Leveraging Technology for a Healthy Planet

Opportunities for philanthropists and investors

Prepared by:
Academy for Sustainable Innovation

ASI ACADEMY for SUSTAINABLE INNOVATION

Prepared for:
Environment Funders Canada

ENVIRONMENT FUNDERS CANADA
Advancing a sustainable future

With support from

RBC Foundation

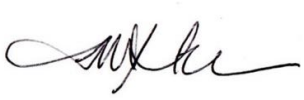
April 2020

Forward

The objective of this report is to illustrate how philanthropic funders can use their resources to advance technological solutions to environmental problems.

Environment Funders Canada (EFC) is a membership organization comprised of approximately 70 funders from across Canada and the United States. Our membership consists of a diverse group of philanthropic organizations, including private, public and community foundations, corporate funders, and government funding programs at both federal and provincial levels. EFC works with its members to strengthen the impact of philanthropy in support of an environmentally sound future. It catalyzes collaboration, supports the building and sharing of skills and knowledge, and works to grow investments to advance a sustainable future for Canada.

This report examines how technology can enhance the development and implementation of environmental solutions. It comes at a critical time – the serious and urgent environmental issues confronting Canada and the planet are of growing concern to Canadians in all regions, and of all ages and backgrounds. Fortunately, the promise of existing and emerging technologies to accelerate progress on environmental solutions is gaining momentum. We encourage funders to consider the opportunities available for impact through their grants and investments in this area.



Thea Silver, Interim Executive Director, Environment Funders Canda

Jason Bates, Chair of EFC Program Committee and Vice-President, Grants and Community Initiatives, Calgary Foundation

Executive Summary

We are at an unprecedented environmental tipping point. Climate change, species decline, the accumulation of plastics in our oceans and other environmental challenges are of broader and deeper concern than ever before. At the same time, technologies such as artificial intelligence (AI), blockchain, and mobile applications can identify, analyze and even solve environmental problems.

This report seeks to help the philanthropic sector better understand and explore the potential of existing and emerging technologies in combatting environmental challenges, and the opportunities to support these advances with grant-making, investment in private sector companies and funds, and through other means. These opportunities continue to evolve and expand.

Based on research and interviews with numerous leaders and experts, this report identifies eight pathways for impact through philanthropy and/or private sector investment:

1. Nature-Based Solutions
2. Low (and no) Carbon Energy
3. Education and Skills Training
4. Community-Based Initiatives
5. Indigenous Partnerships
6. Policy and Advocacy
7. Convening
8. Competitions and Prizes

For each pathway, examples are offered and opportunities for action are highlighted. It is hoped that this report will lead to further investigation and discussion of current opportunities within these pathways – both for individual funders and for collaborative initiatives – and will spark new and creative ideas for opportunities and pathways not yet identified. EFC looks forward to working with its members and other interested parties to explore this emerging area, and gratefully acknowledges RBC Foundation's leadership and support of this initiative.

Acknowledgements

This report was made possible through financial support from RBC Tech for Nature, the RBC Foundation's multi-year commitment to new ideas, technologies and partnerships for our shared future. EFC expresses its gratitude to the RBC Foundation for its support, and to the Academy for Sustainable Innovation – in particular, Nicole Doray, Jennifer Hooper and Ed Whittingham – for the research and writing of this report.

Disclaimer: The views expressed in this report do not necessarily reflect the views of EFC and its members.

Table of Contents

Introduction

We enter a new decade on the cusp of truly historic environmental, social and technological change. Climate change is rapidly out-pacing many scientific predictions.[1] The astonishing loss of wildlife populations shown by the latest Living Planet Index notes a 60% decline in just over 40 years.[2] Extreme weather and natural disasters are disrupting life on the planet at unprecedented rates, placing immense pressures on the communities whose livelihoods and ecosystems are intrinsically linked. This next decade[3] presents us with our greatest, and possibly last, opportunity to reverse environmental damage and drive positive change forward.

Simultaneously, we are witnessing a technological revolution rooted in powerful new technologies, including artificial intelligence (AI), blockchain, big data and smartphone applications. These innovations are reshaping industries and the nature and composition of work around the globe. The digitization of our work and private lives combined with the widespread collection of personal data related to our habits, behaviours and preferences, raises a host of complex practical and ethical questions around privacy, autonomy and the future of work. Philanthropists and investors must proactively ensure that they are supporting organizations and projects that are socially inclusive and equitable as well as environmentally beneficial.

As renowned economic and social thinker Jeremy Rifkin has argued, the past 200 years have seen a series of industrial revolutions sweep across the globe, dramatically improving the quality of life for many.[4] However, each of these eras has impacted ecological, social, and economic systems, borrowing the resources of tomorrow for today's economic growth. This latest industrial revolution, rooted in data and machine learning, can and must be the first to break the cycle of environmental degradation. In order for this to happen, emergent technologies need to be intentionally directed towards enhancing the ecological and social health of our planet and advancing environmental action to restore our natural systems and decarbonize those we have created. With accelerated pace and precision, we can use these technologies to monitor vulnerable

1 Ogden, L. (2019)

2 World Wildlife Fund. (2018)

3 Rogelj, J., et.al. (2018) The 2018 IPCC report warned that a dozen years of action remain for global warming to be kept to a maximum of 1.5C, beyond which even half a degree will significantly worsen the risks of drought, floods, extreme heat and poverty for hundreds of millions of people.

4 Rifkin, J. (2013)

watersheds and habitats, track conservation efforts for at-risk species, reduce greenhouse gas emissions in high-emitting industries and shape healthier and more sustainable communities.

To understand the technological landscape, drivers for change and opportunities for impact, we drew best practices from scientific, technical, social and environmental leaders from across Canada and around the world. We gathered insights from experts in climate, conservation, water and sustainable communities, engaging and interviewing 21 Canadian leaders[5] who are amplifying their impact by leveraging these emergent technologies in their work. Their insights, combined with detailed secondary research, surfaced potential high-impact philanthropic and private sector investment pathways for supporting the development and use of technological solutions to environmental problems.

We hope that this report will help the philanthropic sector better understand and further explore these emerging technologies in the context of bringing about positive social and environmental change and spur thinking about organizational and collaborative opportunities in this space. We also hope that it will provide the sector with some criteria and considerations as inputs to the strategic analysis of their investment portfolios.

5 See Appendix

The Promise of Technology in Advancing Environmental Solutions

Artificial intelligence (AI), blockchain, big data and smartphone applications are revolutionizing the collection, analysis and distribution of information with unprecedented speed, scale and accuracy.

Technologies in Focus

Professor John McCarthy, one of the founding fathers of AI research, defines AI as the science and engineering of making intelligent machines that imitate human behaviour.[6] Through AI, machines can, among other things, analyze images, comprehend speech and make predictions using data.[7]

AI is often undertaken in conjunction with data analytics, working from comprehensive sets of 'big data'. AI analyzes these extremely large data sets computationally to reveal patterns, trends, and associations that enable and enhance monitoring, analysis, prediction and intelligent decision-making. For example, this combination can enable highly efficient and accurate climate-related extreme weather predictions, track vulnerable species and monitor water health. A particularly useful branch of AI is machine learning, which allows computer systems to learn directly from examples, data and experience. Programmers can simply set goals and allow the algorithms to learn for themselves through trial and error and self-modification.

Blockchain, most commonly recognized as the foundational technology for cryptocurrency, is a separate technology, often applied to the collection of encrypted data. It is essentially a list of tamper-proof records that allows for digital information to be distributed, but not copied, thereby spreading verified information accurately across a network. When applied to data collection, blockchain provides rigorous accountability and seamless transparency to all members in the data network. It is a valuable tool for collecting and verifying environmental data from a wide range of sources, including community groups.

6 McCarthy, John (undated).

7 Microsoft Azure. (2020)

"Our projects feature a broad range of technologies including sensors like hydrophones for deep water monitoring, camera traps for remote capture of reclusive species and advanced community-based monitoring for water health.

Sensors mean a huge amount of data and video. AI helps us discern meaningful information from that beyond just the storytelling ability. So clearly, AI is important in terms of the analytical capabilities of determining patterns from all this information. We need the computational capacity alongside it to decipher and make meaningful inferences around what all that is telling us. AI is a cornerstone of that."

James Snider
WWF Canada

Finally, a smartphone application, or app, is a mobile software designed to run on a personal, handheld device. Apps provide ample opportunity for public engagement in environmental action, by collecting, configuring and delivering information in a mobile form. Apps like Bumble Bee Watch and Journey North monitor the health and migration patterns of vulnerable species, building databases of rich information contributed by a community of naturalists, scientists and citizens.

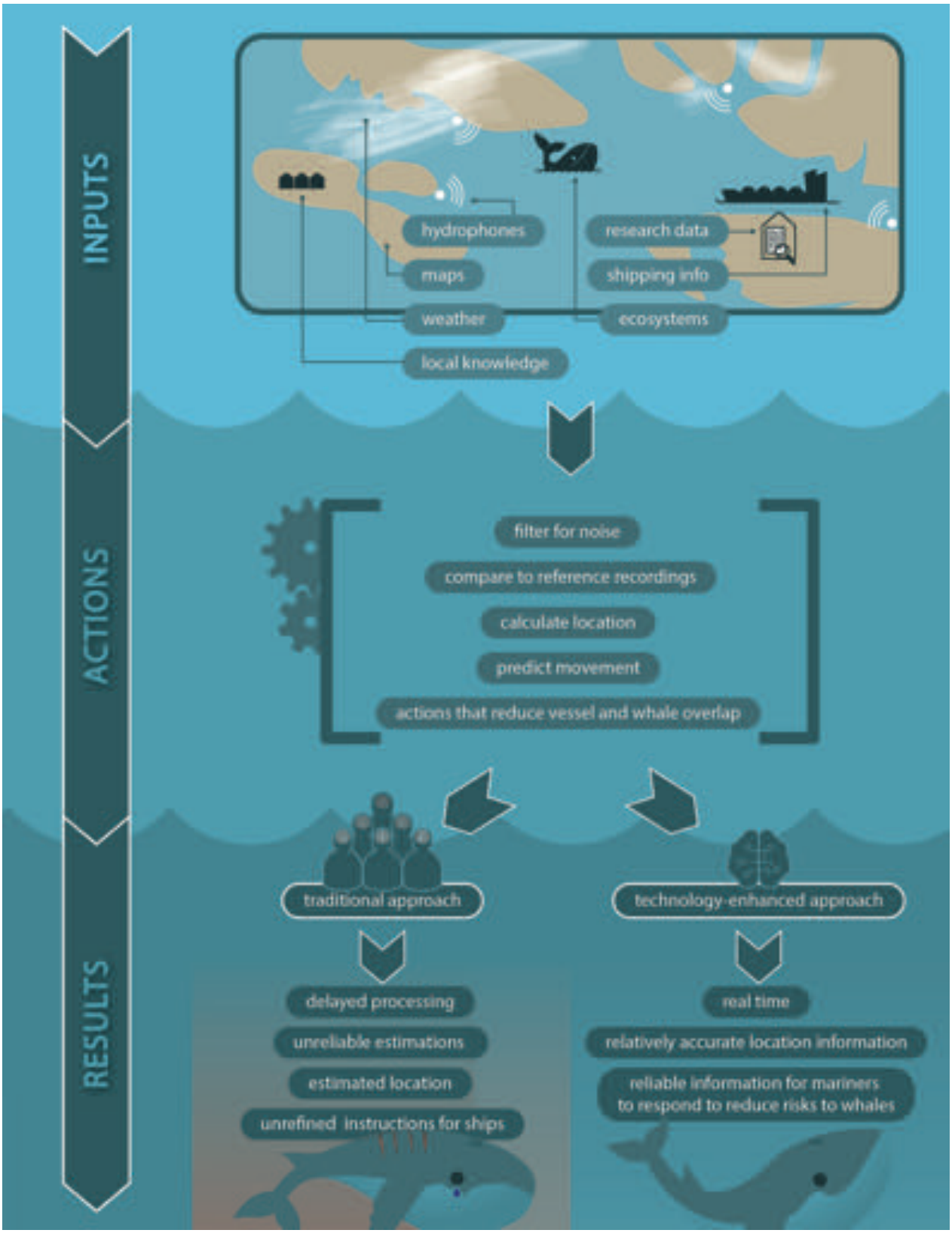
Figure A describes the benefits to leveraging data technologies such as artificial intelligence and blockchain as compared to the pursuit of traditional research methods, using the example of the SWAG project (Ships, Whales, Acoustics in Gitga'at Territory), a collaborative initiative of WWF-Canada, the Gitga'at Nation and North Coast Cetacean Society.

For the purposes of our report, we will refer to the above-noted technologies collectively as "data-based technologies"; innovations that can collect, organize, learn from and leverage the vast amount of information that is available in our modern world. Figure B demonstrates how these data-leveraging technologies can be deployed collectively.

Figure A.

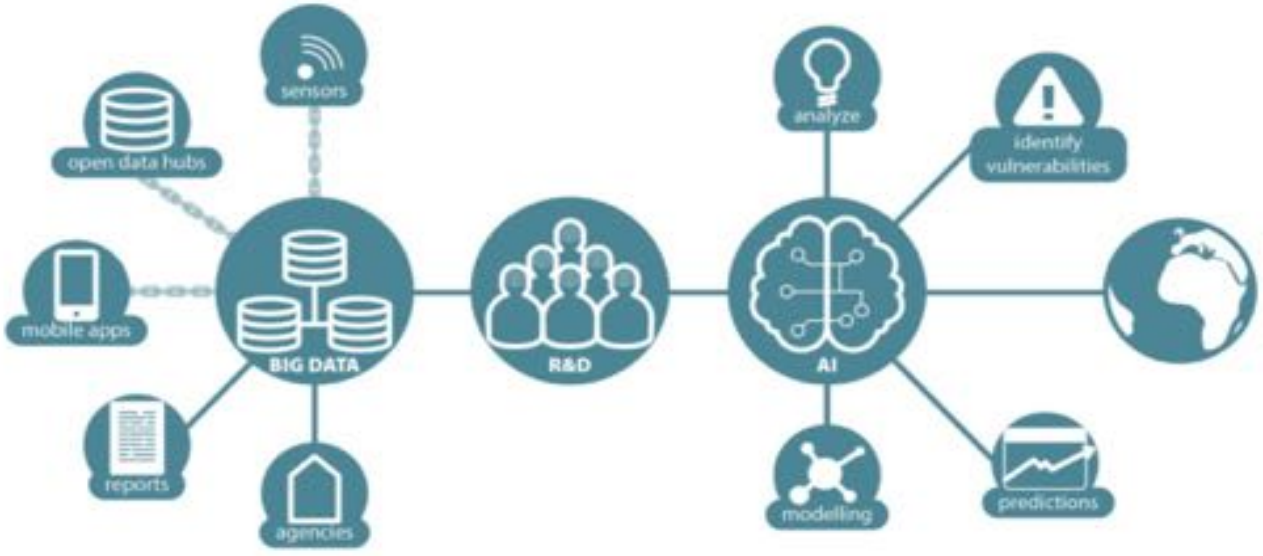
This initiative uses an array of hydrophones to acoustically monitor whale activity in an area of high cultural and commercial use. The hydrophones receive acoustic signals that transmitted to a field station where they are processed using AI to identify the whale calls and locate their source on a map. In an area which has been identified as a potential critical habitat for several vulnerable species, the accurate and near-real time receipt of this information is imperative. The SWAG project is working to operationalize the provision of this information for real-time management. While the inputs are the same in both traditional research methods and those which leverage technology, the results and environmental impacts can greatly differ. The introduction of technologies allows for greater speed and accuracy in the receipt and analysis of information that enables the protection of species in real-time.

Figure A – The Benefits of Data-Leveraging Technologies: The SWAG Project



Designed by Péter Sós

Figure B – The Collective Deployment of Data-Leveraging Technologies



Designed by Péter Sós

Figure B.

Moving from left to right, note how big data is the result of aggregated information from multiple sources. Blockchain technology can provide clarity and transparency in the collection of this data, especially from remote sensors, smaller, open-source data hubs and mobile apps that may benefit from expert validation. Big data is then leveraged for research and development by technical people who design algorithms from which artificial intelligence can, among other things, rapidly synthesize and analyze data, identify vulnerabilities that may have otherwise been overlooked, make predictions and model scenarios. These results can then be used to take informed environmental action.

Key Themes

Our research, including one-on-one interviews with experienced practitioners, secondary dives into the best practices from the world's largest technology firms[8] and methodology from technology accelerators[9], surfaced four key themes of relevance to the use of technology for environmental solutions:

Solutions may require the combined deployment of technologies

Digital data-based solutions can be incredibly efficient at collecting, analyzing and distributing large amounts of information, enabling informed decision-making using near-real-time data and scaling action across expansive geographies. When applied purposefully, the combination of big data sets and machine learning vastly out-paces traditional research methods.

However, these emerging technologies alone will not achieve the transformative level of change needed to reverse species loss, arrest climate change or halt ocean acidification. In most cases, solving these problems will require new types of hardware, including satellites, novel battery formulations, new materials, and different energy production technologies, along with the necessary support infrastructure, to be deployed collectively. Funders may need to consider the broader set of transformative technologies emerging and how these or complementary support tools can be brought to bear for environmental benefit.

We will need to decarbonize power while increasing supply

To leverage fully their potential, these powerful technologies all require large amounts of energy to collect, document, analyze and share information in near real-time, across multi-national networks. The decarbonization of the power sector would reduce any additional planetary strain that this data revolution may prompt, increasing the environmental benefits gained from their usage without the need to balance out emissions created.[10]

Technology solutions require non-technical supports

These technologies must not be considered holistic environmental solutions but simply tools to be leveraged to further environmental action. As communities, academic institutions, environmental non-governmental organizations (ENGOs) and other stakeholders move along the technology journey, the funder community can bring more than grantmaking to the table. Skill training, capacity building, policy work, stakeholder convening and matchmaking

8 Microsoft (2019); Google (2019); IBM (2019)

9 The Natural Step. (2019).

10 Andoni, M., et al. (2019).

between technical people and environmental advocates, are all critical pieces of the environmental puzzle – and equally as valuable as the technical elements themselves.

Technology solutions must be grounded in community and Indigenous partnerships

The implementation of these technologies should be grounded in the realities of those facing environmental challenges firsthand in order to be most effective. The integration of Indigenous voices and community perspectives is imperative to the development and deployment of community-based data-leveraging initiatives. Those at the heart of the community often have the strongest insights into environmental and related social vulnerabilities and can best identify opportunities for long-term community benefit. This valuable local, ancestral and Indigenous knowledge must be embedded thoughtfully and with consideration to that which community members know and believe.

Pathways for Funding: Eight Areas for Philanthropy and/or Private Sector Investment

The funder community can play a critical role in advancing financing models, policies and support for technology initiatives that show promise of identifying and/or scaling environmental solutions quickly.

Building on the best practices of environmental, technical, governmental and industry leaders we offer the philanthropic community eight pathways for maximizing impact. These suggestions have emerged from a synthesis of authoritative reports[11] and the culmination of our one-on-one interviews with experienced practitioners in technology, environment and civil society. Our research revealed numerous examples of this work, representing a wide range of sectors, scales, regions, and contexts in which data-leveraging technologies can be used to solve complex environmental problems. Within each of these, there are opportunities for the pursuit of both individual funder engagement and broader collaboration.

This report prioritizes opportunities that take a holistic, systems approach. This is not a comprehensive list of needs and opportunities but areas we consider to be particularly important for funder focus. We present the following eight pathways for philanthropic engagement and investment:

1. Nature-Based Solutions
2. Low (or no) Carbon Energy
3. Education and Skills Training
4. Community-Based Initiatives
5. Indigenous Partnerships
6. Policy and Advocacy
7. Convening
8. Competitions and Prizes

11 See References

1. Nature-Based Solutions

Protecting the world's land and water ecosystems and allowing them to recover from human development requires a systems-approach to conservation. Not only do these ecosystems serve as habitats for the world's plants and animals but they also provide buffers against severe weather, store vast amounts of carbon and yield valuable economic returns to those whose livelihoods are inextricably linked to them.[12] Nature-based solutions offer an opportunity to address some of the root causes of environmental and social challenges while advancing co-benefits to the communities and ecosystems in which they will be deployed.

"One of the greatest blocks in ecology is that ecosystems are physically large and, we're human, we're not that big. To get across expansive geographies to collect reasonable samples is hugely important in this work. [With the addition of artificial intelligence] we can expand our efforts – collapsing a three-month field session into three hours of monitoring. This means we have so much more information, so much faster and therefore so many more ways to help vulnerable species."

Malory Owen, MSc
York University

Nature-based solutions were a major theme in 2019, both during the United Nations Climate Action Summit in September and at the UN Climate Change Conference COP25 in December. Although both events failed to deliver on big commitments from member states[13], countries collectively pledged USD $9.8 billion to preserve forests, restore wetlands, and deploy sustainable agriculture practices. While nature-based solutions are often associated with initiatives such as simple tree-planting, these tactics extend to all forms of ecosystem support (from agricultural soil carbon stewardship, to protecting endangered whale populations[14], to restoring native grass species after wildfires) and require rigorous accounting and monitoring on the ground, adding to their cost and complexity.

Fortunately, data-based technologies can optimize, adjust and fine tune information in near real-time, much faster than humans naturally can. When implementing nature-based solutions, these technologies can provide rapid insights into ecosystem vulnerabilities, monitor and identify threats, and verify the impacts of environmental initiatives with precision.

For example, the traditional tracking of ecosystem restoration through reforestation can be difficult. In many of the most remote and environmentally valuable landscapes, monitoring the rate of carbon absorption by plant life can be complicated.[15] These areas also require ongoing protection and maintenance from people on-the-ground to thwart illegal logging, poaching, and extraction. Fortunately, this is a challenge that can be effectively addressed with AI solutions.

12 Balian E., Eggermont H. & Le Roux X. (2014)

13 Keating, D. (2019).

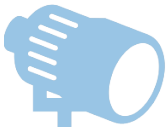
14 Nicklen, P. (2019).

15 Song, L. (2019).

The use of emergent technologies like remote sensing and satellites can help generate and validate data across an expansive geography. AI can analyze the resulting pool of data, identifying ecosystem vulnerabilities in need of support. The addition of blockchain can then create a transparent, credible ledger for, amongst other things, buying and selling carbon credits around the world.

None of these opportunities can be realized without enhanced access to high-speed internet in rural and remote communities. This lack of dependable access represents a critical impediment to forest and agriculture sector efficiency, competitiveness, rural poverty reduction and climate and environmental action that novel philanthropic/public/private partnerships could help to address.

According to the Federal Economic Strategy Table on Agriculture, "*Rural areas in Canada are disproportionately affected by a lack of access to reliable broadband service...a key bottleneck to why precision agriculture technologies and other digital tools have not been adopted as widely or extensively as they could – and should – be.*" [17] Potential benefits to access expansion include the optimization of supply chains through big data analytics, the achievement of higher yields through precision agriculture and the execution of environmentally-beneficial technologies.



Spotlight: Dendra Systems Reforestation

Dendra Systems,[18] a U.K.-based start-up working in Canada[19], has developed AI technology that uses drones and satellite imagery for precision-planting of trees, grasses, bushes, funghi and any other plant species required for ecosystem restoration.[20] The drones can tend to precarious terrain like mountainsides with great ease and plant up to 40,000 trees in a day. According to academics leveraging similar technologies[21], these and other technologies may offer additional opportunities. Data-leveraging technologies may collect neighbouring ecosystem data and apply Dendra Systems techniques to restore excavated oil sands and retired farmland back to their natural states.

17 Government of Canada. (2018).

18 Dendra Systems. (2019).

19 Kent, G.(2018).

20 Stone, E. (2017)

21 As per conversations with York University faculty and researchers.

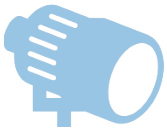
"Overwhelmingly, rural and remote communities have identified challenges accessing affordable, high-speed Internet as the number one issue impeding their economic growth. This was the message heard loud and clear in developing Canada's Connectivity Strategy and the broader Rural Economic Development Strategy. That's what small-business owners told us. Parents. Doctors and nurses. Provincial and territorial governments. Municipalities. Indigenous communities. Non-profit organizations….To take full advantage of the opportunities offered by the modern Internet, 50/10 speeds are necessary, affording the capacity to download at 50 Mbps and to upload at 10 Mbps. At these speeds, there is a clear divide between rural and urban Canada. In 2017, only 37% of rural households had access to 50/10 Mbps, compared with 97% of urban homes. Only about 24% of households in Indigenous communities have access to 50/10 Mbps."

High-Speed Access for All: Canada's Connectivity Strategy[16]

Opportunities for Philanthropic Action

- **Support better internet and cellular connectivity for rural and remote areas.** Consider funding co-operatives, non-profits, advocacy and accountability efforts that address the Canadian last-mile challenge.

- **Invest in early-stage development and scaling of technologies that work in tandem with natural systems.** While these technologies can be incredibly efficient, they can also be extremely costly to develop. Consider funding seed grants or providing investment capital to those taking prototypes from blueprint to reality or repurposing mature technologies towards new goals. Should these innovators not meet philanthropic granting criteria, encourage partnerships between those developing technologies and those deploying environmental solutions (e.g. non-profits, registered charities and other qualified donees) through intermediaries with charitable status, such as universities and accelerators.



Spotlight: Fund Accelerator for Environmental Technologies

Ecofuel is a venture capital fund and a specialized and personalized accelerator dedicated to seed stage environmental startups which focus on technologies. In addition to seed financing of up to $75,000, Ecofuel Accelerator offers training workshops, networking sessions, and an experienced mentor ecosystem.[22]

They identify and support high potential disruptive ventures, reducing the technology and business risks associated with innovative technologies and then improving the pipeline of qualified investment opportunities.

16 Innovation, Science and Economic Development Canada. (2019).

22 Ecofuel. (2020). *Ecofuel Accelerator and Fund.* https://ecofuelaccelerate.com

2. Low (and no) Carbon Energy

Most economic and scientific authorities predict that demand for energy will increase as global populations grow, develop and seek out higher quality lifestyles.[23] The challenges will be to (i) deliver this energy sustainably and competitively in an increasingly carbon-constrained world and (ii) shift consumption patterns to reduce energy demand. While most companies are expanding their portfolios to include cleaner options in the mix, the rate of change must be accelerated. To do so, transformative changes are required in all the systems that we use to live, work and play, as we revolutionize how we generate and consume energy.

In the energy sector, many companies already use sensor information to optimize oil and gas control systems, reducing methane emissions and finding key emitting sites.[24] In fact, energy giant BP is using AI on its natural gas operations in the US. So far, it has reduced gas venting by 74%, increased production by 20%, and cuts costs by 22%.[25]

These data-based innovations can be used to predict power demand and match supply with demand in near real-time, reducing waste. It is estimated that in the European Union alone, increased storage and digitally-enabled demand response could reduce curtailment of solar photovoltaics (PV) and wind power from 7% to 1.6% in 2040, avoiding 30 million tonnes of carbon dioxide emissions.[26]

> "We're becoming more efficient at doing the same old things; minimizing the impact of the process of production... That's not the real issue. The real issue is the use of these products... If we want to get to net zero it's not about getting more efficient, it's about fundamentally re-tooling the system."
>
> Dan Wicklum
> The Transition Accelerator

However, these technologies cannot simply be used to maximize the efficiency of existing carbon-intensive systems. They must also be leveraged to transition the industry as a whole toward lower-carbon alternatives.

There are applications that support a broader transition to a low-carbon energy system. These technologies can also be used to integrate distributed renewable energy sources into the grid, accelerating the impact of cleaner energy by increasing energy self-production and self-consumption.[27] Blockchain offers an opportunity to facilitate peer-to-peer (P2P) electricity trade within local communities[28] but additional technologies are required to truly decarbonize the secor.

23 OECD and IEA. (2011).

24 Source: Jason Switzer, Executive Director, ACTIA

25 Helman. (2019)

26 IEA (2017)

27 Indigo Advisory Group. (undated).

28 See: IEA. (2017). and Burger, C., et al. (2016)

Hardware-Based Innovation: The Case for Philanthropic Investment

Unlike ventures grounded in blockchain, data science and artificial intelligence, transformative technologies at the intersection of frontier technology and breakthrough science require many years and millions of dollars of research and development (R&D) before achieving commercial readiness, and significant capital investment (and tens or often hundreds of millions of dollars) for each deployment. These forms of innovation have greater validation needs for first commercial facility, and a lengthy sales cycle tied to the capital cycles and regulatory approval timelines in their target industry sectors including energy, heavy industry and healthcare.

Private venture investment in these technologies has lagged given the relative risk/return ratio and long timeline to exit, leaving many potential breakthroughs stalled. Specific examples include nextgen fission and fusion power, direct air capture of CO_2 (DAC), novel battery and fuel cell formulations, critical vaccines and resilient food crops, and innovative processes for heavy industry (e.g. aluminum smelting and cement manufacturing).

The energy sector illustrates the lack of early-stage investment, accounting for 10% of global GDP yet only 1-2% of private venture capital (VC) investment. By comparison, only about 3% of global GDP derives from commerce on the Internet, but e-commerce represents the bulk of VC investment. The mix of public and private funding sources that enabled earlier radical energy innovations to reach broad deployment are essentially gone, including, for example, those supporting the Manhattan Project which spawned fission power, AT&T Bell Laboratories which invented photovoltaic cells, and the Alberta Oil Sands Technology Research Authority, which commercialized thermal in situ oil sands recovery[29].

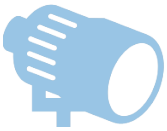
A 2019 energy sector innovation study by thought leader Dan Yergin and former US Energy Secretary Ernest Moniz found that "because clean energy innovation incentivizes only modest financial investments at precommercial stages, and because strategic corporate investment is focused primarily on those innovations recognized as useful to business objectives, strategic philanthropic investors and coalitions of industry investors with long-term horizons could play an important role in identifying and supporting promising technology ventures that are otherwise not commercially viable in the near term."

29 Kearney, et al. (2014)

The acceleration of the transition to a low (or no) carbon energy system requires early-stage, private-sector investment and philanthropic support of organizations looking to expand these efforts. The philanthropic sector also has a role to play in securing the political will and capacity to scale-up renewable energy efforts, advancing the energy transition once these innovative models are ready for larger deployment.

Apps for Behavioural Change

An interesting application of data-leveraging technologies may also lie in behavioural change. Blockchains, in combination with AI techniques, such as machine learning, can identify consumer energy patterns and therefore offer tailored suggestions to consumers looking to reduce their energy demand.[30] While the private sector can leverage these technologies to offer value-added energy products to customers (e.g. energy micro-payments, pay-as-you-go solutions or payment platforms for pre-paid meters)[31] smartphone applications and home monitoring applications can use this information to promote behaviour change. Apps like Google's NEST[32] and G9 Ark[33] actively educate consumers about their household energy usage and gamify reducing consumption.



Spotlight: AI as a Tool for Social Change

Algorithms tailor the content users receive on social media by replicating patterns of previous behaviour and preferences. The challenge is that users only receive information that perpetuates existing biases. An interesting application of technology to the energy challenge is rooted in bias mitigation. At the Energy Futures Lab in Alberta, participants in an AI.Energy workshop brainstormed socially-minded AI solutions.[34] Stakeholders discussed the opportunity for the development of a social media algorithm that depolarizes the energy and climate discussion in Canada, bringing more radical middle messaging to the forefront of social media.[35]

30 Andoni, M., et al. (2019)

31 Andoni, M., et al. (2019

32 Google. (2020)

33 G9 Ark. (2019).

34 Energy Futures Lab, et al. (2019)

35 Source: Interview with Chad Park, Energy Futures Lab

Opportunities for Philanthropic Action

- **Support technologies promoting sustainability through behaviour change.** Many applications promote citizen engagement in energy usage and behavioural change. Consider early-stage investments in data-leveraging applications that help to change consumer mindsets and behaviours.

- **Support the decarbonization of energy and industrial systems through blended financial support for innovation.** There are diverse stakeholders interested in leveraging the power of novel technology applications, including blockchain, to support distributed energy systems in remote areas or AI to accelerate smart grids and solar infrastructure, among other investments. The main investment barriers are (i) high perceived and real risk and (ii) poor returns for the risk relative to comparable investments.[36] Blended finance is a financial structuring approach that allows organizations with different objectives to invest alongside each other while achieving their own objectives (whether financial return, social impact, or a blend of both) thereby reducing the barriers to financing. Through co-investing in distributed and renewable energy systems, smart grids and other energy transition efforts, philanthropists (through funding accelerators or partnerships with energy-focused ENGOs) and private sector investors collectively can improve the availability of capital to pave the way forward for others to follow.

- **Encourage transformational initiatives using systems thinking.** Consider selecting opportunities that will move society into further alignment with sustainability principles and decarbonize the energy sector more broadly. While improving the efficiency of existing systems is a positive step, it is not sufficient to generate the transformational changes required and may lead to the unintended consequence of increased emissions. Philanthropists may consider partnering with academic institutions and non-profits to offer scholarships, employment opportunities and incentives for staff and students to pursue the transition to a low (or no) carbon energy system. Investors might support start-up funding for environmental enterprises focused on renewable energy production, scaling and storage solutions like those supported by PRIME Coalition[37] or the Breakthrough Energy Coalition[38] in the United States. These organizations invest both charitable and private capital in companies that combat climate change with a high likelihood of achieving commercial success.

36 Convergence. (2019)

37 Prime Coalition. (2020)

38 Breakthrough Energy Coalition. (2020)

3. Education and Skills Training

A consistent question that emerged in our conversations with experts pertained to how the widespread adoption of AI would fundamentally change employment in their industries. Shifting traditional tasks away from human employees will certainly change the composition and nature of work but this is not necessarily cause for concern.

Many senior executives in corporate strategy and technology management positions argue that AI will primarily change the nature of work rather than causing widespread unemployment, prioritizing AI efficiency in more physical, repetitive and basic cognitive tasks while prioritizing human capital for softer skills.[39] Therefore, while advanced IT skills, programming and technological literacy will be key for in-house leveraging of these technologies, skills training is not limited to coding and computer science. Social, emotional, and technological skills will become of increasingly high value as ever-smarter machines are integrated into the workforce.[40] Soft skills such as problem solving, critical thinking, innovation, creativity and communication will be key when working in tandem with machines.

> "It's all about having the information when you need it and then having the experience of what to do with that information. The most successful companies that I see offering technologies also offer training services as well. And, a general ethos of connecting and consulting with not only communities but whoever is using and benefiting from the technologies."
>
> Kerry Freek
> Ontario Clean Technology Industry Association

To get ahead of the social dislocation that will likely result from the changing nature of work, those working in conservation, water, climate, sustainable communities and beyond should prepare for the speed and scope of change by developing new skills and wiring themselves for resiliency. Professional development programs, online training programs and peer-to-peer learning initiatives will prepare leaders for the adoption of these technologies.

One pathway for engagement by the philanthropic sector can be found in supporting those working directly to overcome environmental challenges. In our conversations, we found that individuals and organizations engaged in sustainability efforts are at different points in their technology journeys, some more advanced than others. Some ENGOs have strong internal capabilities, with internal data scientists and technology experts, while others have yet to even consider data-leveraging technologies as relevant tools in their field. When these opportunities are considered, such data specialists and training programs can be costly and out-of-reach. Even UNICEF, a large global organization, was unable to establish a data program until Bloomberg Charities funded a Researcher-in-Residence program[41]. Philanthropists looking to help further the work of non-profits can do so through the support of ENGO technology skills and capacity building.

39 Fraser Institute. (2019).

40 McKinsey. (2018)

41 Bloomberg. (2015)

Some technology training for climate leaders is already underway in Canada. For example, the Energy Futures Lab's workshops present AI solutions to environmental challenges. However, there are additional opportunities to build climate and AI resilience training and reskilling within Canada's new Future Skills Centre[42] and Canada's national AI Institutes: Amii in Alberta, Mila in Montreal and, Vector Institute in Toronto.[43] Among those AI facilities, only Mila is putting AI to work for climate by pursuing climate-scenario modelling research. This should be continued and extended to allow partnerships with environmental champions and those working across a variety of climate affected fields as they explore AI within their work.

These AI institutes for example, could use their training facilities to upskill government employees, ensuring that the next wave of decision-makers and civic leaders are equipped to craft policies around AI. It is estimated that half of Canadian jobs will be affected by AI in the next decade.[44] All those engaging with and affected by these technologies should learn how they can be leveraged for a better world.

Opportunities for Philanthropic Action

- **Promote technology literacy and skills development for environmental professionals.** Support the reskilling and upskilling of those working to solve environmental challenges so that they may reimagine solutions with technology in mind.

- **Support technology programs with an environmental focus.** Consider funding programs at universities, colleges schools (both secondary and primary) that build environmental and technological skills and knowledge, and foster the links between them.

- **Convene stakeholders in solution-building.** Consider supporting or facilitating workshops focused on solution-creation where data scientists and technology leaders can meet with and support ENGOs and other agents of change.

42 Future Skills Centre. (2020).

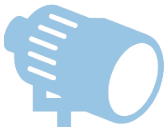
43 CIFAR. (2020).

44 RBC. (2018).

4. Community-Based Initiatives

Regional approaches are critical, both in a Canadian context and around the globe, since environmental solutions must reflect unique development trajectories, resource limitations, political visions and cultural traditions.

Supporting tailored community resilience plans for risk management and sustainability is one of the most impactful opportunities that AI provides. Using big data, often combined with blockchain technology, AI can unlock insights and improve predictions of extreme weather events through climate modeling. As a result of the accelerated forecasting and improved decision-making that these technologies offer, community leaders can formalize environmental management plans, policies and strategies unique to their own ecosystem vulnerabilities. By tapping into community knowledge and engaging local stakeholders, philanthropists and investors can better understand which projects might serve as the basis for larger community developments or environmental solutions, and can select initiatives that offer opportunities for additional benefits beyond the duration of the study.



Spotlight on Climate Modelling: Cree of Eeyou Istchee and Nature Conservancy of Canada

Together with the Cree Nation Government (CNG) and the Cree communities of Eeyou Istchee, the Nature Conservancy of Canada is putting leading-edge data collection and conservation planning tools to work. They are providing technical support (mapping, data-analysis and development) to Cree Tallymen (lead hunters and managers of family traplines), land users and other community members as they work to identify key candidate areas for environmental protection.[45]

By leveraging data technologies, NCC is helping the Cree Nation Government create long-term conservation measures in their traditional territory, amplifying Indigenous voices in environmental policy and practice.

45 Nature Conservancy. 2019. *Cree Regional Conservation Strategy*. http://www.natureconservancy.ca/en/where-we-work/the-north/cree-regional-conservation-strategy.html

When systems are developed that leverage collective public and private sector knowledge with data standards, regulations and open-sharing policies in place, the collection and analysis of data for environmental and social goals may become institutionalized and data may be more readily available. Until then, there is a need to engage citizen scientists who can collect data through community-based monitoring projects that are more economical and scalable than traditional government-led research.[46] *Swim Drink Fish* for example, has rallied over 200 volunteer citizen scientists in their water monitoring efforts through the creation of four *Swim Drink Fish* citizen science monitoring hubs.[47] Such community-based citizen science initiatives have the added benefit of building community buy-in, support and awareness for the conservation of these same ecosystems. Experts suggest that this interaction is connected to shifts in behaviour around personal water usage.

"We're seeing a big shift away from only scientists doing science. People are out there. There are all kinds of really cool, remote, devices that can collect really high-quality data. Arguably, it's the people living in places that are most impacted who should be involved in monitoring and watching that change... The right technologies, deployed in the right ways mean that we can involve people and truly democratize science. People on the ground will feed into our understanding of how our world is changing."

Carolyn Dubois
The Gordon Foundation

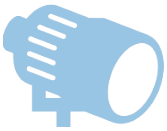
Which technologies facilitate citizen scientists? To start, blockchain allows for greater confidence in the security and reliability of data. Knowing that data cannot be manipulated and seeing the clear chain of custody from collection to reporting allows governments, scientists and other stakeholders to use that data in decision-making.

This is also one area where smartphone applications have proven to be of great value as they allow for independent citizen science to take place without the involvement of external partners. Apps like iNaturalist[48], for example, help citizens share observations, track endangered species and share data with scientists around the world through a collection of photographs and notes. Information received is either used or discarded based on its validity as determined by experts with the help of AI. When citizens work in tandem with organizational partners, smartphones allow them to send information from the field in near real-time to researchers in the lab who can quickly process and analyze it. When working with harmful pathogens and contaminants in water systems, the speed of information is of utmost importance.

46 According to our interviews with James Snider, WWF; Carolyn Dubois, the Gordon Foundation; Anna Warwick Sears, OWBB; Kerry Freek, OCTIA and others.

47 Swim, Drink, Fish. (2020).

48 iNaturalist. (2020).



Spotlight: Community-Based Water Monitoring

This innovative partnership among WWF Canada, Environment and Climate Change Canada (ECCC) and the University of Guelph implements genomics, blockchain and AI technologies to test out a new method of identifying species.

Leveraging community-based monitoring efforts, teams generate bulk samples of biodiversity data from watersheds across the country. With the support of AI and blockchain, information is expedited to labs at the University of Guelph where species can be identified in real-time.

Opportunities for Philanthropic Action

- **Fund community-based monitoring.** To improve the quality and quantity of data and facilitate increased community engagement, funders should consider supporting community-based monitoring through academic, ENGO and Indigenous-led partnerships. For example, a conservation biology research team at York University noted an additional investment opportunity for retired farmland. Once the land is no longer of agricultural value, community-based monitoring efforts by farmers could reveal the valuable social, environmental and economic opportunities for future land-use.

- **Connect technical people with problem-solvers to facilitate collaboration:** Usually, community-based projects are driven by multi-stakeholder partnerships including community groups, technical partners and ENGOs. Creating links between those with the technology and those with the problems is one of the most powerful catalysts for change. Philanthropists can pursue this by sponsoring events, innovation labs or online platforms for widespread collaboration. This is explored further in the *Convening* section of the report.

5. Indigenous Partnerships

A growing number of Indigenous communities are leveraging emerging technologies to monitor the health of local wildlife populations and sacred water bodies and develop informed community health strategies in the face of environmental challenges.

"When we're facilitating these monitoring projects, you know who has the most to offer? The hunters, the trappers, the knowledge holders – It's not CIER. We have some technical expertise but it's the ones who are living out on the land who really hold the knowledge of the land. So, [when working with First Nations], always heed their advice, always ask for permission before recording [their data]. The biggest thing, the core of it, is having respect."

Shianne McKay
Centre for Indigenous Environmental Resources

In the projects that we explored[49], accessible technologies like smartphone applications are often used for community data gathering pertaining to water quality, fish health, traditional knowledge and hydro-climatic data for extreme changes in temperatures. Unfortunately, foundational elements like internet and computer access are oftentimes lacking in Indigenous territories and can make access difficult and software updates cumbersome. When internet access is universally available and reliable, the collected data can be uploaded to a central server and used in landscape analysis, climatic projections and community infrastructure and economic development planning.[50]

When Indigenous voices are consulted in algorithm development, sites of traditional importance are monitored more closely, native species are more intimately documented and valuable traditional knowledge can inform traditional Western approaches.[51]

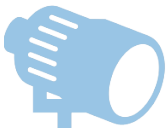
Interview participants noted that many First Nations elders remain skeptical of the role of technology in tracking the wildlife populations they have known intimately for generations and are often hesitant to share their traditional knowledge. ENGOs working with Indigenous partners told us that the communities had voiced concerns about using AI-enabled tools they did not trust when handling sacred information. Our conversations with Canadian ENGOs also revealed that researchers and scientists studying on First Nations land do not always share the data or research findings with the communities post-research. These factors may have unfortunately led to some resistance from Indigenous communities in sharing traditional knowledge openly with external partners.

Indigenous-led data collection programs can help scale-up these innovations, demonstrating the cultural and geographic relevance of emergent technologies to First Nations communities who are seeking open communication with trusted researchers.

49 See Appendix

50 Source: CIER Interviews

51 Source: Interviews from Carolyn Dubois, Anna Warwick Sears, Shianne McKay and others.



Spotlight: Coastal First Nations RMS

Coastal First Nations developed a Regional Monitoring System (RMS)[52] that ensures a standardized approach to data collection for Indigenous peoples monitoring coastal ecosystems. The issues reflect priority concerns about conservation, security, declining wildlife and more, identified by the communities themselves. The ownership of data and creation of standards by Indigenous groups are key in securing buy-in from hesitant communities. This initiative not only promotes engagement but allows for natural integration of traditional knowledge into complex data systems.

Opportunities for Philanthropic Action

- **Support Indigenous-driven data projects.** Working closely with Indigenous leadership in data collection is the first step in engaging with the communities that have stewarded sustainability efforts since time immemorial. Indigenous-led conservation efforts have proven comprehensive and effective in supporting and amplifying Western approaches.[53]
- **Integrate Indigenous perspectives broadly.** It is equally as important to include Indigenous participation in projects that are not necessarily Indigenous-led, but are of relevance and benefit to Indigenous peoples.
- **Ensure Indigenous ownership over traditional knowledge.** Affirm that Indigenous partners retain ownership of the data they choose to share, and explicitly discuss the sharing and use of data with local leadership. While, ideally, data collected on Indigenous land would be shared more broadly, any restrictions imposed by Indigenous data and information owners must be respected, and this should be a condition of funding by donors.

"I think the funding community has an important role to play here and I'll give you one example. When we first started our work, a lot of researchers were going up to the Northwest Territories and collecting data without ever showing the communities the results. [In response], a local government program actually made it mandatory that anyone receiving their funding share water data openly on DataStream. And it's working really well!

The NWT and the Arctic in general really seem to be ahead of the game when it comes to pushing academics to open up and work with communities. Southern programs could learn a lot from what's happening in the North. I really think the funding world can play a similar role across the country. Because communities are saying "enough is enough". They want to see that information and want to be involved in the research design."

Carolyn Dubois
The Gordon Foundation

52 Coastal First Nations. (2019)

53 Artelle, K., et. al (2019).

- **Support First Nations youth in technology:** Indigenous youth can play key roles in bridging the technology gap with elders who may be more resistant to adoption. Help to reduce the barriers that young people face in accessing skills training and technology by providing learning opportunities that can lead to employment and inter-generational projects. Nature United's community-led SEAS program[54] (Supporting Emerging Aboriginal Stewards) offers a strong example of this leadership and their open-access toolkit[55] provides replicable strategies for success.

6. Policy and Advocacy

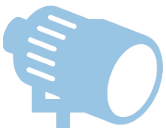
Our conversations and supplementary research have revealed two key policy gaps to consider when promoting AI as a tool for environmental solutions. First, AI is only powerful when it leverages comprehensive and high-quality data sets. Unfortunately, privacy and property rights associated with private sector data can make environmental collaborations difficult. Second, without common and trusted standards for collection, archiving and sharing, it is difficult to analyze and extract value from these data sets. Building trust in this area could be furthered by the integration of blockchain technology, as it can help to solidify transparency and credibility in data sharing and the preservation of privacy. In addition, the integration of social justice frameworks in algorithm development can serve to mitigate bias and facilitate appropriate data usage by both public and private firms.

If AI is going to drive environmental decision-making, Canada needs to increase the quality and quantity of public and private data available to researchers, ENGOs and those at the frontlines of environmental action, including Indigenous peoples, local municipalities and climate workers. These policy issues are vital to the future of Canadian sustainability, as the quality of algorithms is directly tied to the quality and utility of the utilized data.

By supporting and promoting policy development and advocacy initiatives, the philanthropic sector can facilitate the development of an ecosystem of information sharing and promoting fair and responsible collection, integration and usage of private data into shared data platforms.

54 Nature United. (2020)

55 Nature United & Access Planning. (2020)



Spotlight: Atlantic DataStream

DataStream[56], an open-access, online data hub for freshwater health, offers an exciting opportunity to collect, visualize and analyze comprehensive water data across Canada. Currently working with 23 monitoring groups nationwide, they form respectful and collaborative relationships with businesses, communities, First Nations peoples, ENGOs and data stewards to foster information sharing with accessibility and sustainability in mind. Using blockchain technology, DataStream can trace where information comes from and how it was collected, building trust and clarity in the data collection process.

In its pursuit of open-data sharing practices, the Government of Northwest Territories instituted a requirement that all data from their funded Cumulative Impact Monitoring Program must be made available on DataStream.[57] Government initiatives like these open the door for others to follow suit, building towards a healthier ecosystem of information sharing which in turn reduces knowledge gaps, advances collaborative water stewardship and supports informed environmental decision-making.

Opportunities for Philanthropic Action

- **Where appropriate, support shared data and open-access data hubs**. Beyond funding individual initiatives pursuing this work, many foundations are also funding social data infrastructures and open-data policies. The Ontario Trillium Foundation, for example, one of the largest granting foundations in Canada, is supporting Transform the Sector[58], which aims to accelerate social-sector impact by sharing data openly in collective action with funders, NGOs and government stakeholders. Philanthropists may further this and other action by supporting policies and open-access data platforms that advance data sharing across industries as it

"In the natural and environmental sciences, if we practice open data-sharing in a way that is practical, reusable and citable, scientists could figure out new questions to ask, better, smarter ways of working or even fill in the gaps for others [to] see how our findings connect... To make that happen we need the cyber-infrastructure and the partnerships in place to ensure that the standards [and quality] of data are set and are high enough to reap the benefits. Canada has entered the game a little late but I'm hopeful that we can leapfrog and learn from our partners in other countries, not just in the States but in the European Union. Not just because someone tells us to but because it helps us all do better science and enables discovery. At this point in time, that's critical."

Dr. Christopher J. Lortie
York University

56 The Gordon Foundation, & Atlantic Water Network. (2020).

57 Government of Northwest Territories. (2020).

58 Powered by Data. (2017)

pertains to environmental efforts. Consideration could be given to making data sharing a mandatory funding requirement, except in cases where Indigenous and community partners with ownership of the data prefer otherwise.

- **Fund academic efforts.** Philanthropists may consider funding research, thought leadership and data-sharing efforts with academic partners in this space. Our conversations with academic stakeholders surfaced a willingness to promote and expand data-sharing efforts between scientific faculties across institutions. Their challenge is rooted in securing funds for the organization of data and community liaising. Funders may consider (i) funding such a data-sharing initiative and (ii) acting as conveners between these institutions, technical people who may develop complementary technology to leverage the data and ENGOs who can make use of these technologies for environmental field work.

- **Land and water protection.** Use data-leveraging technologies to inform policies directed at stopping deforestation, land conversion, degradation of oceans and waterways, grasslands and wetlands. Support government efforts that protect and rebuild threatened ecosystems using nature-based solutions through technical and traditional tools.

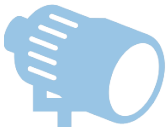
7. Convening

Effectively deploying technology to advance environmental solutions is complex work requiring a combination of technical expertise, funding, infrastructure, community-knowledge and policy tools.

Our conversations and research revealed that these initiatives are almost always the collective effort of multiple stakeholders across sectors, and that building relationships is a critical component of the work. Most often we saw the combination of at least one technical partner with an ENGO and a community partner, backed by philanthropic support, impact investors and/or government support.

Action-oriented gatherings of innovative and diverse stakeholders are an exciting way to engage with others in scaling this field, share information and build research. Many of the algorithms and data that currently underlie AI do not reflect the society that they are meant to serve. Convening diverse stakeholders in workshops, summits, conferences and solution labs encourages teams to take account of multiple perspectives while developing and applying technology solutions to environmental problems.

For example, WaterTAP, the former water accelerator, funded workshops on corporate-Indigenous partnerships for water technologies through the Ontario Federation of Indigenous Friendship Centres. The program included one full-day of competency training for corporate technology partners where they learned about the circumstances of the relationship between First Nations and external partners. The second day included panels and presentations from those working for and in Indigenous communities around water issues. The workshops allowed for an open dialogue between technical, business and civil society groups around themes of community engagement and technological capacity. Technology companies were then supported in pursuing respectful and collaborative environmental solutions with First Nations after the workshops.[59]



Spotlight on Energy.AI

The Energy Futures Lab hosted the first of a series of Energy.AI workshops to explore the question of, "How can artificial intelligence enable Alberta to thrive in a competitive, low carbon future?"

The one-day event convened thought leaders, innovators and industry leaders in AI and energy. The sixty attendees at the event were challenged to surface opportunities and challenges in deploying AI for the energy transition.[60]

At the end of the day, 12 breakthrough initiatives had surfaced, three of which the group selected to pursue and deploy collectively.[61] This is a shining example of the types of collaborative, purposeful discussions that can take place among stakeholders from across the energy ecosystem.

Opportunities for Philanthropic Action:

- **Fund workshops and innovation labs that include a diversity of perspectives**. Goal-oriented workshops that include community members, policy makers, NGOs, investors, and innovators at the regional, national and global levels, can help developers of technical solutions to be more successful by better understanding and accomodating all relevant interests.

59 Source: Interview with Kerry Freek, former Vice President, External Affairs at WaterTAP Ontario, Currently with OCTIA

60 Energy Futures Lab, et al. (2019).

61 Source: Interview with Chad Park, Energy Futures Lab

8. Competitions and Prizes

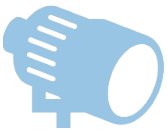
Competitions and prizes offer entrepreneurs, engineers, researchers and innovators the opportunity to create tailored solutions to the world's most challenging problems, with cash prizes for the most innovative and impactful ideas. These malleable data-leveraging technologies must inherently be programmed toward an objective. As such, they offer the ideal conditions for the facilitation of competitions around a specific goal.

Research from McKinsey[62] suggests three "paramount" conditions for prize givers: a measurable and achievable objective; the availability of a relatively large population of potential problem solvers; and a willingness of participants to bear some of the cost and risk. If one or more of these conditions cannot be met, the research suggests that grants or other funding alternatives should be considered.

This is a great opportunity for philanthropic engagement within an academic context, supporting the execution of technical goals by graduate students working under professorial guidance. Our conversations and research suggest that the biggest challenge that competitions present is the cost to participants of time, labour and technology development. Many universities already invest in the foundational data-collection equipment required (camera traps, microphones, drones, etc.). While their collections could use supplementation, the main cost to participants tends to be labour (algorithm coding and software design- some of which is already required for course work) and transportation to and from research sites. With the help of philanthropists, both prize money and participant labour may stretch substantially farther.

The Everglades Foundation may offer a replicable strategy to explore. In 2017, their research revealed a concerning amount of phosphorous and nitrogen in water supplies as a result of agricultural run-off. These compounds were found to be feeding the 'red tide'- toxic algal blooms devastating the Florida coastline. Inspired to act, the foundation sponsored a $10 million innovation award, the "George Barley Water Prize," in association with corporate, NGO and government partners. The purpose of the competition was to find safe, effective and affordable technology solutions to remove excess phosphorous from fresh water supplies. In 2019, finalists were announced in Toronto, after proving their innovation's ability to work in cold climates. The grand finale will take place in Florida in warmer conditions. This is an excellent example of the use of competition to drive purposeful action towards a specific goal.

62 Bays, J., Goland, T., & Newsum, J. (2009).



Spotlight on AquaHacking

AquaHacking[63] is a Canadian tech competition created by the de Gaspé Beaubien Foundation. It brings together young professionals with a passion for water science, engineering, sustainable development and data analysis. Placed in teams, they compete to solve their community's most urgent water challenges. The top five teams win a spot at a local startup incubator and up to $20,000 to pursue their initiative.

AquaHacking offers both environmental and social value. Participants develop the technical skills required to leverage the data revolution and receive mentorship from industry experts to fuel their entrepreneurial journey.

Opportunities for Philanthropic Action:

- **Collaborate with others to establish new competitions and prizes.** Consider pursuing partnerships with academic institutions, ENGOs and community groups who are already exploring the capacity for data-leveraging technologies to further accelerate impact. As a result, the solutions may be supported by experienced practitioners and implemented immediately within predetermined areas of need. There are collaborative funding opportunities to pursue as well. Multiple foundations, investors and philanthropists may consider pooling funds for larger prizes towards the pursuit of common interests.

63 De Gaspé Beaubien Foundation. (2020).

Funding Technological Solutions: Considerations

As with all technologies, there are potential risks to development and implementation without proper care and oversight. For the significant potential of these technologies to be realized, it is critical that they are developed and used responsibly, with attention paid to the potential social and environmental harms and barriers to impact. This section describes some of the matters that philanthropists should consider when assessing opportunities for funding and investment in this space.

Data Sharing – Privacy and Responsibility

Data is the cornerstone of all of these technologies. Without comprehensive and complete data sets, AI lacks effectiveness, blockchain lacks purpose and smartphone applications lack substance. While maintaining a respectful sense of community knowledge, permissions, ownership, and engagement, funders might also promote data-sharing (where appropriate) by making the publication of data related to water, conservation and climate on an open-source platform mandatory for their grantees. As private sector data is critical in advancing sustainability efforts, philanthropists may also consider supporting policies related to responsible collection and usage of data. That said, there may be circumstances where sharing may not be acceptable (e.g. where Indigenous communities have concerns about the sharing of their data and knowledge). In such cases, restrictions on access and sharing must be respected.

Current and future developments must build in privacy safeguards to protect private citizen data, give opportunity for notice and consent and provide appropriate transparency and control over the use of personal data.[64] Policy-makers should also be encouraged to explore the roles of governments, the private and philanthropic sectors in institutionalizing these measures, updating laws and regulations in response to the widespread usage of data-leveraging technologies.

64 For more information on industry best practice, see Google (2019), Microsoft (2018) and the Information Technology Industry Council (2017)

Access and Infrastructure

In our conversations with experienced practitioners, we heard concerns about the efficacy of these technologies in practice. Community-based ENGOs working on-the-ground often find themselves in rural environments without reliable technology infrastructure. While the more accessible smartphone applications allow for citizens to track and photograph flora and fauna with ease, more complex water and wildlife monitoring projects also require additional equipment like water monitoring kits for collecting samples, sensors and drones. Thoughtful considerations to the supplementary infrastructure will help facilitate the deployment of data-based technologies in rural and remote communities. These technologies are also costly and out-of-reach for action-oriented groups with smaller budgets. Financial support for both the technologies and training are important elements for funders to consider.

Automation and Employment

Many prominent business executives and management consultants have argued that widespread applications of AI place valuable employment under threat of automation.[65] However, it is possible that the integration of data-based technologies may primarily change the nature of work rather than cause widespread unemployment.[66] Providing and supporting opportunities for upskilling and reskilling, specifically for those working on climate, conservation, water and sustainable communities, may mitigate the social dislocation that could result from automation. Funders can make a real difference to ENGOs who face challenges in keeping up with technological developments, driving effective and skillful environmental work.

Philanthropic Constraints

In Canada, activities of philanthropic foundations are regulated by the Canada Revenue Agency. A key requirement is that foundations' grant-making must, generally, be made only to "qualified donees", such as registered charities. At first glance, this would appear to make supporting technologies developed by the private sector challenging. However, there are a variety of ways for philanthropists to play a powerful role in this area. For example, gifts may be made to qualified donees who are developing their own technologies, making use of existing technologies developed elsewhere, or are otherwise working with for-profit technology innovators to pursue solutions to sustainability issues. Grants can also be made to universities for environment-related technology research

65 Atkinson, Robert & Carl Frey. (2019).
Knoess, Christopher., et al. (2016).

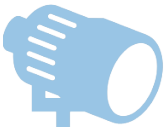
66 Fraser Institute. (2019).

and development, or to university-based accelerator programs that support start-up technology businesses. On the non-grants side, financial investments may be made in private sector companies or in specialized environment technology funds (to the extent they are available) from a foundation's endowment. And, newer forms of hybrid investments may be pursued, combining charitable grants with non-charitable financial investments for even greater impact.

Environmental Considerations of Technology Itself

AI, blockchain, big data and smartphone applications all leverage data centres to collect, document, analyze and share information in near real time, across multi-national networks. These data centres consume vast amounts of energy. In fact, U.S. data centres use more than 90 billion kilowatt-hours of electricity a year, requiring roughly 34 giant (500-megawatt) coal-powered plants.[67] Experts say this figure is likely to double every four years.

While there is much work being done in pursuit of data centre energy efficiencies,[68] without the decarbonization of the energy sector, a fossil fuel powered data revolution may result in additional ecosystem strain.



Spotlight on 100% Renewable Data

Technology leaders like Microsoft, Google and Facebook have each committed to go 100% renewable, powering their expansive data-hubs with biomass (including biogas), geothermal, solar, water and wind – either sourced from the market or self-produced. The recent launch of the Business Renewables Centre,[69] which offers a suite of tools to aid the transition to renewables, may support Canadian technology companies to join the movement.

67 Delforge, P. (2016).

68 Huang, R. & Masanet, E. (2015).

69 Business Renewables Centre. (2020).

Toward a Sustainable Future: Concluding Thoughts

Recent natural events, including the bushfires in Australia, cyclones in Southern Africa, extreme flooding in South Asia and drought in Central America represent a universal call to action to address humanity's greatest environmental challenges. While not holistic solutions in themselves, emergent technologies such as AI, blockchain, big data and smartphone applications provide us with tremendous opportunities to improve the protection of our planetary systems, vulnerable species and communities.

As we pursue environmental action in this critical moment, let us focus on building the enabling condition for success: a socially-equitable and environmentally-conscious ecosystem for their adoption and deployment. One piece of the puzzle lies in addressing community infrastructure needs including access to highspeed internet, AI tools, open-access data, and complementary technologies (e.g. drones, satellites, sensors, monitoring technology). Let us also help to accelerate Indigenous-led efforts by fostering authentic partnerships with Indiginous-led and other culturally-competent organizations building trusting relationships with local communities.

Philanthropists have an opportunity to support the individuals and organizations working every day to meet environmental challenges by helping them accelerate the pace and precision of their efforts, highlighting the technical tools that organizations have at their disposal and funding reskilling and upskilling so that they may maximize the value of these technologies.

All stakeholder groups are affected, and the pace of change is rapid. Leveraging technologies for a healthy planet will require increased collaboration between those who create the tools and those who understand the systemic challenges. Acting as matchmakers between technology partners and problem-solvers, philanthropists can facilitate purposeful relationships and help to shape innovative new partnerships.

The range of themes and recommendations explored in this report, while not exhaustive, provides pathways for funders to consider as they evolve their own strategies and approaches. We hope this work is a first step in a larger conversation around the opportunities for deployment of these emerging technologies, as well as their social and environmental implications. In particular, we hope this report motivates funders to explore new and creative solutions to our largest global challenge: climate change. These efforts must be accelerated if we hope to secure a healthy and prosperous planet for generations to come.

Appendices

References

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., … Peacock, A. (2019). *Blockchain technology in the energy sector: A systematic review of challenges and opportunities*. Renewable and Sustainable Energy Reviews, 100, 143–174. doi: 10.1016/j.rser.2018.10.014

Atkinson, Robert & Carl Frey. (2019). *Will AI Destroy More Jobs Than It Creates Over the Next Decade? Debate*. Wall Street Journal. https://www.wsj.com/articles/will-ai-destroy-more-jobs-than-it-creates-over-the-next-decade-11554156299

Artelle, K., et. al (2019). *Supporting resurgent Indigenous-led governance: A nascent mechanism for just and effective conservation.* Biological Conservation.

Balian E., Eggermont H. & Le Roux X. (2014) *Outputs of the Strategic Foresight Workshop "Nature-Based Solutions in a BiodivERsA Context"*, Brussels June 11-12 2014. BiodivERsA report, 45 pp.

Bays, J., Goland, T., & Newsum, J. (2009). *Using prizes to spur innovation*. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/using-prizes-to-spur-innovation.

Bloomberg. (2015) *UNICEF and Bloomberg Announce Data Science Researcher-in-Residence Program.* https://www.bloomberg.com/company/press/unicef-and-bloomberg-announce-data-science-researcher-in-residence-program/

Breakthrough Energy. (2020) *Reliable, Affordable Energy for the World. Investing in a Carbonless Future*. https://www.b-t.energy/

Business Renewables Centre. (2020). *Simplifying and accelerating large-scale renewable energy use across Canada*. https://businessrenewables.ca/

Burger C, Kuhlmann A, Richard P, Weinmann J. (2016) *Blockchain in the energy transition a survey among decision-makers in the German energy industry.* https://shop.dena.de/fileadmin/denashop/media/Downloads_Dateien/esd/9165_Blockchain_in_der_Energiewende_englisch.pdf

Canadian Water Network, PSD Consulting, Federation of Canadian Municipalities & Canadian Water and Wastewater Association. (2019). *Using Better Data to Identify Climate Change-Related Infrastructure Vulnerabilities in Canadian Communities.* http://cwn-rce.ca/wp-content/uploads/Case-Studies-Using-Better-Data-to-Identify-Climate-Change-Related-Infrastructure-Vulnerabilities-in-Canadian-Communities.pdf

Charities Aid Foundation. (2019). *Machine Made Goods: Charity, Philanthropy and Artificial Intelligence*. https://www.cafonline.org/about-us/caf-campaigns/campaigning-for-a-giving-world/future-good/machine-made-goods-charities-philanthropy-artificial-intelligence

CIFAR. (2020) *CIFAR Pan-Canadian Artificial Intelligence Strategy*. CIFAR. https://www.cifar.ca/ai/pan-canadian-artificial-intelligence-strategy

Coastal First Nations. (2019) *Regional Monitoring System*. https://coastalfirstnations.ca/our-environment/programs/regional-monitoring-system/

Convergence. (2019). *Blended finance*. https://www.convergence.finance/blended-finance

Copeland, B.J. (2019). *Artificial Intelligence*. Encyclopædia Britannica. https://www.britannica.com/technology/artificial-intelligence

De Gaspė Beaubien Foundation. (2019). *The AquaHacking Challenge*. https://aquahacking.com/en/.

Delforge, P. (2016). *America's Data Centers Consuming and Wasting Growing Amounts of Energy*. Natural Resources Defence Council. https://www.nrdc.org/resources/americas-data-centers-consuming-and-wasting-growing-amounts-energy.

Dendra Systems. (2019). *Our Products*. https://www.dendra.io/sales

Ecofuel. (2020). *Ecofuel Accelerator and Fund*. https://ecofuelaccelerate.com

Energy Futures Lab, et al. (2019) *Cutting Costs, Cutting Emissions: How can artificial intelligence enable Alberta to thrive in a competitive, low-carbon world?*. Energy Futures Lab. https://energyfutureslab.com/wp-content/uploads/2019/03/Energy.AI-workshop-2018.pdf

Fraser Institute. (2019). *Technology, Automation and Employment. Will this time be different?*. Fraser Institute. https://www.fraserinstitute.org/sites/default/files/technology-automation-and-employment.pdf

Future Skills Centre. (2020). *Latest from the Future Skills Centre*. https://fsc-ccf.ca/

G9 Ark. (2019). *G9 Ark- About the project*. https://g9ark.org/.

Google. (2019). *Responsible AI Practices*. https://ai.google/responsibilities/responsible-ai-practices/.

Google. (2020). *Nest Thermostats – Keep Comfortable and Help Save Energy*. https://store.google.com/ca/magazine/compare_thermostats?hl=en-CA.

Government of Canada. (2018). *Report of Canada's Economic Strategy Tables: Agri-food*. https://www.ic.gc.ca/eic/site/098.nsf/eng/00022.html

Government of Northwest Territories. (2020). *NWT Cumulative Impact Monitoring Program (NWT CIMP).* https://www.enr.gov.nt.ca/en/services/cumulative-impact-monitoring-program-nwt-cimp/finding-data-and-information

Harrison, H.; Birks, M.; Franklin, R; & Mills, J. (2017) *Case Study Research: Foundations and Methodological Orientations*, Forum Qualitative Social Research, 18(1), Art. 19. http://nbn-resolving.de/urn:nbn:de:0114-fqs1701195.

Helman. (2019) *How Algorithms are Taking Over Big Oil*. Forbes. https://www.forbes.com/sites/christopherhelman/2019/01/14/how-algorithms-are-taking-over-big-oil/#278147708e2f

Huang, R. & Masanet, E. (2015). Data Center IT Efficiency Measures. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* National Renewable Energy Laboratory.

IEA (2017), *Digitalisation and Energy*, IEA, Paris https://www.iea.org/reports/digitalisation-and-energy

IBM. (2019). *Everyday Ethics for Artificial Intelligence*. https://www.ibm.com/watson/assets/duo/pdf/everydayethics.pdf

Indigo Advisory Group. (undated) *Blockchain in energy and utilities use cases, vendor activity, market analysis*. https://www.indigoadvisorygroup.com/blockchain. Accessed December, 2019.

iNaturalist. (2020). *Connect with Nature*. iNaturalist. https://www.inaturalist.org/

Innovation, Science and Economic Development Canada. (2019). *High-Speed Access for All: Canada's Connectivity Strategy*. https://www.ic.gc.ca/eic/site/139.nsf/vwapj/ISEDC_19-170_Connectivity_Strategy_E_Web.pdf/$file/ISEDC_19-170_Connectivity_Strategy_E_Web.pdf

IPCC. (2019). *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems Summary for Policymakers.https://www.ipcc.ch/srccl/*

Information Technology Industry Council. (2017). *ITI AI Policy Principles.* https://www.itic.org/dotAsset/50ed66d5-404d-40bb-a8ae-9eeeef55aa76.pdf

Keating, D. (2019). *Failure In Madrid As COP25 Climate Summit Ends In Disarray*. Forbes. https://www.forbes.com/sites/davekeating/2019/12/15/failure-in-madrid-as-cop25-climate-summit-ends-in-disarray/#18fc35c53d1f.

Kearney, S, Murray, F and Nordan, M. (2014) *A New Vision for Funding Science*. Stanford Social Innovation Review. https://d2l8rne3sx3c3l.cloudfront.net/wp-content/uploads/2015/02/A_New_Vision_for_Funding_Science.pdf?x40247

Kent, G. (2018) *Alberta drone test could show faster, cheaper way to replant forests*. Edmonton Journal. https://edmontonjournal.com/business/local-business/alberta-drone-test-could-show-faster-cheaper-way-to-replant-forests

Knoess, Christopher, Ron Harbour, and Steve Scemama (2016). *Prepare Your Workforce for the Automation Age*. Harvard Business Review. https://hbr.org/2016/11/prepare-your-workforce-for-the-automation-age

Merriam, Sharan. (1998). *Qualitative Research and Case Study Applications in Education*. 2nd ed., Jossey-Bass Publishers.

Merriam, Sharan. (20019) *Qualitative Research: A Guide to Design and Implementation*. 2nd ed., Jossey-Bass.

McCarthy, John (undated). *What is AI? / Basic Questions*. Interview with Professor McCarthy. http://jmc.stanford.edu/artificial-intelligence/whatis-ai/index.html Accessed November 2019.

Microsoft. (2018). *AI Principles & Approach from Microsoft*. https://www.microsoft.com/en-us/ai/our-approach-to-ai.

Nature Conservancy. (2019). *Cree Regional Conservation Strategy*. http://www.natureconservancy.ca/en/where-we-work/the-north/cree-regional-conservation-strategy.html

Nature United. (2020) *The Next Generation of Indigenous Leaders. The SEAS Community Initiative*. https://www.natureunited.ca/what-we-do/our-priorities/investing-in-people/seas--supporting-emerging-aboriginal-stewards/

Nature United and Access Planning. (2020) *The Seas Toolkit.* https://www.natureunited.ca/content/dam/tnc/nature/en/documents/canada/SEAS-toolkit_v7_FINAL.pdf

Nicklen, P. (2019). *How much is a whale worth?* National Geographic. https://www.nationalgeographic.com/environment/2019/09/how-much-is-a-whale-worth/.

OECD and IEA. (2011). *Green Growth Studies: Energy*. OECD. https://www.oecd.org/greengrowth/greening-energy/49157219.pdf

Ogden, L. (2019) *Climate Change Outpaces Species Shifts in Amazon*. BioScience. 69(3). https://doi.org/10.1093/biosci/biy162

Potschin, M.; Kretsch, C.; Haines-Young, R., E. Furman, Berry, P., Baró, F. (2016): *Nature-based solutions*. In: Potschin, M. and K. Jax (eds): OpenNESS Ecosystem Services Reference Book. EC FP7 Grant Agreement no. 308428. www.openness-project.eu/library/reference-book

Powered by Data. (2017). *The Capacity for Data Report. How The Social Sector can Build Data-Informed Organizations*. http://transform.thesector.ca/the-capacity-for-data

Prime Coalition. (2020). *Prime Impact Fund*. https://primecoalition.org/investments/

RBC. (2018). *RBC Future Skills Report. Humans Wanted: How Canadian youth can thrive in the age of disruption*. RBC. https://www.rbc.com/dms/enterprise/futurelaunch/_assets-custom/pdf/RBC-Future-Skills-Report-FINAL-Singles.pdf

Rifkin, J. (2013). *The third industrial revolution : how lateral power is transforming energy, the economy, and the world* (1st Palgrave Macmillan pbk. ed.). New York: Palgrave Macmillan.

Rogelj, J., et.al. (2018) *Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development*. In: Global Warming of 1.5°C. An IPCC Special Report. In Press.

Song, L. (2019). *An (Even More) Inconvenient Truth: Why Carbon Credits For Forest Preservation May Be Worse Than Nothing*. ProPublica. https://features.propublica.org/brazil-carbon-offsets/inconvenient-truth-carbon-credits-dont-work-deforestation-redd-acre-cambodia/.

Stone, E. (2017) *Drones Spray Tree Seeds From the Sky to Fight Deforestation*. National Geographic. https://www.nationalgeographic.com/news/2017/11/drones-plant-trees-deforestation-environment/

Swim, Drink, Fish. (2020) *Citizen Science*. https://www.swimdrinkfish.ca/citizen-science

The Gordon Foundation, & Atlantic Water Network. (2020). *Atlantic DataStream*. https://atlanticdatastream.ca/.

The Natural Step. (2018). *Our methodology*. https://thenaturalstep.org/approach/

Winick, E. (2019). *Every study we could find on what automation will do to jobs, in one chart*. https://www.technologyreview.com/s/610005/every-study-we-could-find-on-what-automation-will-do-to-jobs-in-one-chart/.

WWF. (2018) *Living Planet Report: Aiming Higher*. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland.

Interviews Conducted

1. Carolyn DuBois, The Gordon Foundation
2. Navi Brar, Royal Bank of Canada (RBC)
3. James Snider, World Wildlife Fund (WWF) Canada
4. Chad Park, Energy Futures Lab
5. Dan Wicklum, The Transition Accelerator
6. James Stauch, Mount Royal University
7. Sandra Odendahl, Scotiabank
8. Tom Rand, MaRS Cleantech
9. Shianne McKay, Centre for Indigenous Environmental Resources (CIER)
10. Wendy Ross, Centre for Indigenous Environmental Resources (CIER)
11. Kariann Aarup, De Gaspé Beaubien Foundation
12. Andrea Moffat, Ivey Foundation
13. Jason Switzer, Alberta Clean Technology Industry Alliance (ACTia)
14. Kerry Freek, Ontario Clean Technology Industry Association (OCTia)
15. Anna Warwick Sears, Okanagan Basin Water Board (OBWB)
16. Sarah Hastings Simon, Pembina Institute
17. Nargol Ghazian, York University
18. Mario Zuliani, York University
19. Malory Owen, York University
20. Christopher Lortie, York University & Eco Blender
21. Andrea Nemtin, The Social Innovation Institute, formerly with Rally Assets

Research Methodology

Overview

The core question addressed in the report is: ***How can the philanthropic sector best support the development and use of technology solutions to environmental problems such as climate change, water quality and access, conservation and sustainable communities?***

Scope

Environment Funders Canada and the Academy for Sustainable Innovation:

- Understand that environmental issues are of increasing concern and that there is a need for new and more innovative approaches to action.
- Aim to explore the use of technologies for addressing these issues with a particular interest in AI, blockchain, app development and the use of big data.
- Aim to identify actions within the powers of philanthropic organizations and individuals to accelerate the pace of change within Canada and beyond.

Interviewee Selection

Interviewees were selected based on what they could reveal about technological solutions to environmental challenges in Canada and/or innovative models for supporting these efforts, with an emphasis on the philanthropic sector. Data was gathered from the most experienced levels of staff across academic, NGO, philanthropic and civil society organizations.

Interview Process

The interviews were semi-structured with open-ended questions, using the 'pragmatic constructivist' approach, as developed in the work of Merriam.[70] This approach asserts that case study research can use both quantitative and qualitative methods aimed at generating "inductive reasoning and interpretation rather than testing a hypothesis."[71] Following Merriam's approach to inquiry, questions were asked with the intent of understanding the landscape and individual participant experiences, not with the sole purpose of proving a theory.

70 Merriam. (1998, 2009)

71 Harrison et al. (2017)

Guiding Questions

1. What are the technological innovations that have the greatest potential to offer environmental solutions? What are the conditions under which they are most effective?

2. What investment opportunities are there (Canada and elsewhere) that may help support the development and/or leveraging of technology for environmental benefit?

3. What are the social and environmental considerations to the implementation of these technologies?

4. What opportunities are there for further collaboration in this work?

Secondary Research

A review of multiple sets of literature was conducted. The first set related to a broad, technical perspective on the role of emergent and data-leveraging technologies in environmental action. The second set revolved around philanthropic and private-sector investment opportunities, exploring the opportunities for multiple stakeholders to engage and take action in this space.

A search of electronic databases including JStor and Google Scholar was conducted together with a manual search of reference lists and bibliographies of identified articles and reports and other leading publications to obtain additional source material. Some of the search terms included 'artificial intelligence for good', 'blockchain uses for conservation, water, climate', 'philanthropic support of technology for the environment' and 'the future of environmental work with AI, blockchain, data and smartphone apps'. Websites and documents published by the organizations of interview participants, as well as business, environmental and technology publications were used to ground interview results in the larger picture. This multi-modal search strategy aimed to yield a complement of peer-reviewed articles, abstracts, reports, and websites.

Environment Funders Canada
c/o Foundation House
2 St. Clair Avenue East, Suite 300
Toronto, Ontario
M4T 2T5

Phone: 647.288.8891
Twitter: @EnviroFundersCA

environmentfunders.ca