally tight and loose contexts: A case study of Germany vs. Russia. *Culture & Brain*, 8, 46–69. doi: 10.1007/s40167-018-0073-3

Santos, H. C. & **Grossmann, I.** (2020). Cross-temporal exploration of the relationship between wisdom-related cognitive broadening and subjective well-being: Evidence from a cross-validated national longitudinal study. *Social Psychological and Personality Science*. doi: 10.1177/1948550620921619 (4.39)

Kung, F. Y. H. & **Grossmann, I.** (2020). Wisdom across cultures. In O. Braddick (Ed.), *Oxford Research Encyclopedia of Psychology*. New York: Oxford University Press. doi: 10.1093/acrefore/9780190236557.013.586

Homer-Dixon, T. (2020). *Commanding Hope: The Power We Have to Renew a World in Peril* (Toronto: Knopf Canada, 2020).

Raffoul, A.*, Goodman, S., Hammond, D., **Kirkpatrick, S.I.**. (2020). Weight management attempts, but not weight perceptions, are associated with diet quality among young adults in Canada. *Journal of the Academy of Nutrition and Dietetics*. Epub ahead of print. [PubMed](#).

Andrade, L.*, Lee, K.M.*, Sylvetsky, A., **Kirkpatrick, S.I.**. (2020). Low-calorie sweeteners and human health: A rapid review of systematic reviews. *Nutrition Reviews*. 28(11)2078-2082. [PubMed](#).

Acton, R.B., **Kirkpatrick, S.I.**, Hammond, D. (2020). How does the probability of purchasing moderately sugary beverages and 100% fruit juice vary across different sugar tax structures? *Obesity*. 28(11):2078-2082. [PubMed](#).

Subar, A.F., Potischman, N., Dodd, K.W., Thompson, F.E., Baer, D.J., Schoeller, D.A., Midthune, D., Kpnis, V., **Kirkpatrick, S.I.**, Mittl, B., Zimmerman, T.P., Douglass, D., Bowles, H., Park, Y. (2020). Performance of recalls completed using the Automated Self-administered 24-hour

Dietary Assessment Tool (ASA24) in relation to other self-report tools and biomarkers in the Interactive Diet and Activity Tracking in AARP (IDATA) Study. *Journal of the Academy of Nutrition and Dietetics*. 120(11):1805-1820. [PubMed](#).

Minnick, C.*, Raffoul, A.*, Hammond, D., **Kirkpatrick, S.I.**. (2020). Intentional weight gain efforts among young Canadian adults aged 17-32 years. *Eating Behaviors*. Epub ahead of print. [PubMed](#).

Haslam, R.L., Truby, H., Attia, J., Hutchesson, M., Burrows, T., Callister, R., Hides, L., Bonevski, B., Kerr, D.A., Lubans, D., **Kirkpatrick, S.I.**, Rollo, M.E., McCaffrey, T.A., Collins, C.E. (2020). Investigating the efficacy and cost-effectiveness of technology-delivered personalized feedback on dietary patterns in young Australian adults in the Advice, Ideas and Motivation for My Eating (Aim4Me): Protocol for a randomized controlled trial. *Journal of Medical Internet Research*. 9(5), e15999. doi: 10.2196/15999. [PubMed](#).

Bodnar, L., Cartus, A., **Kirkpatrick, S.I.**, Himes, K., Kennedy, E., Simhan, H., Grobman, W., Duffy, J., Silver, R., Parry, S., Naimi, A. (2020). Machine learning as a strategy to account for dietary synergy: an illustration based on dietary intake and adverse pregnancy outcomes. *American Journal of Clinical Nutrition*, 111(6):1235-1243. [PubMed](#).

Raffoul, A.*, **Kirkpatrick, S.I.**.(2020). Clustering of health-related behaviors: Examining the co-occurrence of dieting and other risky behaviors among girls using secondary data from the COMPASS. *SAGE Research Methods Cases*. Doi: 10.4135/9781529711172. [View](#).

de Vlioger, N.M., Weltert, M., Molenaar, A., McCaffrey, T.A., Rollo, M.E., Truby, H., Livingstone, B., **Kirkpatrick, S.I.**, Boushey, C.J., Kerr, D.A., Collins, C.E., Bucher, T. (2020). A systematic review of recall errors associated with portion size estimation aids in children. *Appetite*, 147:104522. [PubMed](#).

Foerster, F.*, [Dautenhahn, K.](#), [Nehaniv, C.](#) (2020). Towards Scalable Measures of Quality of Interaction: Motor Interference. *ACM Transactions on Human-Robot Interaction* 9 (2), (February 2020), 25 pages. DOI:<https://doi.org/10.1145/3344277>

Förster, F., Dautenhahn, K., Nehaniv, C. (2020). 'Toward Scalable Measures of Quality of Interaction: Motor Interference', *ACM Transactions on Human-Robot Interaction (THRI)* 9(2), 1-25, February 2020.

Innocenti, E., Detotto, C., Idda, C., Parker, D.C., Prunetti, D. (2020) An iterative process to construct an interdisciplinary ABM using MR POTATOHEAD: An application to Housing Market Models in touristic areas. *Ecological Complexity*. 44

Ligmann-Zielinska, A., Siebers, P.O., Magliocchia, N., Parker, D.C., Grimm, V., Jing Du, E., Cenek, M., Radchuk, V., Arbab, N., Li, S., Berger, U., Paudel, R., Robinson, D.T., Jankowski, P., An, L., Ye, X. (2020). One size does not fit all': a roadmap of purpose-driven mixed method pathways for sensitivity analysis of agent-based models. *Journal of artificial societies and social simulation*. 23(1): 6.

Parker, D.C., Huang, Y., Feng, D. (2020). The effect of bicycle infrastructure on residential property values in a midsized Canadian city. 2020 Association of Collegiate Schools of Planning Annual Meeting, Conference Date: 2020/11

Webber, K. Parker, D.C. (2020). Retail and Light Rail: Investigating the relationship between transit-induced intensification and retail gentrification in Waterloo Region. Association of Collegiate Schools of Planning Annual Meeting, Conference Date: 2020/11

Doucet, B. Parker, D.C., McDougall, E., Huang, Y., Feng, D. (2020). Cycling Infrastructure and Its Relationship to Residential Property Prices. University of Waterloo

Sun, Z., Mueller, D., Mueller, B., Parker, D.C., and Bakker, M. (2020). Current status, challenges and ways forward in modelling human-environment interactions in land systems. (7/2020) GLP Blog: <https://glp.earth/news-events/blog/current-status-challenges-and-ways-forward-modelling-human-environment-interactions>.

Loyal, S. & Quilley, S. (2020). State Formation, Habitus, and National Character: Elias, Bourdieu, Polanyi, and Gellner and the Case of Asylum Seekers in Ireland. *Historical Social Research* 45 (1(171)), 226-261. Doi:10.2307/26873887

Kish, K. & Quilley, S. (2020). "Work, Labour, and Regenerative Production" *Sustainable Wellbeing Futures*. Costanza, R., Erickson, J., Farley, J., Kubiszewski, I. Edward Elgar. 27-44.

Hensher, M., Kish, K., Farley, J. & Quilley, S. (2020) 'Open knowledge commons versus privatized gain in a fractured information ecology: lessons from COVID-19 for the future of sustainability' *Global Sustainability* Volume 3 2020, e26 DOI: <https://doi.org/10.1017/sus.2020.21> Cambridge University Press: 19 August 2020

Kish, K.; Zywert, K.; Hensher, M.; Davy, B.J., Quilley, S. (2020). Socioecological System Transformation: Lessons from COVID-19. *World* 2021, 2, 15–31. <https://www.mdpi.com/2673-4060/2/1/2/htm>.

Schweizer, V.J., Ebi, K.L., van Vuuren, D.P., Jacoby, H.D., Riahi, K., Strefler, J., Takahashi, K., van Ruijven, B.J., Weyant, J.P., (2020) Integrated Climate-Change Assessment Scenarios and Carbon Dioxide Removal. *One Earth*, 3, 166–172, doi: 10.1016/j.oneear.2020.08.001

Kurniawan, J.*, **Schweizer, V.** (2020) Using Network Analysis to Find Key Leverage Points for Canadian Energy Futures. *Society and Natural Resources*, 33, 1419-1437. Topical Issue on "Climate Change and Energy Futures", doi:10.1080/08941920.2020.1781988

Elsawah, S., Hamilton, S., Jakeman, T., Rothman, D., **Schweizer, V.**, Trutnevte, E., Carlsen, H., Drakes, C., Frame, B., Fu, B., Guivarch, C., Haasnoot, M., Kemp-Benedict, E., Kok, K., Kosow, H., Ryan, M., van Delden, H., (2020) Scenario processes for socio-environmental systems analysis of futures: A review of recent efforts and a salient research agenda for supporting decision making. *Science of The Total Environment*, 729, 138393, doi:10.1016/j.scitotenv.2020.138393

Keisler, J.M., Collier, Z.A., Ayyub, B.M., Dempwolf, C.S., Gibson, J.M., Porter, A.L., **Schweizer, V.J.**, Thorisson, H., Wang, L., Ye, M., Lambert, J.H., Linkov, I., (2020) Modeling and Analytics to Support Emerging International Innovation Partnerships. *IEEE Engineering Management Review* 48, 54–64, doi:10.1109/EMR.2020.2989391

Sharma, A. *, Hipel, K.W., **Schweizer, V.** (2020) Strategic Insights into the Cauvery River Dispute in India, *Sustainability*, 12, 1286. Special Issue on “Water Resources and Green Growth,” doi:10.3390/su12041286

Schweizer, V. (2020) Reflections on cross-impact balances, a systematic method constructing global socio-technical scenarios for climate change research. *Climatic Change*. Editorial essay for a Special Issue on “Integrated Scenario Building in Energy Transition Research,” doi:10.1007/s10584-019-02615-2

Schweizer, V., Lazaruko, A. * (2020) Cross-impact Balances: A Method for Bridging Social Systems and Cybernetics. In: Proceedings of the 2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC), 11-14 October 2020, Toronto, 4486-4492. 7 pp.

Sharma, A., **Schweizer, V.**, Hipel, K.W. (2020) Analyzing Cauvery River Dispute Using A System of Systems Approach. In: Proceedings of the 2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC), 11-14 October 2020, Toronto, 3969-3975. 7 pp.

de Wildt, T.E. and **Schweizer, V.J.** (2020) Incorporating scenarios of value change in robust decision making using Cross-Impact Balances. In: A. van Griensven, J. Nossent, and D.P. Ames (Eds.), Proceedings of the 10th International Congress on Environmental Modelling and Software, 14-18 September 2020, Brussels. 0.5 p.

Drakes, C. *, **Schweizer, V.** (2020) Mitigating socio-ecological risk in small island states through sustainability scenarios for economic restructuring under COVID-19. 2020 Annual Meeting of the Society for Risk Analysis, 14-17 December 2020, Online.

Kearney, N. *, **Schweizer, V.** (2020) Strategies for Sustainability Transformations in Self-Reinforcing Social Systems. Poster Presentation for the 2020 Fall Meeting of the American Geophysical Union, 1-17 December 2020, Online.

Lazaruko, A. *, Kearney, N. *, Kurniawan, J., Siddhantakar, N. *, **Schweizer, V.** (2020) Interdependence and emergence in the Sustainable Development Goals: A scenario assessment approach for modelling multi-sector futures. 2020 Fall Meeting of the American Geophysical Union, 1-17 December 2020, Online.

APPENDIX F: STUDENT TRAVEL GRANTS AWARDED 2016-2020

WICI Student Travel Awards

YEAR	NAME	PROJECT	AWARD
2016	Perin Ruttonsha	Attendance at the Global Sustainability Summer School on Urban Sustainability at Santa Fe Institute, New Mexico	\$1500
2016	Amanda Raffoul	Attendance at the Complex Systems Modeling for Public Health Research course at University of Michigan	\$1000
2016	Teresa Branch-Smith	On-site work in Zenith's research labs in Montpellier, France	\$150
2016	Virginia Capmourteres	Attendance at M. Sackler Colloquium in Washington, DC	\$500
2016	Corey Pembleton	Presentation at the Esri Geodesign Summit in Redlands, California	\$500
2017	Yu Huang	Attendance at the North American Meetings of the Regional Science in Vancouver	\$800
2017	Scott Janzwood	Presentation at the Decision Making under Deep Uncertainty annual workshop at Oxford Martin School, Oxford University	\$1,000
2017	Katherine Laycock	Attendance at the Association of Collegiate Schools of Planning's Annual Conference in Denver	\$675
2018	Scott Janzwood	Joining the Future of Humanity Institute at the University of Oxford as a visiting fellow	\$500
2018	Katherine Laycock	Presentation at the Urban Affairs Conference, Toronto	\$800
2018	Thomas Bury	Presentation at the Dynamics Days conference in Denver Colorado	\$1,000
2018	Thomas Bury	Workshop on Human-Environment Systems hosted at the Fields Institute, Toronto	\$200
2018	Thomas Bury	Attendance at the Ecological Society of America's Conference in New Orleans	\$1,000
2018	Kathryn Fair	Attendance at the Ecological Society of America's Conference in New Orleans	\$1,000
2018	Julia Goyal	Presentation at Qualitative Analysis Conference in Fredericton, NB	\$1,000
2018	Diana Luna Gonzalez	Attendance at the Workshop on Human-Environment Systems hosted at the Fields Institute, Toronto	\$75
2018	Jude Herijadi Kurniawan	Presentation at PyCon Canada in Toronto	\$320
2019	Kevin Church	Presentation at SIAM Conference on Applications of Dynamical Systems in Snowbird, Utah	\$500
2019	Yu Huang	Attendance & presentation at Canadian PhD and Early Career Workshop in Environmental and Resource Economics in Calgary, AB	\$500
2019	Thomas Bury	Presentation at CAIMS Annual Meeting in Whistler BC	\$500
2019	Kristen Lee	Presentation at Canadian Student Health Research Forum, Winnipeg, MB	\$500
2019	Kirsten Wright	Attendance and workshop at CANSEE	\$120
2019	Jonathan Hui	Attendance and workshop at CANSEE	\$150
2019	Katharine Zywert	Attendance and workshop at CANSEE	\$100
2019	Mark Tovey	Attendance and workshop at CANSEE	\$200

2019 WICI MEMBERSHIP SURVEY REPORT

Prepared by Brenda Panasiak, Administrative Coordinator
March 1, 2020

Introduction

In fall 2019, WICI sent a survey to all current members to gauge their past interaction with the Institute and solicit their thoughts on our direction moving forward. Thirty-five people completed the survey. Feedback from the survey identifies interdisciplinarity as WICI's comparative advantage, encourages WICI to strengthen our position as a complex systems networking hub, with a focus on training and education opportunities for students and faculty in the future. The full results are included starting on page 5 of this report (note, names and email addresses of the respondents have been excluded for confidentiality purposes, but respondents who requested to be contacted with the results will receive a copy of this report).

Membership

Core members accounted for 17.65% of the responses; 23.5% were from Student Members; and 14.28% from Affiliate Researchers. Interestingly, the largest number of responses to the survey (41.18%) were from non-members in attendance at a WICI talk.

Engagement

Many of the ways respondents have engaged with WICI in the past five years (Question 2 in the survey) would not apply to the 41.18% of people who are not members. Thus, of the 20 members who responded, half indicated they have attended and/or presented at a WICI conference in the past 5 years; 30% indicate that they have organized a workshop and/or conference; 30% have advised, served on the committee of, or examined a WICI student(s); and 30% have received WICI travel funds.

Thirty percent of the total number of respondents have viewed recorded WICI talks/Occasional papers on the website, and 30% of total respondents (or 60% when looking at only those responses by WICI members) participated in a WICI research networking event.

Perceived Value

The majority of respondents suggested that WICI's greatest value lies in sharing current research through the speakers series (32%) and/or network-building for complex systems research on campus and beyond (28%). The next two greatest values WICI provides appear to be in direct support for cross-faculty collaborative research (17%) and training/education opportunities through workshops, reading groups or working groups (16%).

Some of the comments about how WICI has provided value:

- "WICI networking event led to collaboration on a New Frontiers grant"
- "I need a peer reference group for sharing, deepening and pursuing interests in complex systems"
- "WICI can play a key role, since it is otherwise hard to get a variety of researchers from different faculties together"

I have attended several Speaker Series organized by WICI and have always learned a great deal about complex problem solving from diverse perspectives."

- [WICI provides value by]”connecting with local off-campus experts in complex systems & innovation”
- “Support for grant acquisition”

Areas for Development

Thirty percent of respondents suggested that WICI could strengthen its activities in training/education opportunities through a WICI workshop, reading group or working group. The next most popular choice for an area to develop was in directly supporting cross-faculty collaborative research (21%), followed by network building (11%) and sharing research through speakers series/occasional papers (10%).

Some of the comments offered in response to areas for WICI development:

- “Well-timed workshops, mini-retreats”
- “Funding and organizing interdisciplinary, problem-based research teams”
- “WICI could be more intentional about [network building], employing software to help WICI members make connections (e.g. Exaptive) or supporting student members in identifying appropriate internal-external committee members for exams/defences”
- “More nodes which would interact with one another as well as with WICI in Waterloo”
- “We could raise the profile of WICI Occasional Papers for people to deposit working papers or even commission working papers”
- “Occasional papers could be leveraged more”
- “Please find a way to livestream activities. I suggest free-of-charge zoom.us which I have used before. No extra hardware needed.”
- “Make more of an effort to foster industry links through relevant complex systems research”
- “Opportunities for students to see non-academic opportunities”

Comments relating to training/education opportunities specifically:

- “Regular trainings for students would be great”
- “Training on existing tools and methodologies: integrating approaches to complex problems”
- “More exploratory/conversational opportunities would be very interesting”
- “Best if these can include remote participation somehow”
- “Training/education opportunities could be considered that target post-docs and faculty”
- “Complex systems certificates (grad/undergrad) esp. methods classes at Waterloo”

When asked for additional activities that WICI could consider engaging in (Question 5 of the survey), one member suggested designing initiative(s) to attract industry:

- “Initiatives designed to attract industry. This could be a "problems solved" seminar detailing how a company solved a problem through an analysis of complex systems. Alternatively, this could be a "hard unsolved problems" series where industry presenters seek to take a complex systems approach to difficult problems they face. This could better actualize the "innovation" part of WICI.”

To determine perception of WICI's scope and mission, question six asked how respondents would describe the mission and scope of WICI to someone outside of WICI. The responses to this question reflect that WICI is primarily viewed as a networking organization that facilitates and promotes interdisciplinary collaboration on complex research problems.

In response to what respondents see as WICI's comparative advantage, many emphasized network building capacity and interdisciplinarity in the topic area of complex systems and systems thinking. One respondent indicated that WICI is the "leading applied institute of complex systems and the leading Canadian centre of complex systems" and that the University of Waterloo "has an opportunity to sustain this advantage by acting decisively/investing now."

"[WICI is the] leading applied Institute...and the leading Canadian center of Complex Systems."

*-Kirsten Wright
WICI Student Member*

Members were also asked about possible areas of improvement for WICI. Respondents felt WICI could do more to promote itself to University of Waterloo faculty and students and improve engagement within our membership. Main themes that were mentioned in the comments for this question include:

- Improving engagement throughout the departments/schools by having WICI representatives (faculty and student) in each, tasked with promoting WICI, recruiting members, and leveraging collaboration opportunities
- Consider accessibility of events outside of business hours (and possibly with remote livestream) to allow industry/practitioner members and community participation
- Facilitating organization and leadership that can be more active to allow for regular, reliable event scheduling, improved promotion and advertising
- Narrowing the scope of the mission, and/or focus of core project(s) to be more specific

The following were suggestions were received on the topic of a vision for WICI's next five years (Question 9 of the survey):

- "Orienting scholarship and graduate work towards pressing problems of our time, like climate change, AI, and political-economic shifts needed in the 21st century"
- "WICI may wish to work in conjunction with the Office of Research and time any seed grant offerings to support the success of Waterloo interdisciplinary grant programs (e.g., Trailblazer, NFRF)"
- "Promoting collaborative work to address global problems such as climate change that require complex coordination"
- "Build and lead Canadian Complex Systems Network"
- "Try to develop more industry linkages....facilitate hiring co-operative students in their upper years to solve complex problems with organizations, [enabling] Canadian organizations to experiment with innovation while providing students with research-industry experience"
- "Organizing speaker series that highlights student research and combines with professionals from related fields and industry[...]facilitated sessions for complex problems, presented by professional members, to be problem solved through an event or seminar, with the outcome being open source or reported back to the professional who presented the problem"

Finally, a concept that was introduced in the 2019 survey was the idea of pursuing and developing a Canadian Network for Complex Systems. Question 10 of the survey asked respondents to share their vision for a such a network.

- “Identifying existing researchers and institutions dedicated to complexity and building strong networks and collaborations between them through conferences, social media platforms, annual meetings”
- “Raising the profile of Canadian work in this space; promoting Canada as a world leader in this space”
- “Source & network to support collaboration projects and funding, esp. in complex systems & government/funding agency awareness to fund complex systems initiatives, wholistic approaches to solving societies'/world's 'wicked problems', e.g. global warming, water, integrate systems thinking for planet earth”
- “Network to request for interest in collaboration based on expertise, a network to market relevant research, a network to share students and improve recruitment opportunities”
- “I would like to see WICI continue with building its grass roots organization among researchers while also extending its reach both nationally and internationally. I like the idea proposed of increasing the industry engagement of WICI. This could provide increased funds and greater recognition of the relevance of complex systems research among policy makers and the general population”
- “Key to leveraging Waterloo's position as a first mover into advancement in fundamental and applied research in complex systems.”

In conclusion, it was strongly felt from this survey that WICI members recommend a clearly defined mission and scope, which includes a continued commitment to maintaining and growing a strong local (and national) network of complex systems scholars, regular delivery of activities that include talks and or/workshops, additional training and/or education initiatives, with consideration for external members and/or partners as well as students.

The full survey report, including the Qualtrics generated results, can be viewed in Appendix J of the [WICI 2019 Annual Report](#).