Living Lakes CANADA

REPORT

COLUMBIA BASIN WATER HUB

A TRANSBOUNDARY WATER DATA SOLUTION FOR THE COLUMBIA BASIN

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BACKGROUND AND ACKNOWLEDGEMENTS

This report by Living Lakes Canada is a product of collaboration between non-profit water stewardship groups, Indigenous communities, academia, industry and government working together to increase climate adaptation options and support the longer term viability of natural ecosystems and ecosystem services within the Canadian Columbia Basin.

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Contact cbwaterhub@livinglakescanada.ca

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BC Hydro, Canadian Digital Technology Supercluster partners (Carl Data Solutions, Teck Resources Ltd., Microsoft, Astra Smart Systems, i4C Innovation, the University of Victoria and Genome BC), Columbia Basin Trust, EcoCanada, Fisheries and Oceans Canada, Healthy Watersheds Initiative partners (Stronger BC, Real Estate Foundation of BC, Watersheds BC), Kicking Horse Coffee, LUSH, MakeWay, RBC Blue Water Project, RBC Tech for Nature, Regional District of Central Kootenay, Sitka Foundation, and the Vancouver Foundation.

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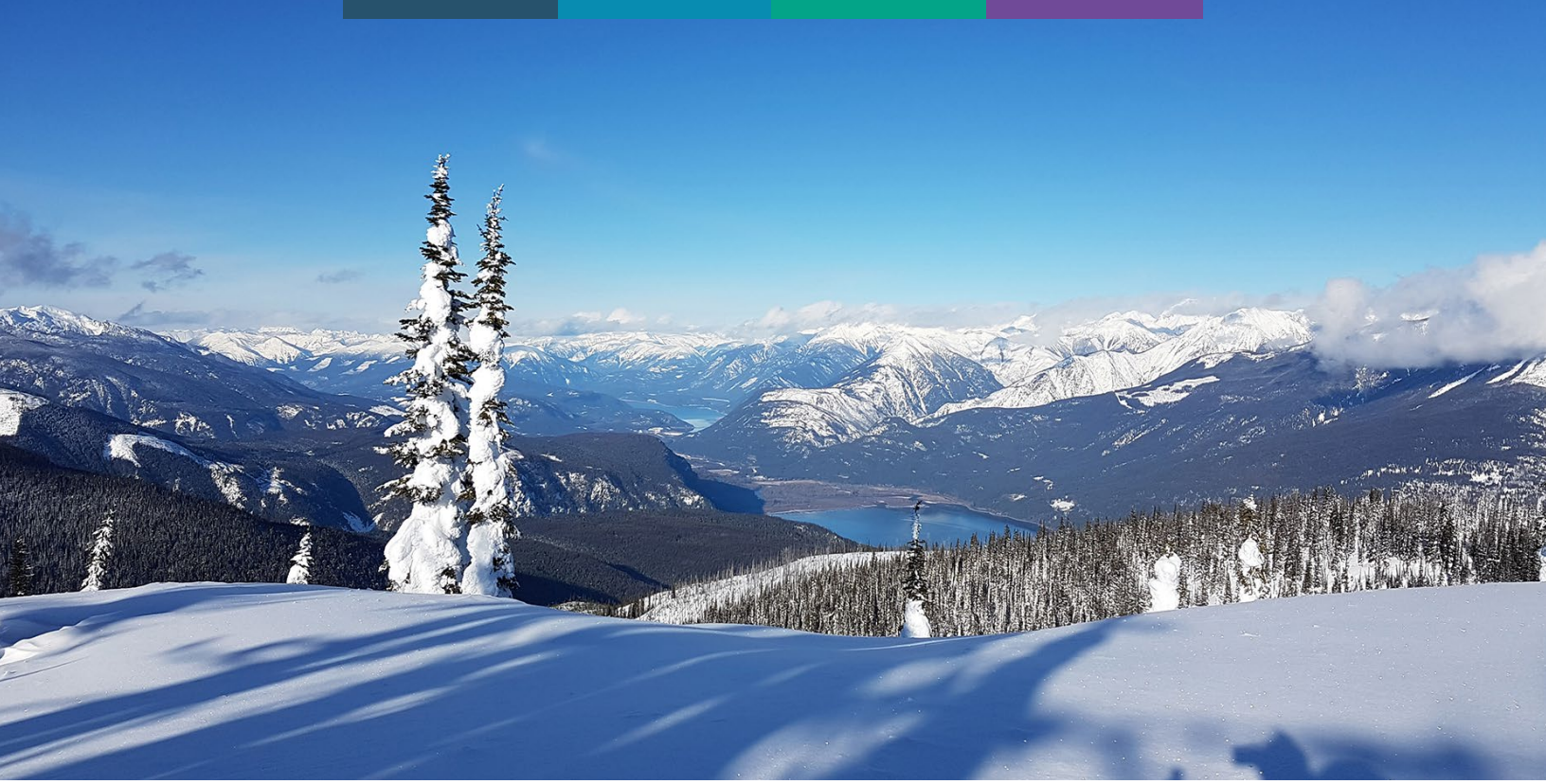


EXECUTIVE SUMMARY

Over the past two decades, a series of reports projected the impacts of climate change on hydrological cycles in the Canadian Columbia Basin, which are now playing out. Given cumulative impacts and the mounting pressures on water in the Columbia Basin, collecting, sharing, and using water data to inform water use and distribution is essential. Water-related data is used by decision makers to understand freshwater needs for the viability of watershed health and the sustainability of human communities.

In the Columbia Basin, research has concluded that there are significant water data gaps, which means there is insufficient knowledge for the informed water management decisions needed for increased climate adaptation options in many of the Basin's hydrologic subregions.

A coordinated water monitoring approach with a central repository to store and access current and historical water data was needed. In response to this need, Living Lakes Canada, guided by a steering committee, developed the Columbia Basin Water Monitoring Framework and the associated Columbia Basin Water Hub. The Water Hub, formally launched in March 2021, supports data-driven decision making for a holistic and transparent approach to water management in the Columbia Basin.

Users can now access data collected by community-based monitoring groups, government, industry, academia and consultants from a single repository. The Water Hub database has features for easy access to data including providing links to other existing water data portals relevant to the Columbia Basin. Customized support is provided for each contributor to ensure that the data sharing process is accessible to people of all technical levels.

The benefits of this project for water stewardship groups in the Columbia Basin include: the preservation and increased access to water-related data; improved data collection and management practices; cross-sector relationship building; and the prioritization and coordination of monitoring efforts.

This innovative and collaborative project has also garnered interest from groups outside of the Columbia Basin and can be used as a template model for other regions across Canada and internationally.

INTRODUCTION

Climate impacts are taking place in the Canadian Columbia Basin, including extreme temperature and precipitation, flooding and fire events, peak flow for streams, and peak glacial melt[1]. Water quantity, quality (temperature, acidity, turbidity, etc.), and timing of flow are changing. Climate impacts are present in both high and low elevation lake ecosystems, soil moisture, wetlands, and groundwater aquifers in the region.

Given cumulative impacts and mounting pressures on water in the Columbia Basin, collecting, sharing, and using water data to inform water use and distribution is essential. Water-related data is used by decision makers to understand freshwater needs for the viability of watershed health and the sustainability of human communities.

Water data is being collected by organizations across the Canadian Columbia Basin, including community-based water stewardship groups; municipal, regional, Indigenous, provincial and federal governments; consultants; and industry, but prior to the launch of the Water Hub the data was often not accessible to those outside of the monitoring organization.

COLLABORATIVE DEVELOPMENT PROCESS

Background

The development of the Columbia Basin Water Hub has been informed by reports detailing the impacts of climate change on the Columbia Basin, and the state of water monitoring in the Basin.

In 2006, a Pacific Climate Impacts Consortium (PCIC) report prepared for Columbia Basin Trust, Preliminary Analysis of Climate Variability and Change in the Canadian Columbia River Basin: Focus on Water Resources[2], assessed the impacts of climate change on the Basin and identified the importance of water monitoring programs to fill important water knowledge gaps, allowing for more informed decision making. A follow up report by PCIC in 2013, Climate Extremes in the Canadian Columbia Basin: A Preliminary Assessment[3], predicted many of the climate change impacts currently affecting the Columbia Basin.

In 2017, a report released by the Columbia Basin Trust examined the status of knowledge of water quality and quantity in the Columbia Basin. The report, Water Monitoring and Climate in the Upper Columbia Basin, Summary of Current Status and Opportunities[4], highlighted data gaps and the need for a coordinated monitoring effort and “streamlined archival and retrieval technologies” for water data.

This report prompted Living Lakes Canada to organize and co-host a conference (An Open Source Data Dialogue Towards a Columbia Basin Water Monitoring Framework) in late 2017 in Invermere, BC[5]. The need for a water monitoring framework and data hub was agreed upon by the water data experts in attendance from across North America. This conference was the catalyst for the Columbia Basin Water Monitoring Framework and collaborative Water Hub development process.

Development of a Monitoring Framework and the Columbia Basin Water Hub

Following this conference, individuals from all levels of government, First Nations representatives, members of community-based monitoring groups, databases managers and professional consultants formed a steering committee composed of both volunteer and paid advisors who pooled their expertise to envision a water data hub for the Upper Columbia Basin. The steering committee provided insights at different stages of the database development.

Their recommendations included creating a simple interface, ability to support various file formats, inclusion of metadata standards, clearly defined data ownership, and that the database be "secure, transparent, autonomous [and], free of bias." Throughout the development process, the operators of existing databases such as the Skeena Salmon Data Centre[6] and DataStream[7] also provided valuable input.

Once the purpose and desired features of the proposed database had been defined by the steering committee, the process of building the platform itself began. The CKAN (Comprehensive Knowledge Archive Network)[8] system was selected and approved by the steering committee to serve as the database platform, and a web developer was contracted to deploy the site and incorporate the custom features deemed necessary during the consultation process. Efforts were made to ensure that the Water Hub would adhere to FAIR data principles[9], meaning the data would be Findable, Accessible, Interoperable and Reusable.

Throughout the engagement and development process, questions arose regarding how the Water Hub, a single platform, could display data that had been collected using many different protocols, standards, and instruments. It was recognized that disallowing the upload of data that did not conform to a specific protocol or standard would prohibit many contributors from sharing their data or knowledge due to the diversity of monitoring that occurs throughout the Columbia Basin.

Instead, it was decided that contributors would be encouraged to share detailed metadata along with their data. Metadata includes information about the data, such as the site location, data collection, data processing and QA/QC, instrument specifications and more. By examining the metadata, data users could assess whether data would be appropriate for their purpose. A grading system was also designed to make data users aware of the varying levels of data quality and different standards that resources in the Water Hub may adhere to.

In 2020, iterative testing of the database with stewardship groups from around the Basin was undertaken. A series of three instructional webinars was delivered, providing potential users with an overview of the user interface and data upload process. Feedback from webinar participants included concerns about the complexity of the upload process, and whether community-based monitoring groups would be able to undertake this.

In January 2021, a survey was released to better understand the needs and expectations of potential database users, both for sharing data and for accessing it. Through this survey, more information was gained regarding the QA/QC processes that monitoring groups were undertaking, user expectations, and issues that respondents had experienced when using other databases.

Based on the feedback from the webinars and survey, efforts were made to simplify the upload process as much as possible within the parameters required by the CKAN platform, and without omitting the metadata and QA/QC elements that survey respondents indicated were important for data use. Upload templates and data management plans were revised, and instructional materials were created.

The Columbia Basin Water Hub officially launched to the public in March 2021.

Supporting the Data Needs of a Priority Monitoring Matrix

In the summer of 2020, as progress was being made towards finalizing the Columbia Basin Water Hub, Living Lakes Canada convened an online workshop of 50 invited senior hydrologists from federal and provincial governments, academia, and industry to discuss a proposed science-based approach for building out the water monitoring network required to fill the data gaps that had been identified in earlier CBT reports.

The workshop outcomes and proceedings[10] demonstrated participant consensus that a water balance approach would provide a scientifically defensible and widely accepted framework for a Priority Monitoring Matrix, the tool to help prioritize watersheds for monitoring to be developed in consultation with Indigenous groups; water stewardship groups; industrial/commercial water users; and municipal, regional, and provincial governments to reflect local priorities. In 2021, Living Lakes Canada commissioned the development of a Terms of Reference[11] document for the Priority Monitoring Matrix outlining the next steps for prioritizing and collecting important water data in the Basin with an accompanying preliminary budget to implement monitoring required over the next decade.

The Columbia Basin Water Hub will serve as the central repository for the data collection guided by the Columbia Basin Water Monitoring Framework.

OPERATION & CONTINUED DEVELOPMENT

Since the public launch of the Water Hub in March 2021, Living Lakes Canada has supported the ongoing operation and continued development of the database through community engagement with both contributors and data users, facilitating the data sharing process, and system maintenance.

Internal processes related to the operation of the Water Hub, including QA/QC and data management, are defined in the Columbia Basin Water Hub Data Management Plan and Operational Framework[12]. A QA/QC process was developed to maintain data quality throughout the upload process. A grading system was designed to make data users aware of the varying levels of data quality and different standards that data in the Water Hub may adhere to. The QA/QC processes are summarized in the Data Management Plan and Operational Framework and are further detailed in the Water Hub QA/QC and Grade Procedures[13].

Initially, the Water Hub team uploaded data on behalf of contributors to ensure that the database,

templates, and internal processes were functioning as expected. The Water Hub team now trains contributors to upload their own data while providing continued support where needed.

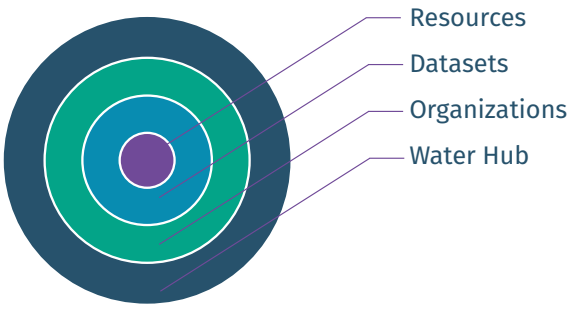
As the volume of data hosted by the Water Hub increased, additional features were added to assist data users in finding datasets of interest including the clustering of nearby data points on the map, and the ability to filter data by date.

The operation of the Water Hub is participatory, and incorporates feedback received from users. Contributors have expressed interest in enhanced data analysis and visualization tools, and the development of these tools is underway.

The Water Hub team continues to build relationships with stewardship groups, local governments, Indigenous governments and knowledge holders, and the private sector to support and facilitate the upload of their data.

FEATURES OF THE WATER HUB

Several factors have contributed to the success of the Water Hub, including the technical features of the database and the customized support offered to each contributing group.



THE WATER HUB STRUCTURE

Technical Features of the Database

The CKAN platform was selected because it offered functions that were identified as important during the consultation process with the steering committee. The user interface is simple and familiar for many users since numerous other databases use the platform, including the provincial BC Data Catalog[14].

FLEXIBLE

SUPPORT FOR MANY FILE FORMATS

The CKAN platform is not limited to hosting data in tabular or spreadsheet format. PDF, JPEG, XLSX, CSV, HTML links, GIS files and other formats can be shared. A wide range of different types of information are available through the Water Hub, including reports summarizing data analysis, descriptions of historical use of water bodies, and site photos. Links to data on other platforms can also be shared through the Water Hub, increasing the amount of data that can be accessed through the Water Hub without duplication of files.

SEARCH ABLE

DATA SEARCHING, FILTERING AND CATEGORIZATION

Users can easily search for data by location, type of waterbody, keywords or contributor. A Map Search[15] function was custom-made by the database developer, allowing users to explore and identify monitoring locations spatially. This provides a high level snapshot of the regions that have greater data deficits, which will help inform the development of the Priority Monitoring Matrix for the Columbia Basin.

DATA GOVERNANCE

Contributors maintain ownership and control over how their data is shared. CKAN allows each group sharing data to create an Organization profile page, which includes their logo, a description, and all data shared by the group.

Metadata fields have been created to allow groups to declare who uploaded the data, who collected the data, and their preferred citation. Groups can also select their preferred licensing, which specifies the types of use and attribution that are acceptable for their data (e.g. allowing for commercial use or strictly non-commercial use).

One or more individuals from the data sharing group receive Administrator permissions for the Organization, allowing them to add, modify or delete their data and add new Members. Members can also be added to the Organization as Editors or Members with fewer permissions. Through these mechanisms, contributors maintain ownership and control over their data and can ensure that it is being shared according to their preferences and needs. The Organization feature also ensures that those sharing data are recognized for their contributions and have a convenient link to share with others interested in accessing their data.

Through these features and tools, the Columbia Basin Water Hub adheres to the First Nations Principles of OCAP® (Ownership, Control, Access, and Possession)[16], which provide a framework for storing, sharing, and using First Nations' data.

DATA VISIBILITY

Data visibility can be set as either Public, meaning that anyone can view and download the data, or Private, meaning that the data is only visible to Members of the Organization without being available to the public This function can also be used to allow individuals from the Organization to review data that has been uploaded and provide feedback before it is set to Public visibility.

METADATA

Metadata, information about the data, is included alongside all resources on the Water Hub. This includes details about the site location, data collection, processing and QA/QC, instrument specifications and more. This information allows data users to further understand the data and make informed decisions regarding whether it will be suitable for their needs.

API

APPLICATION PROGRAMMING INTERFACE (API) AND APPLICATION DEVELOPMENT

CKAN offers a versatile Application Programming Interface (API) which provides users with the ability to access vast amounts of data quickly. APIs are an efficient way to access and manage data that exists online and are commonly used to bring data into external application developments. The API also allows for the automation of various tasks, such as the upload of data, sharing of data, and carrying out QA/QC processes.

In the age of Big Data, the API allows for the integration of Big Water Data into the creation of applications that provide decision makers, industry, and citizens with insight into their water resources. For example:

- The creation of a web or mobile application that uses water quantity data from the Water Hub to provide farmers with a seasonal forecast for water availability.
- The fast query of vast amounts of water data through the API into an application that summarizes the data into knowledge, to facilitate efficient decision making (e.g., managing flows for aquatic ecosystem health versus power generation).

Customized Support and Accessibility

The customized support offered to each data sharing group by the Water Hub team has led to successful data sharing relationships with a wide variety of groups. The existing relationships between Living Lakes Canada and community-based monitoring groups in the Basin were integral at all stages of the Water Hub development and launch.

DATA PLANS

DATA MANAGEMENT PLANS ALLOW FOR SUPPORT FROM WATER HUB

At the beginning of the data sharing process, each contributing group is encouraged to complete a Data Management Plan, using provided templates. These documents detail the group's monitoring programs, data management practices and how the Water Hub can best support the group. Preferences for methods of communication, file sharing and display of data are also identified. Research[17] has shown that creating Data Management Plans can improve collaboration, communication, and data management for community-based water monitoring groups.

Due to the diversity of groups collecting data in the Basin, there is considerable variation in capacity, digital literacy and interest level across contributors. Using the information included in Data Management Plans and through building relationships with each group, customized support and guidance from the Water Hub team can be provided. Some groups have requested support to manage the formatting and upload of their data, while other groups have conducted data

uploads independently after receiving training from the Water Hub team. In either case, the Data Management Plan provides information required to collaborate with the contributor efficiently and upload the data properly.

DATA SHARING AGREEMENTS

Communication and clearly defined expectations have been critical in maintaining strong relationships with contributors. A data sharing agreement is signed with each group to clarify the terms of data sharing, and the rights and responsibilities of each party. The Water Hub has created a data sharing agreement template, which groups can either sign as-is or request modifications to meet the needs of their group. When multiple parties are involved with monitoring and data collection, efforts are made to obtain consent and sign a data sharing agreement with all relevant parties.

ACCESSIBILITY

Efforts are made to ensure the process is accessible to anyone who is interested in sharing data. The Water Hub uses a "technology agnostic approach," and the team uses the technologies and platforms that each contributor is most comfortable with, allowing for a flexible and adaptive process to meet the needs of each contributing group. The team also offers customized support to ensure access for people with varying levels of digital literacy and access to technology.

There is continued opportunity to facilitate improving data management practices and data literacy for contributors and data users through research, education and training. Since digital technologies are constantly evolving, staying relevant and current in this realm is very necessary.

WATER HUB FUNCTION OUTCOMES

Data Access

Users can now access data that has been collected by community-based monitoring groups, governments, industry, and environmental consultants from a single repository. Much of the data that has been shared was not previously available online. Data available through the Water Hub can be used for many purposes (e.g., support the Water Balance Approach and subsequent water budgets; support the assessment of the condition of watersheds across the Basin; examine the impacts of climate change on water timing, flows and quality; gain understanding of current data gaps; and create a "state of the Basin water data" report).

Preservation of Data

Prior to the development of the Water Hub, most of the data was held on private computers, and at risk of being lost due to changes in programs, technology or as people retired. This data is now archived with detailed metadata through the Water Hub and will be useful to identify long-term trends and climate change impacts in the Columbia Basin.

Improved Data Management

Data contributors indicated that completing the Data Management Plan templates and engaging in the data sharing process has helped to identify opportunities for improvement in their own monitoring, QA/QC or data management practices. Completing Data Management Plans through the Water Hub has created a greater awareness of the need for detailed record keeping, conducting QA/QC, and proper data management, which will increase the overall standard of data collection and management in the Basin.

Additionally, several monitoring groups have evolved, collaborated, or ceased to operate, resulting in partial records for some sites with data often held by multiple groups without clarity surrounding who had responsibility for the data management. The Water Hub support team met and worked with all groups to organize and document as much data and associated metadata as possible, thereby improving the internal data management practices of the groups involved and preserving this data for future use.

Relationship Building

The relationships built between the Water Hub team and the data contributors allow for continued collaboration and increased coordination of monitoring activities across the Basin.

Monitoring Prioritization

Identifying where monitoring is currently occurring supports the initiative to prioritize water monitoring needs as guided by the Columbia Basin Water Monitoring Framework.

APPLICATIONS OF WATER DATA

Easily accessible water data will facilitate informed decisions regarding the protection and use of the Columbia Basin's freshwater supply. The data hosted by the Water Hub is contributing to the establishment of a unified monitoring network in the Basin based on the Priority Monitoring Matrix developed in consultation with First Nations, local governments and communities to reflect local priorities for expanded monitoring while informing a scientific water balance approach[18]. This collaborative approach will provide the optimal configuration for tracking and understanding the full range of implications of climate change on the water supply for Basin ecosystems and its people.

The Water Hub is the primary host of the provincial Foreshore Integrated Management Planning (FIMP) data. FIMP is a methodology developed in partnership with Fisheries and Ocean Canada. It maps shoreline habitats, assesses habitat value and establishes Shoreline Development Guidelines to conserve ecosystems, support climate resiliency, protect species of conservation concern and provide best management practices to decision-makers, stakeholders, and shoreline property owners. FIMP is used by municipal and regional governments to support the development of lake management plans which can inform and/or be adopted by Official Community Plans for foreshore zoning and related land use decisions.

The Water Hub also supported the Watershed Governance Initiative (WGI) Data Portal and Story Map[19] created by the Regional District of Central Kootenay to highlight how RDCK communities are responding to the pressures faced in their drinking water watersheds

Data from the Water Hub has been utilized for academic research projects, and these opportunities continue to be explored through partnerships with Selkirk College, College of the Rockies, University of British Columbia, University of Victoria , Simon Fraser University, University of Acadia , University of Guelph, University of Sherbrooke, University of Manitoba, University of Waterloo, University of Saskatchewan, University of Northern British Columbia, University of British Columbia Okanagan and other post-secondary institutions.

In the future, the Water Hub may provide analysis of the hosted data through watershed report cards, dashboards or other formats. This will allow users who do not have a background in water monitoring or data science to benefit from the data that is available.

Living Lakes Canada partnered with a consortium of organizations on a project funded by Canada's Digital Technology Supercluster called the Fresh Water Data Commons[20] led by Carl Data Solutions, which includes Teck Resources Ltd., Microsoft, Astra Smart Systems, i4C Innovation, Living Lakes Canada, the University of Victoria and Genome BC.

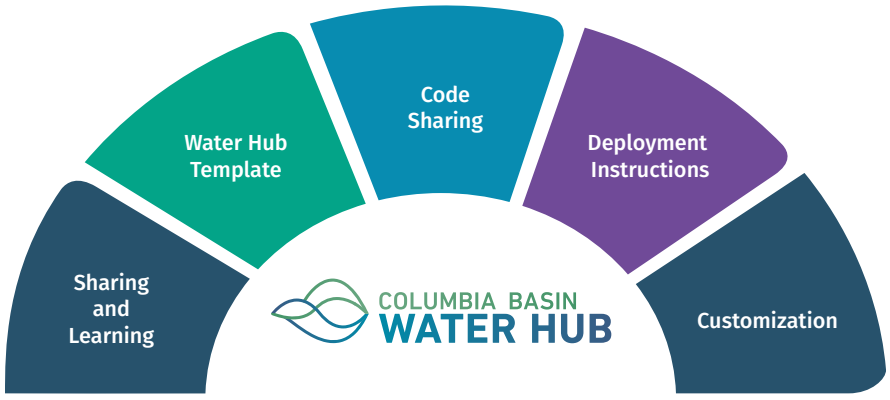
The goal of the Fresh Water Data Commons was to develop and deploy a platform for harnessing water monitoring data from an entire river basin to better understand the health of the surrounding ecosystem. To help test proof of concept and business model, Living Lakes Canada supported this pilot-only project in planning, site selection, and station installation. The project resulted in the installation of a low cost and wide area network of sensors in the Anderson Creek Watershed, close to Nelson, BC, and the creation of a commercial data analysis software tool called FlowH2O[21].

Through the use of this sensor network and software platform, water balance models can be created, similar to those proposed by the Columbia Basin Water Monitoring Framework. Data collected and analyzed through the products of the FlowH2O platform once proven can be made available through the Water Hub, allowing communities, industry, and decision makers access to near real-time data necessary for climate adaptation.

Living Lakes Canada continues to advocate for the use of community-based water monitoring data in decision making and to further the understanding of climate impacts on smaller freshwater systems, thereby allowing for increased community adaptation options.

RECOMMENDATIONS

The continued development of the Water Hub is an iterative and inclusive process, involving various groups across the Columbia Basin and subsequent sharing of our work with others throughout the province, Canada, and internationally. There has been interest in the Water Hub from numerous organizations including other non-profits, NGOs and various levels of government.



To support building climate resilient communities, Living Lakes Canada envisions a network of community-led Water Hubs throughout other river basins in British Columbia and Canada. Our recommendations include:

1. Using the Columbia Basin Water Hub as a template for the standardized creation, deployment, and maintenance of regional Water Hubs. This can be achieved through the use of technology tools such as GitHub[22] for sharing code, which, combined with either physical or cloud servers, can provide an efficient, customized, and community-managed water-focused repository. Alongside new Water Hubs, a website that serves as the confluence of all the new Water Hubs should be created to make access to the network of Water Hubs easy and efficient.
2. The creation of community standards that provide the opportunity to increase data sharing and comparison between basins, and provide the tools for decision makers to use the data in these repositories. These standard practices will ensure that important water data is easily accessible, comparable, and usable in water management contexts..
3. Utilizing a “train-the-trainer” approach, combined with a potential fee-for-service for the creation, deployment, and maintenance of new Water Hubs in order to overcome the challenge of the technology and computer science knowledge needed to deploy Water Hubs in other river basins. This creates opportunity for other organizations to take on the management of their own Water Hub, or for Living Lakes Canada to support the operation of Water Hubs for those organizations that do not have the capacity to manage this.

Growing a network of Water Hubs creates an opportunity for increased inclusion of the community-based water monitoring data shared through these data portals into the decision-making process, informing policy creation that aims to support the balance of ecosystem function and human activities.

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