Project Title:	Sensors 4 People / 3 Drops
Canadian Principal Investigator:	Michael Serpe
Canadian University:	University of Alberta
Indian Principal Investigator:	Soumyo Mukherji
Indian Institution:	Indian Institute of Technology Bombay
Industry Partner(s) [if any]:	
Other Partner(s) [if any]:	Akvo Waterlution Wells for India SACIwaters Ashoka Sutradhaar Social Ventures Trust for Research in Ecology and on the Environment (ATREE) Arghyam The Centre for Integrated Water Resource Management (C-IWRM)
Length of Demonstration Project:	18 months
Deployment Budget Request:	45 000 CA$
Additional Student Involvement Request (if any):	10 000 CA$
Total Budget Request from IC-IMPACTS:	55 000 CA$
Total Expected Cash Contribution by Partners:	

Total Expected In-kind Contribution by Partners:			32 000 CA$
Total Number of Students Involved in Project:			6

DETAILED PROJECT PROPOSAL

1. Demonstration Project Abstract (for public purposes – maximum 250 words). If application is successful, this section will appear on IC-IMPACTS website and in other print IC-IMPACTS materials.

Access to dependably safe drinking water is a major challenge across India. Diseases caused by drinking contaminated water are numerous and disproportionately affect the young, elderly, and poor, with water-related diseases as the leading cause of infant mortality and morbidity in 2015[1]. 9% of habitations in India are subject to chemical contamination, this number increasing due to the creation of deeper borewells.[2] Climate change brings a risk of increasing the water constraints of the country as projected in the IPCC report. Access to water is given priority in Indian constitution (Article 47). Impacts of poor water quality on human health is targeted to be reduced or eliminated under the UN Sustainable Development Goal 6 (SDG 6)[3].

Particularly pertinent to the challenge of safe drinking water in India is the problem of water quality monitoring at household level. Periodic monitoring of water quality at the level of the consumers is a logistical challenge that is hard to overcome, especially given limited resources. This perpetuates the existence of widespread water contamination problems which often go undetected by authorities, greatly impacting the health and well-being of the consumers.

As an attempt to tackle this challenge, the National Rural Water Quality Monitoring & Surveillance Program has been established since February 2005 to monitor water quality at household level by collaborating with trained local community members. This program ensures monitoring of one sample per 200 inhabitants, twice per year. The development of easier and cheaper reliable measurement technology, and the use of a measurement protocol based on a smartphone app with would further the functionality of this program and increase the empowerment of the community.

[1] https://www.unicef.org/wash/index_water_quality.html
[2] Strategic Plan – 2011- 2022 Department of Drinking Water and Sanitation – Rural Drinking Water
[3] https://sustainabledevelopment.un.org/sdg6

Our project aims to develop and implement a framework for the collaborative monitoring and mapping of water quality using new water quality sensing technology. In 5 pilot communities in India, working with appropriate authorities and local NGOs, our initiative will provide a forum to engage and educate local citizens on water issues, allowing them to measure water quality and to log data on a dynamic map using a smartphone interface.

The proposed collaborative approach involves community members in monitoring and exploring solutions to local water quality issues. After some initial training, participants in the communities will log measurements, observations, and comments which can be used in different ways on the mobile app. The technology and collaborative framework promote inter-community knowledge sharing and contribute to know-how and awareness within the community and amongst local stakeholders. Ultimately, this will encourage local water resilience initiatives to adapt to changing water quality and contribute to the design of a scalable framework for water resilience initiatives in India.

2. Research Team

Canadian Principal Investigator Information:

Last Name:	**Serpe**	**First Name:**	**Michael**
Title:	**PhD, Associate Professor**		
Department:	**Chemistry**		
Institution:	**University of Alberta**		
Telephone:	**+1 780-4925778**		
Email:	**serpe@ualberta.ca**		
Street Address:	**11227 Saskatchewan Drive**		
City:	**Edmonton**	**Province:**	**Alberta**
Postal Code:	**T6G2G2**		

Indian Principal Investigator Information:

Last Name:	**Mukherji**	**First Name:**	**Soumyo**
Title:	**PhD, Institute Chair Professor**		
Department:	**Biosciences and Bioengineering**		
Institution:	**Indian Institute of Technology Bombay**		
Telephone:	**+(91-22) 2576-7767**		
Email:	**mukherji@iitb.ac.in**		
Street Address:	**Powai**		
City:	**Mumbai**	**State:**	**Maharashtra**
PIN Code:	**400076**		

3. Other Project Members:

List other members of the research team, their role and expertise.
Also list all partners including industry, community, government partners, etc, noting the individual involved, the organization and their role in the project.
Add additional lines to each section as required.

Research Team Members			
Name	**Academic Institution or Organization**	**Project Role**	**Area of Expertise / Qualifications**
Gaspard Durieux	AgroParisTech, SciencesPo & Waterlution Alumni	Field operations	Collaborative water monitoring, water sensing technology, community engagement
Olivier Saint-Jean	University of Sherbrooke	Researcher	Water sensing technology, community engagement
Fuhar Dixit	University of British Columbia	Researcher	Drinking water treatment

Sutapa Chandra	Indian Institute of Technology Bombay	Field operations	Water Sensing technology
Danielle Lindamood	University of Waterloo	Researcher	Governance; stakeholder engagement; facilitation
Wei Zhang	University of Alberta	Researcher	Water sensing technology, waste water treatment

Industry and Other Partners		
Name	**Organization / Community**	**Role**
Ayan Biswas	Akvo	Technical assistance in collaborative water quality monitoring in India
Safa Fanaian	SACIwater	Technical assistance in workshop development India
Om Sharma	Wells for India	Bridge with local communities
Dona Geagea	Waterlution	Interdisciplinary research in water resilience, water knowledge in innovation.
Priyanka Ghosh; Bejoy Thomas	Ashoka Trust for Research in Ecology and on the Environment (ATREE)	Water quality specialist; community engagement and research
Srinivasa Rao Podipireddy	The Advanced Centre for Integrated Water Resource Management (AC-IWRM)	Networking and building scale capacities
Agatha Tommasi	World Youth Parliament for Water	Consultancy and collaborative water governance
M. Lord Savariraj	Action for Food Production (AFPRO)	Water security consultant
Archana Tomar	Sutradhaar Social Ventures	Field operation and community engagement

3. Summary of Innovative Demonstration Initiative

Include a discussion of the following: (maximum 500 words)

- current status of research and development of technology

- identification of whether the technology has been successfully deployed in any prior setting (i.e. previously deployed in Canada, now testing effectiveness of deployment for India, or vice versa; deployed in larger community, now testing in smaller community, etc.)
- relevance of initiative to national needs in India and Canada

In the frame of the IC-IMPACTS proposal, we intend to deploy cheap, simple to use, reusable water quality tests in communities in India. The research will focus on establishing the drivers of citizen participation in water monitoring in order to develop a framework for integrating local monitoring initiatives into water resilience programs.

Concerning the sensing technology, Dr. Serpe's research group at University of Alberta has over eight years of experience working on water quality biosensor research. In his laboratory, a colorimetric sensing platform has been developed for the detection of various characteristics of water, such as temperature, pH, heavy metals, biomolecules (DNA/proteins), and the presence of bacteria. [4-8] This technology uses smart polymers that respond to their environment to detect water contaminants. It is inexpensive and is being applied to develop an easy-to-use, handheld device which ensures user-friendliness in any context.

For the deployment of the sensors, recently developed collaborative water monitoring platforms, which allow ordinary citizens to co-create water databases using their smartphones and low-cost water sensors, present a unique opportunity. The open-source water platform Akvo Caddisfly has already collected 50,000 data points in India, Bangladesh and West Africa investigating water quality. The Caddisfly software offers tools to automatically map the data on a geographic interface to visualize the water quality of surveyed areas.

While the technology and platform have obvious merits, the major challenge is that they are not currently used widely by the public. Past water monitoring pilots have been implemented to collect data on very precise locations over a short period of time, limiting our knowledge on scalability and sustainability. Additionally, technology developers have given little consideration to long-term community engagement in their designs, even though prior studies demonstrate the positive impact of public participation in water management adaptation to climate change.

4."Structured Materials for Sensing Applications", in *Encyclopedia of Analytical Chemistry*, **2015**, DOI: 10.1002/9780470027318.a9436.
5."Responsive Polymer-Based Assemblies for Sensing Applications", *Macromolecular Rapid Communications*, **2015**, 36, 1382-1392.
6."Stimuli-Responsive Microgel-Based Etalons for Optical Sensing", *RSC Advances,* **2015**, 5, 44074-44087.
7."Responsive Polymers as Sensors, Muscles, and Self-Healing Materials", *Topics in Current Chemistry*, **2015**, DOI: 10.1007/128_2015_626.
8."Responsive Polymers for Analytical Applications: A Review", *Analytica Chimica Acta*, **2013**, 789, 17– 32.

In the Strategic Plan for 2011 to 2022 of the Indian Department of Drinking Water and Sanitation - Rural Drinking Water, the researchers recommended a holistic approach with active community participation in villages at a watershed, aquifer or hydrologically-significant unit level. [4] The development of new smartphone-based geographical applications allowing access to community data sharing, on-line analysis and mapping, meteorological models, and IOT connected sensors open new perspectives on how technologies will empower collaborative initiatives in water management.[5] Our project is designed to address these recommendations and consider challenges identified from prior deployment processes.

In India, the desire for progress on meeting the needs for water quality assurance, improving strategic planning capacity, and engaging diverse local stakeholders around water issues is apparent. While this work focuses on India, there are obvious overlaps in applicability to the Canadian context. Particularly, boil water advisories which disportionately affect indigenous communities are considered a water crisis in Canada[6]. Understanding water quality in real-time and the ability to explore potential solutions collaboratively could have numerous implications for addressing this crisis.

On a global level, at least 2 billion people use potentially contaminated water sources (WHO, 2016)[7]. Many illnesses and deaths around the world, specifically implicating children and the elderly, come from drinking contaminated water. Even though the facilities may be in place for treating water, many systems are not maintained properly due to capacity and financial issues. Looking to the future, climate change has numerous implications for water quality and the consistency of quality. Given these threats to water quality, we envision empowering people to understand the quality of their drinking water and design solutions when needed, building their capacity to address their own water quality issues in a collaborative effort with local NGOs and government bodies. This technology and framework ultimately have the potential for wide application in other geographic and cultural contexts.

[4] http://mdws.gov.in/sites/default/files/StrategicPlan_2011_22_Water.pdf

[5]http://www.aidis.org.br/PDF/cwwa2015/CWWA%202015%20Paper_Integrated_Solutions_addressing_the_Impact_of_Climate_Change_-_Final+NeilsJensen.pdf

[6] http://canadians.org/sites/default/files/publications/report-drinking-water-0315_0.pdf

[7] http://www.who.int/mediacentre/factsheets/fs391/en/

4. Unique and Innovative Aspects of the Demonstration Initiative:

(maximum 500 words)

Briefly describe what is innovative about the technology to be demonstrated and deployed.

The technology used in this project is innovative in many aspects.

The first innovative aspect of the proposal is the nature of the colorimetric sensor itself. The color change that can be related to the presence of certain species of interest (analyte) is not a result of a “reaction” between the analyte and the sensor component. Instead, it is a result of a structural change of the polymer composing the sensors. This allows the colorimetric test to be reusable and much more precise than traditional colorimetric tests. The technology is also able to be used with cell phone-based cameras, which can be used to photograph the sensor. With the use of a mobile application, the color of the sensor can be processed and related to analyte concentrations, meaning the color test readout is simplified by the use of the cell phone camera to recognise the shade of the colorimetric-patch on a calibrated color scale. This technology is low cost as the sensing devices are printable on a paper medium like a business card or advertisement which are commonly available in the vast majority of communities.

Second, the application interface being developed is quite unique. In order for people with little scientific background to understand the health and environmental information being produced, we promote an integrated approach that offers the user :

► Pedagogic app: We inform the users of the risks associated with the level of contamination, and provide links to adapted low cost solutions to the identified water issues.

► Gamification: The app offers users a personal profile to gamify their water monitoring activities through providing achievement tracking of completed missions, the possibility to level up, and build their reputation as bigger missions are completed.

► Regional forum: The app contains a discussion platform for local issues that facilitates dialogue between leaders and the community to communicate and address water issues.

Finally, we intend to use all the recent innovation in the field of information management to develop an independent, collaborative water monitoring system able to fulfill alarm and response tasks, share water knowledge, and develop localized initiatives through:

► Block-Chain data: Developing this platform so the personal data is secured in blockchain. The data gathered is stored and exchanged locally rather than on a centralized server.

► Open development: By working in open source and with industrial partners we encourage the users to implement the geographical features and sensors themselves which allows for self organisation of the movement.

5. Innovative Demonstration Initiative Deliverables and Outcomes

(maximum 500 words)

In bulleted or short paragraph format, describe the specific activities, objectives and verifiable indicators of progress for each stage of the deployment. Describe clearly the overall relevance and expected outcomes of the deployment or prototyping.

Existing water monitoring technologies are not widely used by the public, but practitioners and researchers alike agree on the importance of public participation in water management for more sustainable outcomes. Our multidisciplinary team will deliver water sensing devices and develop the collaborative water monitoring framework as a gateway to facilitate the use of adaptive co-management in water resources management. The main outcome will be a science-based, participatory process to enhance the water resilience of communities in India with a bottom-up approach.

Objectives

- Refine the water quality sensor design for inexpensive, effective, user-friendly monitoring
- Develop community-level knowledge of water resources, water quality monitoring processes, and application usage
- Collect and map water quality data on pilot sites
- Identify the drivers of water users participation in water monitoring
- Facilitate collaboration and communication between water users, managers, NGOs, and decision-makers to for water quality monitoring and management
- Develop a framework for enhancing water resilience in communities

Activities

- Developing workshops to educate communities on water resources, provide training on the proper use of the technology, and engage other local stakeholders
- Developing metrics to evaluate the sensor design, participation, and improvements to water resilience
- Assessment of the best strategies to engage rural, urban and peri-urban citizens in collaborative water monitoring
- Framework design (iterative process of community engagement, data analysis, and design, and consultation)
- Optimizing the design of the water sensor technologies and mobile interface to maximize public engagement in water monitoring

Indicators of progress

The objectives and activities outlined above provide a roadmap for indicators of progress. We will continually make sure our actions are in line with these objectives and activities. Accomplishing them in accordance with the timeline of milestones (found below in section 6) will

ensure progress is happening on the different objectives at the appropriate time. Additionally, we will monitor the following as other indicators of progress:

- Participation levels in the water monitoring activities; attendance to workshops
- Evolution of the water quality on pilot sites over time
- Communication and engagement levels with and between other stakeholders
- Successful design and implementation of water solutions by community members
- Knowledge of water resilient behaviors among community members
- Sharing of water solutions on the mobile App.

The appropriateness of indicators will be reassessed and adapted as the pilot projects are chosen to ensure socio-cultural and scientific fit at the commencement of the project.

6. Key Milestones:

<table>
<tr><td></td><td></td><td colspan="4"></td></tr>
<tr><td>Project element</td><td>Milestone to be achieved</td><td>0-3 months</td><td>3-6 months</td><td>6-9 months</td><td>9-18 months</td></tr>
<tr><td>5 initial pilots</td><td>Community involvement in water monitoring</td><td>Technology deployment; workshops and educational training</td><td colspan="3">Collaborative water quality mapping and local solution design.</td></tr>
<tr><td>Improved design</td><td>Optimized design to maximize participation</td><td colspan="4">Continuous improvement of water sensors and App</td></tr>
<tr><td>Phase 1: Extended pilots</td><td>Development of water knowledge sharing</td><td></td><td></td><td>Technology deployment; educational training</td><td>Water knowledge sharing on the app and promotion of local solution design.</td></tr>
<tr><td>Phase 2: Promotion of collaborative water monitoring</td><td>Improvement of water quality and water resilience</td><td colspan="4">Evaluation of water quality improvement. Assessment of behavior changes</td></tr>
</table>

7. Research Outcomes Deployment:

Discuss the following issues: (maximum 1000 words)

- Specify the strategy for deployment or knowledge transfer of the research outcomes into a community context.

In the proposed project the target group will be community people with smartphone access in small Indian cities, particularly Bhuj, Patan and Palanpur in Gujarat, as well as the larger cities of Mumbai and Bangalore. In partnership with local NGOs Wells for India, SACIwaters, Trust for Research in Ecology and on the Environment (ATREE), Arghyam, and The Centre for Integrated Water Resource Management (C-IWRM) community leaders will be contacted. With the help of our local NGO partners and community leaders, we will be able to interact with people from the local communities in the most appropriate way.

For the pilot study, a one-week workshop will be organized to engage and inform the community people. The purpose of the workshop will be to teach the communities on how the technology is going to assist them to assess local water issues, as well as develop a basic understanding of the significance of the data they will collect and why water resilience matters. The sensors and mobile app uses will be demonstrated. Another purpose of the workshop will be to enhance the awareness about the drinking water quality monitoring and how best practice can enhance water resilience with a better water management. Community leaders will be asked to choose 50 people - Initiators (excluding children) from the community who will use the sensor, collect data and spread awareness on the ongoing initiative. Data will be collected and uploaded in the open database. The data will be accessible to every community member through the application. A continuous learning process will take place during the pilot in order to incrementally improve the collaborative water monitoring tools and platform in an iterative fashion.

For phase 1 of the study, the objective is to engage more communities in the study. These communities will be offered connectivity with the other communities, donors, and NGOs through the mobile collaborative water monitoring platform application. At this stage, the e-platform will enable knowledge and solutions sharing among the involved communities to implement grassroots water resilience project designs.

For phase 2 of the study, it is very important to consider if the water resilience of communities has improved through means including behavior change, knowledge enhancement, and strategic planning. These could include avoiding garbage disposal in the water bodies, using water conservation strategies, development of contingency plans, and more. Successful communities will inherently have more visibility and connectivity on the network to further develop. Results will be presented at the World Water Forum in Brasilia in March 2018.

- Identify any anticipated challenges in the deployment or knowledge transfer or research outcomes into a community context and how you plan to mitigate these challenges if they arise.

The water-bodies in the communities might not have the same characteristics during the collection of database as data points like pH levels, TDS, and turbidity of water have seasonal variability. Thus it might be a challenge to overcome the cross interference during sensing any particular contamination from water. This can be overcome through long-term monitoring, but to resolve this issue, a validation study will be done in standard lab set-up at our partner university, the Indian Institute of Technology (Mumbai).

- Address how you will identify opportunities for knowledge translation and end-user utilization in the development and application of the proposed innovations and technologies.

From the pilot study, mapping of contaminated water will be possible. Using the smartphone based app system, knowledge sharing among the communities and other stakeholders will be easier. Collection of data will be helpful for building the database. From phase 1 of the study through the smartphone app, community people will have the access to the data of the other communities. The data will help contextualize the safety or pollution of water bodies, as well as allow communities, decision-makers and NGOs to use the information to build water resilience. At the end of the project, sharing knowledge, experience, and solutions among the communities and relevant stakeholders will enhance the collective ability to better understand drinking water quality at different scales and ultimately move towards more water resilient communities.

- Identify what knowledge dissemination activities you will engage in to share the outcomes of your deployment initiative.

The outcomes sharing will use both onsite and remote dissemination activities.

Onsite, we will run workshops using the Participatory Rural Appraisal (PRA) methodology to directly interact with the stakeholders. Workshops will be organized in community spaces with the help of local partners who are cultivating deep relationships with stakeholders. Workshops will focus on communicating the importance of water issues, communicating how the technology works, and communicating how the monitoring of water quality can benefit stakeholders. In parallel to the workshop activities, research will be done to understand the impact of the sensing technology on group dynamics through social mapping, interviews, focus group discussions, semi-structured interviews and triangulation. To ensure that people are not excluded from participation, some communication will rely on oral and visual communication such as speeches, theatre, music, pictures, participatory mapping, and symbols.

Remote dissemination activities will take place on the mobile App and popular social media such as facebook and Whatsapp. The mobile application will offer gamification features to

incentives participants to deeper water monitoring activities and to share their results on social media. Personal relationships will be cultivated with participants who will receive personal messages and feedback depending on their involvement.

Dissemination of the outcomes both onsite and remote will be supported by the development of incentive programs. Incentive program will be developed at the community and participants scale. Community will be offered financial support, knowledge and network to improve water management. Individual will be offered community support, knowledge and network to improve their participation in collaborative water management.

8. Partner Involvement and Technology Utilization:

Discuss the following issue: (maximum 1000 words)
- Describe the specific role of partners involved in the project and how they will contribute.

The project will involve water sensing technology developers, water knowledge and governance disseminators, and local NGO partners.

- Water sensing technology developers are University of Alberta, Indian Institute of Technology and Akvo. The University of Alberta will provide sensing devices to the field officers located in India.

During all the project phases, University of Alberta main researcher Michael Serpe will interact on a minimum monthly base with field officers to receive updates and feedback on the operations. University of Alberta will incorporate field reports in the research and development process of more efficient water sensors. Multiple designs of the water sensors will be tried to maximize measurement accuracy water and citizen monitoring. Specifically, innovation will focus on developing instant feedback for the enduser.

During the pilot phase, the Indian Institute of Technology main researcher Mukherji Soumyo will be in weekly contact with to the field officers. Indian Institute of Technology will play a key role in the evaluation of the field measurements performed with University of Alberta sensing devices. Indian Institute of Technology will assist the field officers to certify accuracy of the measurements that were made during the pilot phase. During the phase 1 and 2, the Indian Institute of Technology will interact on a minimum monthly base with field officers to receive updates and feedback on the operations. These feedback will be incorporate in the research and development process of more efficient water sensors.

During all the project phases Akvo will have a minimal weekly contact with to the field officers. Akvo has developed the mobile app Akvo Caddisfly to proceed to water quality monitoring using smartphone. Akvo Caddisfly is an open source app that has been used to develop the tools mobile tools to read out University of Alberta colorimetric test from a smartphone. Field officers

communicate with Akvo officers to further develop the coding of a user friendly to facilitate users involvement in water monitoring.

- Water knowledge and governance partners are Waterlution and the World Youth Parliament for Water.

Waterlution coordinator Dona Geagea will work together with the field officers to run the workshops in India. Field officers will communicate field results to Waterlution. During phase 2, Waterlution will communicate field results among water organizations and bridge the community water adaptation projects with donors.

During all the project phases The World Youth Parliament for Water will have a minimal monthly contact with the field officers. The World Youth Parliament for Water will be involved in connecting field officers with water activist and communicating field results among water organizations. The World Youth Parliament for Water will be involved in bringing the results to the World Water Forum in march 2018 in Brasilia in order to bridge the community water adaptation projects with donors.

- Local NGOs partners are Sutradhaar Social Ventures, Wells for India, SACIwaters, Trust for Research in Ecology and on the and the Environment and The Centre for Integrate d Water Resource Management.

These local partners have been chosen because of their deep involvement with resolving water issues in Indian community. These partners have excellent relationships and confidence of local communities. Particularly our team members have developed previous work with Archana Tomar, director of Sutradhaar Social Ventures, in the mountain community Leh, Ladakh region and the Kondakarla community in Visakhapatname in Andhra Pradeshbe state. Our team collaborated with Wells for India in communities of Rahajastan. Our team member Dani Lindaohood has been doing some field work with communities in Bangalore with the assistance of Trust for Research in Ecology and on the and the Environment and The Centre for Integrated Water Resource Management officers. Finally we got in contact with SACIwaters officers is particularly involved in the monitoring of arsenic in water who offered assistance to work with Indian communities. We have close relationships with all our local partners. The local partners we have identified have a deep interest in the technology to be deployed as they are convinced it would facilitate their operations. Local partners officers will provide daily assistance to field officers in their work with community. They will help with logistic, communication and daily work on the field.

9. Synergies and Cross Fertilization with Other Projects

Discuss the following issue (maximum 500 words)

- Describe opportunities for how your technology may work synergistically with other projects in IC-IMPACTS network or with other project outcomes within your demonstration community to have multiplier effects for the inhabitants of the community (refer to the IC-IMPACTS Research Project website: http://www.ic-impacts.com/research/research-projects

The project holds close synergies with Dr. Khalse's project (Laval university), on biosensor applications for water quality monitoring and Dr. David Junker's (McGill University) project on development of low cost water monitoring kit with aptamer-based sensors. Both the projects could potentially be a source of valuable feedback and inputs for our work, particularly concerning the optimization of the water sensors design.

Apart from these, Dr. Clarence de Silva's (UBC) project on 'development of an 'ICT platform for water quality monitoring' is closely related to the collaborative work with Akvo on developing open-source water platform. Further, Dr. Jamal Dean's project on pH and chlorine sensor development using palladium and carbon based materials could also be a very valuable input for our project.

In India, our NGO partners have many different projects for water security, behavior change, policy development, and adaptive co-management which will be directly benefited or enhanced by this project.

10. Highly Qualified Personnel Training Summary:

Summarize the quantity and identify the role of graduate students, other highly qualified personnel (HQP) or professional practitioner training in the proposed project and summarize the anticipated nature of their role in the research project.

HQP Training Summary			
Level of HQP	**Number participating from Canada**	**Number participating from India**	**How involved in project**
Masters Students	**Olivier Saint-Jean, Danielle Lindamood**		**Research and partnerships**
Doctorate Students	**Fuhar Dixit, Wei Zhang**	**Sutapa Chandra**	**Research and partnerships**
Professor Fellows	**Michael Serpe**	**Soumyo Mukherji**	**Technology providers**
Professional Practitioners	**Karen Kun**	**Gaspard Durieux, Priyanka Ghosh, Srinivasa Rao Podipireddy, M. Lord Savariraj**	**Field operations and logistics**
Other HQP		**Archana Tomar**	**Facilitation and community engagement; translation**
Total # HQP	**6**	**7**	

11. Highly Qualified Personnel Training – Unique Training Opportunity:

(maximum 1000 words)

Describe the unique potential training opportunities, opportunities for training within communities, and other opportunities to interact with end-user communities.

Within this project, the opportunities for providing communities with environmental education, citizen training, knowledge transfer skills, and continued learning are numerous. The activities will encourage interactions among all the individuals involved, developing skills for effective communication and partnership.

The onsite demonstration of the technology will be done by the field officers team, and will garnered significant knowledge. Through discussion amongst the local and international team, as well as through group presentations and conferences, we believe the team will be poised to demonstrate the technology to the rural communities. Through the demonstration and workshops, the team hopes to establish close communication with the chosen communities.

Because our objective is to design a new technology for the services of the communities, we will develop a strategy to maximize the knowledge transfer amongst our team, to the community members, and between communities and stakeholders. Community members and other stakeholders will benefit from training on the use of technology and how it can be used for improving local water resilience and livelihood.

Team members will benefit from accrued local knowledge on water management and cross-cultural expertise, as well as from training and experience in the field of innovative water analysis techniques. The researchers and field officers will collaborate on designing efficient biosensors, optimizing the dynamic of light scattering and the processing of Fourier Transform analysis on the mobile App. These are techniques needed in the job market of materials and will prepare the candidates for the job market in academia or industry. Moreover, the team members will gain work experience in a networked multicultural environment. In all, these skills combined with the research skills developed will prepare the team members well for any future prospect.

12. Requested Budget from IC-IMPACTS and Funding from Other Sources

Use the budget form to enter the project budget requested from IC-IMPACTS and as provided from other funding sources.

IC-IMPACTS Portion of Project Budget Request			
	0-12 months	13-24 months (if required)	Total
Salaries to students (including benefits)			
Bachelors - Canadian and Permanent Residents	$0	$0	$0
Bachelors - Foreign	$0	$0	$0
Masters - Canadian and Permanent Residents	$10 000	$0	$10 000
Masters - Foreign	$7 000	$0	$7 000
Doctorate - Canadian and Permanent Residents	$8 000	$0	$8 000
Doctorate - Foreign	$5 000	$0	$5 000
Salaries to non-students (including benefits)			
Post-doctoral - Canadian and Permanent Residents	$0	$0	$0
Post-doctoral - Foreign	$0	$0	$0
Technical / Professionals / Others (Described in Note 1)			
Research Technician (analytical support)	$10 000	$0	$10 000
Other	$0	$0	$0
Other	$0	$0	$0
Other	$0	$0	$0
Travel			
Field work	$1 000	$0	$1 000
Conferences	$0	$0	$0
Collaboration / consultation	$0	$0	$0
Student Exchanges	$0	$0	$0
Project Related Travel	$8 000	$0	$8 000
Other (described in Note 2)	$0	$0	$0
Research Equipment			
Purchase or rental	$1 800	$0	$1 800
Maintenance and/or operating costs	$0	$0	$0
User fees	$1 144	$0	$1 144
Materials, supplies, and other expenditures			
Research Materials (described in Note 3)	$3 000	$0	$3 000
Other Supplies (described in Note 4)	$0	$0	$0
Knowledge Mobilization and Technology Transfer			
Publication expenses	$0	$0	$0
Field Trips	$0	$0	$0
Prototyping	$0	$0	$0
Policy Development		$0	$0
Workshops		$0	$0
Other KMTT expenses (described in Note 5)	$0	$0	$0
Other (specify below)			
Other (specify)	$0	$0	$0
Other (specify)	$0	$0	$0
Other (specify)	$0	$0	$0
Other (specify)	$0	$0	$0
Total	$54 944	$0	$54 944

Note 1: For our demonstration project to be fully successful we intend to increase student participation in the execution of the deployment within community contexts. We sollicitate extra 10 000 CA$ from IC IMPACTS to perform. This money will be used to facilitate participation of all team members in field operations: workshop, sampling, analysis and design set-up for large scale water remediation. This budget is necessary to provide all team members with field experience and work experience in a networked multicultural environment; that is with skills that will prepare team members well for future prospect.

Note 3: consumables required to generate materials,e.g., gloves, pipets, kim wipes, etc. Also need solvents, polymers, monomers, and various other chemicals

In addition, please address in writing each of the following issues: (maximum 500 words)

a) Describe how any leveraged sources, funding or programs available to you will contribute to the budget and enhance the outcomes of this project or make it more achievable.

The below table details how the funding and contributions that will enhance the outcomes and make our objective more achievable.

Activity	**Contribution**	**Remarks**
Smart Phone based App optimization	$5000 - Akvo	The source code is available. This budget provision is to improve the design of the user interface based on the results of the study
Testing equipment	$5000 - University of Alberta	Includes testing of the sensing equipments, consumables and materials, sample analysis charges
Sensor deployment	$3500 - University of Alberta	For the study sites, 50 sensors will be distributed to 50 users of the community.
Validation of study	$10,000 - Indian Institute of Technology Bombay	Optimization of the sensor according to the variation of pH, turbidity of water has to be done. Validation study will be done to test the reliability and robustness of the sensor for field application.
Training of the community people	$4000 - Waterlution	1 week workshop will be organized on each pilot sites to train the community people on water resources, the sensor uses, logging data, and using the mobile interface.
Development of water design project in the community	$5000 - SACIwaters	Provision to implement water project appropriate to community needs and location as designed through a facilitated process using adaptive co-management strategies.

Total	$32500	

b) Describe budget provisions for knowledge dissemination, knowledge translation and technology commercialization activities.

Workshops for training local community members are planned within the budget, for 4000$.

Furthermore, The smartphone platform will be connected to a water encyclopedia, water knowledge-sharing platform and other educational propositions.

The deployment of our sensing technology in India will be the proof of concept of collaborative water management. Outputs will consist of an optimized sensing device to collaboratively test and improve water quality. At the end of the deployment period, our team will start commercialization of a new technology appropriate to develop collaborative water management.

Outtakes / Extras :

Often, collaborative pilots have been implemented to collect data on a very precise location and over a short period of time. The research will assess the drivers of longer-term citizen and community involvement, focusing on assessment of different drivers of behavior and social learning processes in different locations. This will demonstrate which strategies are best suited to engage citizens and communities to locally tackle water issues and spread water knowledge among populations.

This research aims to develop a framework to integrate citizen and community participation in the development of water resilient policy making. The research will assess different collaborative water monitoring strategies and their capacity to develop solutions at local level. This research will develop, in partnership with NGOs and The World Youth Parliament for Water, a bridge between grassroots and top-down water adaptation policies. A road map to integrate collaborative water monitoring in the development of water resilience programs at the World Water Forum 2018 will be developed.

In order to optimize the design of the water sensor technologies and mobile interface, we will provide different sensors to the participants in order to evaluate how the design affects the participation in the water monitoring.

Following quotes attest of the need for our technology in Canada and in India:

- **Lalita Bharadwaj, an associate professor of toxicology at the University of Saskatchewan and a co-lead of the school's Safe Water for Health Research Team.**

"Ensuring timely and easy detection of contaminants is one way to improve water monitoring in First Nations communities"

"In some communities that don't have appropriate onsite testing equipment, water samples have to be sent out to accredited laboratories and they have to wait to hear back about results"

"A quick realtime monitoring device would provide communities the capacity to monitor their water for microbial contaminants in a timely manner and also allow for effective and timely communication of any risk if detected"

" acking access to clean water affects physical and mental health, cultural traditions and can result in lost economic opportunities – not to mention the challenges it creates for day-to-day use".

- **Barry Strachan, the public works manager with Keewaytinook Okimakanak, the Northern Chiefs Council that represents six communities in Ontario**

"Having a device that can detect biological contamination in real time would be a breakthrough in water treatment,"

"Presently we must incubate water samples for 24 hours to detect the presence of these pathogens. This means that, if coliform bacteria is present, the consumers may have been exposed to the pathogens for at least 24 hours,"

"An effective strategy will require more than investments in infrastructure, he added. First Nations also require assistance in developing operational and management capacity to sustainably manage their water and wastewater systems. Investment in training and capacity building is more important than investment in water treatment facilities in my opinion."

- **Assembly of First Nations National Chief Perry Bellegarde** said in an August news release, it is "completely unacceptable that there are more than 100 First Nations communities in this country that do not have access to safe drinking water."

"The serious risks relating to First Nations drinking water are well-known and well-documented. It's time for action now. First Nations citizens are suffering," added AFN Manitoba Regional Chief Kevin Hart, who holds AFN's portfolio on Water, Housing and Infrastructure.

Bharadwaj suggested “solutions to the issue may gain momentum when there are strong relationships built on trust and respect as well as understanding among the parties involved in First Nations Drinking Water policy regulation, management and monitoring.”[8]

END OF APPLICATION
SUBMIT ALONG WITH ALL OTHER REQUIRED FORMS USING ON-LINE APPLICATION PORTAL ON THE IC-IMPACTS WEBSITE.

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT
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[8] https://www.canadiangeographic.ca/article/university-alberta-researcher-developing-simpler-way-test-water-quality