



**Pacific Climate
Impacts Consortium
Strategic Plan
2021-2025**

October 2021

Introduction

PCIC is a regional climate service provider dedicated to ensuring the provision of quantitative, high-quality climate information to stakeholders and the public in BC and more widely. PCIC considers itself to be a competent, innovative and reliable climate service provider that works at a very high level of technical proficiency. Motivated by our stakeholders' needs, PCIC bases its services on results obtained from the global climate research community and its own applied, regional climate research. It also works to increase the capacity of others to use climate information and understand its limitations.

PCIC works with users to understand what information they require and how that information will be applied. It advises users on the suitability of these applications, accounting for both quantified and unquantified sources of uncertainty, and in cases where confidence in the information is insufficient, may suggest alternative types of information and approaches to its use to help users reach their objectives. PCIC does not, however, have the capacity to develop climate change adaptation and mitigation solutions. Rather, we view our work as enabling and strongly complementing the portfolio of solutions options that are being developed by our sister organization, the Pacific Institute for Climate Solutions.

The work that we do occurs in the context of a climate that has changed considerably over the past century, and that will change further over the coming decades. The Canada's Changing Climate Report (CCCR, 2019) indicates that annual mean temperatures in BC rose by 1.9°C between 1948 and 2016, with double that amount of warming in winter (3.7°C). Globally, the annual mean temperature is now about 1°C above pre-industrial levels¹. While information on precipitation is substantially less certain, CCCR (2019) indicates that annual mean precipitation in BC increased modestly (5%) between 1948 and 2012, and more substantially (~18%) across Canada as a whole.

There is abundant and unequivocal evidence that most of the observed warming is due to increases in atmospheric greenhouse gas concentrations that result primarily from fossil fuel use. The evidence that annual mean precipitation and damaging precipitation extremes are being affected is also very strong, although it is not always as easily discernible at country and regional scales due to the relatively larger background variability of precipitation. Canada and BC are being affected by these changes, and are experiencing substantial impacts. For example, the unprecedented heatwave of June 2021, which appears to have claimed hundreds of lives in BC, would have been virtually impossible in the absence of human induced climate change (WWA, 2021).

Future warming and impacts will depend on the global future emissions. Typically, impacts assessments, including those performed at PCIC, have considered the direct emissions trajectory considered by IPCC (2014), RCP8.5². Increasingly, however, this scenario is considered to be an implausible representation of the future. For example, Hausfather and Peters (2020)³ argue that lower emissions scenarios that stabilize global temperatures at levels 2-3°C above preindustrial well before

¹ As represented by average global mean temperature during the period 1851-1900.

² Representative Concentration Pathway 8.5 (Moss, et al., 2010). RCP8.5 describes a world in which emissions continue to increase rapidly throughout most of the 21st century and global mean temperature rises to ~5°C above pre-industrial levels.

³ See also the recent PCIC Science Brief on emissions scenarios, which is available at https://www.pacificclimate.org/sites/default/files/publications/Science_Brief_39-June_2021-final.pdf.

the end of this century should be considered to be more plausible. Such scenarios should, therefore, draw much more of PCIC's attention than they do at present. While not as dire as RCP8.5, such scenarios nevertheless pose considerable risks for BC and Canada, with warming in both cases likely to be double the global mean warming (i.e., 4-6°C), corresponding changes in temperature and precipitation extremes, and importantly, sea levels that will continue to rise inexorably, possibly for centuries, long after surface temperatures have stabilized.

This plan articulates PCIC's ambition to serve as THE authoritative climate services provider in our region by setting out several service objectives for the organization that encompass a spectrum of activities ranging from direct data delivery to user-specific interpretation and training. These overarching service objectives are supported by several strategic objectives that are required to achieve our service objectives as well as a strategy for electronic services delivery. A key tool in achieving these objectives will be the careful use of climate change simulations produced for Phase 6 of the Coupled Model Intercomparison Project (CMIP6; Eyring et al., 2016), which uses updated models compared to those considered in IPCC (2014), and considers a wider range of emissions scenarios, called Shared Socioeconomic Pathways (SSPs).

Mission statement

PCIC's mission is to translate, create and deliver authoritative quantitative information about the climate of our region, including its historical and future variability and change, and to assist the users of that information in understanding the impacts of climate variability and change.

PCIC achieves its mission by providing climate data and information services that are delivered directly to the public, by working closely with users and stakeholders within our region, and by working as part of a larger group of collaborating climate services providers that work nationally and in other regions of Canada, thereby enabling access to expertise and information that may not be directly available in our region.

Scope

PCIC was created to serve Canada's Pacific and Yukon region, encompassing BC, Yukon, and adjacent areas, for example, as delineated by the river basins that are important to BC but extend beyond its borders⁴. This continues to be PCIC's primary domain of interest. PCIC nevertheless occasionally extends service to adjacent regions, such as we have in a project to provide some services based on observational data to Yukon and Northwest Territories. In addition, we take on specific national projects where this allows PCIC to develop expertise and capability that can help it serve users in the Pacific and Yukon region. PCIC is part of a national network of regional climate service providers that is coordinated by the Canadian Centre for Climate Services (CCCS) of Environment and Climate Change Canada (ECCC)⁵. Thus, there is opportunity to serve and have impact at a national scale, particularly in topic areas where PCIC has unique expertise and capability, and to facilitate access in our region to information and expertise that are only available elsewhere. The resulting recognition strengthens PCIC's reputation as a competent and trusted climate services provider, allowing users in our primary service area to have confidence in our services by knowing that they are accepted nationally.

⁴ See the Appendix for background on PCIC's historical development, organization and governance.

⁵ Current membership includes PCIC, ClimateWest, Ouranos and CLIMATlantic.

PCIC serves four types of users: i) the general public, ii) organizations seeking assistance in understanding how the climate may change in the future and the impacts that this might have for their domains of responsibility or interest, iii) stakeholders who make a significant commitment to working with PCIC to develop and sustain capacity in a specific area, and iv) peers with whom we develop capabilities and material that are beneficial to the delivery of climate services across Canada. The *public* is served without cost to the user primarily via PCIC's data and information portals, several of which are directed to general users. These users are also served through the provision of our newsletters, science briefs, seminars and webinars, primers, education and training materials, and our participation in the CCCS supported climatedata.ca portal. The development and delivery of information and services for the public is very often enabled through the support and collaboration of provincial and federal government partners. *Organizations* are served via custom projects that we develop in partnership with those users, and are provided on a cost recovery basis. These projects, some 15-25 per year, generally result in publicly available information and data products. They often have education and training as a component or even as the primary objective. *Stakeholders* provide sustained resources and/or a sustained mandate to PCIC to allow us to develop capabilities and services that are of specific interest to them. Examples include BC Hydro, with whom we work closely to develop and apply hydrologic models for BC watersheds that are used for hydroelectric production, and the BC Ministry of Environment and Climate Change Strategy. *Peers* are organizations, such as the CCCS or the ECCC's Climate Research Division, who provide us with resources to develop materials and capabilities that are of common interest. Examples include downscaled climate change scenarios that are produced at a national scale, climate change training material that is shared between climate service provider organizations, and a multi-partner effort to develop systems for climate data analysis.

PCIC's expertise is in documenting and analyzing BC's historical climate, developing detailed scenarios of the future climate of the region, helping our users and the public understand the implications of those changes and providing the future climate data that is required to support their efforts to adapt to climate change, and in the modelling of BC's surface water resources and how they might change in the future. In addition, we have very strong expertise in the analysis of extremes, the training and education of the users of climate information and the electronic delivery of climate services. The services we deliver are built on our expertise. This plan accounts for the fact an expansion of services is only possible without compromising existing services when additional resources are available and if our expertise can be feasibly extended to competently develop and support additional services.

Underpinning assumptions

Attainment of the service objectives and strategic goals described in this plan during the 2021-2025 period will require the continued involvement, support and financial engagement of our users and stakeholders, as well as collaboration with a host of others who are not directly engaged financially. Indeed, the plan assumes that PCIC's ability to leverage its financial resources through the engagement of others will continue at roughly current levels⁶.

PCIC relies on investments from strategic partners to strengthen the development and delivery of services, information and knowledge. It is assumed in the drafting of this plan that partnerships with stakeholders such as BC Hydro, BC ministries and ECCC will continue, but that these will evolve over

⁶ In-kind resources provided by users, stakeholders and collaborators more than double the value of the financial support that PCIC receives.

time as funding opportunities and stakeholder objectives and priorities change. PCIC will be responsive to those changes, and will manage its resources so that it can balance the requirements for long-term engagement with the reality of a dynamic funding situation.

It is also assumed that PCIC will continue to enjoy the strong institutional support of the University of Victoria (UVic), including core financial support and the provision of space and a range of support services. UVic is an internationally respected centre of climate and ocean-focused research and an ideal location for a climate service centre such as PCIC. This plan assumes that UVic will continue to recognize the unique nature of PCIC as a service organization that undertakes knowledge transfer from the climate science community to regional users. PCIC in turn will strive to maintain a level of excellence and activity that enhances UVic's reputation as an authoritative source of climate information for users within the region and more broadly.

Finally, this plan assumes that there will be a continued evolution of the climate service delivery system in Canada towards a more structured three-tier system of federal, regional and private sector service delivery agents. The advent of the federal CCCS in 2018 and its efforts to develop a coordinated national network of regional partners, which includes PCIC as an inaugural member, has added considerable positive momentum to this evolution. This coalition of service providers collectively augment the services available to each region by allowing each to benefit from services that draw on unique expertise not available in their regions. Within this framework, regional climate service providers such as PCIC will continue to innovate and to undertake and further develop knowledge transfer between the producers of scientific information and its regional users. It is assumed that the private sector, which is increasingly involved in the provision of climate services but may sometimes be limited in its ability to innovate scientifically, will focus primarily on the technical requirements of individual clients. The boundaries between these three tiers of service providers are necessarily fluid and are defined by the expertise and opportunities for collaboration that are available at each level. PCIC is endowed with talent and stable resources that allow it to take on projects requiring a greater degree of innovation than would likely be possible in a for-profit consulting company.

In summary, this plan is founded on the assumptions that PCIC will continue to receive stable funding, maintain and develop strategic partnerships, receive strong support from UVic as our host institution, maintain managerial flexibility and be an active and influential player in the evolution of the climate service delivery system in Canada. From our perspective, these are sound assumptions that support the successful realization of this plan.

Service objectives

Success of this five-year plan will be measured against PCIC's ability to deliver three principal types of services to the public and its users and stakeholders:

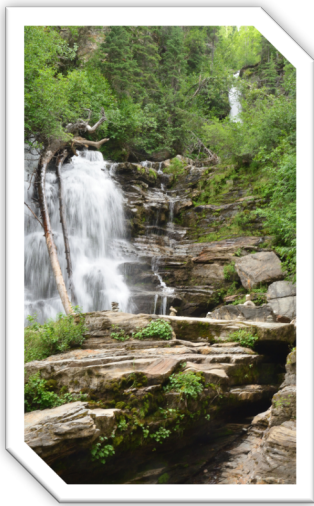


1. The provision of historical data, fine scale projections of future climate conditions and quantification of the impacts of past and projected climate changes.
2. Interpretation of this information from a climate perspective and support for the use of this information by users and stakeholders.
3. User training and education.

PCIC seeks to achieve its service objectives by delivering regional climate information in a comprehensive way to a complex and diverse user base. The modes of service delivery used by PCIC include delivery via openly accessible data and information portals, direct delivery to users via user-commissioned projects, co-development of services and information with users, user training and education activities, and the publication of research, reports and other materials.

1. Provide climate data and quantify climate change impacts

PCIC provides, and will continue to provide, a wide range of climate data to our users and the public via freely accessible data portals that are hosted on our website. This includes an extensive database of historical meteorological data collected by multiple agencies across the province and an equally extensive collection of statistically downscaled climate change projections.



PCIC's holdings of historical weather data are served to the public via an interactive web portal that provides access to observations from roughly 7300 locations⁷ across BC, with observations beginning as early as 1871 and extending to the present. Data holdings are continually updated, and coverage within BC is being expanded further in step with increases in the number of participating agencies in the BC Climate Related Monitoring Program (CRMP⁸) of the BC Ministry of Environment and Climate Change Strategy. This data is used extensively at PCIC for very high spatial resolution climate mapping, the development of driving datasets for our hydrological models and the production of climate monitoring products and updates. Important directions for the next five years will be to increase the quality and temporal resolution of the mapped products, ensure the homogeneity of the station data and the resulting climate mapping products and develop a BC climate dashboard.

PCIC's statistically downscaled bias-corrected climate change projections are provided at daily time resolution and 10 km spatial resolution for locations across Canada. Downscaled scenarios are currently available for up to 27 global climate models (GCMs) that participated in CMIP5 (Taylor et al., 2012) and 3 emissions scenarios (RCP2.6, RCP4.5 and RCP8.5). They can be conveniently downloaded from our website in one of several formats or can be studied by means of one of two interactive tools – Plan2Adapt, which is directed to a less technical audience, and the PCIC Climate Explorer (PCEX). They also provide the basis for a very wide range of impacts assessments that we undertake with our users. PCIC is currently updating this resource by downscaling climate change simulations produced with 24 updated GCMs that participated in CMIP6 (Eyring et al., 2016) using the revised SSP1-2.6, SSP2-4.5 and SSP5-8.5 emissions scenarios. The downscaled CMIP6 scenarios will figure heavily in our work over the next 5 years. Plan2Adapt and PCEX will be updated to use these new scenarios, and the downscaling methodology itself will be improved to ensure that dependencies between different climate variables are respected. Additional directions over the next five years will be to consider the possibility of using observational constraints for scenario selection and additional climate variables beyond the temperature and precipitation variables currently available.

⁷ PCIC's station data portal currently allows access to 7017 of the ~7300 station records held in PCIC's database.

⁸ <https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/climate-related-monitoring>

Two continuing areas of focus at PCIC over the next five years will be the quantification of impacts of climate change on BC's water resources and on BC's and Canada's built infrastructure. Impacts on BC's surface water resources will be quantified with the VIC-GL and RAVEN semi-distributed hydrologic models, both with coupled glacier and water temperature components. Over the period covered by this plan, our core hydrologic modelling capability will evolve from the VIC-GL modelling suite that PCIC previously developed and continues to use heavily at present, to RAVEN (Craig, et al., 2020), which has a modern modular design that facilitates the rapid coupling of new components and is also used by our hydrologic modelling partner, BC Hydro. Both models are also being used in our partnership with Fisheries and Oceans Canada (DFO), who is concerned about the implications of climate change for the salmon that use BC rivers. We will also continue to expand services delivered to the engineering community, starting with operationalizing the current beta-test version of PCIC's engineering Design Value Explorer (DVE). We think that this will lead to continuing opportunities to support standards setting and the adoption of engineering practices at the national and BC levels that account for projected changes to the climate.

An important direction is that we plan to continue to evolve towards the delivery of climate impacts information as a function of global warming level rather than primarily as a function of emissions scenario and time in the future. This is consistent with the way global climate policy has developed (the Paris agreement, for example, focuses on keeping global warming below 2°C above preindustrial levels) and takes advantage of the extensive body of climate research that has focused on pattern (or temperature) scaling, including much such work on extremes that has been performed at PCIC. Focusing on impacts as a function of global warming level shifts much of the uncertainty surrounding climate model and emissions scenario selection from the assessment of impacts to an assessment of the likely timing of the occurrence of the impacts, which we think helps to advance and focus user thinking about the impacts and how adaptation might occur.

2. Interpretation and support

Interpretation and support for the use of the data and information we produce is provided in a number of ways. At a very basic level, this involves informing users of recent developments in climate science via our Science Briefs, Primers, seminars and webinars, and of recent developments and projects at PCIC via our newsletters and website. In addition, PCIC also occasionally engages with the local, regional and national media. More specifically, this involves written guidance material that we develop and publish in a variety of formats and venues, peer reviewed papers and other published material. It also involves the incorporation of the data and metadata that PCIC curates and develops, and information derived from that data, into PCIC developed tools such as Plan2Adapt, PCEX, the DVE, the salmon risk assessment tool that we are developing with DFO, and into the analysis capabilities of climatedata.ca. For those who are technically proficient, it involves the creation of APIs (application programming interfaces) that allow users to interact directly with our data and systems. For the latter community, it also involves active participation in the Canada Foundation for Innovation (CFI) funded DACCS (Data Analytics for Canadian Climate Services) project, which is creating a system of data servers and software tools, including a server located at PCIC and software contributed by PCIC, that will allow the analysis of large volumes of climate data where it resides. PCIC is committed to continue to develop and provide this variety of mechanisms for supporting the users of our data and information.

PCIC will also work directly with individual user organizations in order to best meet their needs. Users from different sectors such as agriculture and engineering have different information needs and

therefore require different types of interpretation and presentation. Also, many users have analysis skills and insights that they are able to use to assess climate change impacts provided they are well supported by an organization that well understands the attributes and limitations of available climate data and information. By working with these users, PCIC can determine their specific needs and build on previous applied research to produce user-specific results, or to help users produce their own results in a co-production mode. It is anticipated that PCIC will be continually engaged in user commissioned and co-produced projects that will typically have a duration of less than one year, although some projects will occasionally extend up to two years. They will often involve custom analyses and the development of new capabilities such that they contribute to the overall improvement of PCIC's capabilities. These projects are generally user supported on an incremental cost basis, and will often include active user participation, co-production and training.

3. User training and education

PCIC provides user training and education in a number of ways. User training and education has always been a part of the user-commissioned projects that we undertake. This type of training occurs on a peer-to-peer basis in a way that is specific to each project. Indeed, each such project is an opportunity to learn, both for PCIC and the user, even in the case of small projects that may only involve providing an expert review of work performed by a third party. Recently, with the support of the CCCS, PCIC has also been able to establish a more general user training program that is designed to reach a wider audience. Training materials targeted to those who are just starting to learn about climate change and its potential impacts have been developed for use in our region, and via the CCCS, for use nationally, and many PCIC-led training events have already occurred. PCIC is also working closely with BC's Climate Action Secretariat (CAS) to develop additional training and education materials. Demand for training that is specific to our region and supports BC's climate adaptation plans continues to grow, but our ability to provide more training and education is limited by capacity and the financial support from stakeholders such as CAS and the CCCS that is currently provided for this purpose. We have nevertheless developed a preliminary user training and engagement plan, and have used the opportunities that have presented themselves so far to hire top-notch staff dedicated to user training and education who have the ability and desire to lead a substantial expansion of our user training and education activities should resources become available.

Strategic goals

In addition to its service objectives, PCIC also has some strategic goals that are required to enable it to meet its service objectives. These goals, which are listed below, focus on the partnerships that enable and support service delivery, the development and enhancement of PCIC's expertise, and our husbandry of the human and financial resources that are entrusted to us.



1. Build partnerships that support and enable service delivery.
2. Empower PCIC staff to innovate and develop their climate and service delivery expertise for the benefit of our users and stakeholders.
3. Achieve and maintain operational and managerial excellence.

PCIC exists to serve its users and stakeholders, and can only be effective when it works in partnership with them. These relationships are privileged and precious. They enable us to learn continuously about the implications of climate change and the multiple ways in which climate data are used. These relationships also provide us with opportunities to innovate and excel in the development of services and their delivery that would not otherwise be available. Encouraging our staff to innovate, develop their expertise, and publish their research allows us to take best advantage of these opportunities. And it goes without saying that it is imperative that we manage the resources entrusted to us efficiently and to the greatest possible benefit of our users and stakeholders.

1. Partnerships that support and enable service delivery

PCIC will further improve its two-way dialogue with its diverse user community. This community includes many individual researchers, colleagues in private consulting companies, municipal and regional governments, provincial and territorial governments, BC Hydro, the National Research Council, ECCC, and DFO amongst others. The results of this dialogue will be demonstrated in PCIC's products and communication materials.

PCIC will also partner with other climate service and research organizations to ensure that our activities are complementary to, and relevant to, those of our partners. These include the national coalition of climate service organizations that are coordinated via the Canadian Center for Climate Services, with whom we have a formal agreement, ECCC's Climate Research Division, the government of Northwest Territories and, as opportunities allow, organizations similar to PCIC in the Pacific Northwest region of the United States.

PCIC undertakes innovative science when it is necessary to do so to meet user needs. It also contributes to the climate and hydrologic research communities through collaboration with academic and federal government grant-funded research networks involving climate researchers from Canada and elsewhere around the world. These collaborations provide PCIC with opportunities to expand its knowledge base, and access to new scientific data, state-of-the-art climate modelling and the continually expanding body of knowledge on climate variability, change and impacts. We will continue to enable such relationships by encouraging and supporting PCIC personnel to develop and maintain academic research partnerships in areas that contribute to PCIC's objectives.

2. Empower PCIC staff to innovate and develop

To succeed, PCIC needs a staff of talented professionals who are empowered to innovate, develop their skills and expertise, and encouraged to publish their work – whether it be a scientific development, the creation of a novel dataset, or open-source software that enables others to produce their own services or information. Our unique funding model, by which PCIC is supported by both its users and an endowment administered by UVic, enables us to provide our staff with the opportunities and time required to excel as innovators and to develop their skills and expertise. This is further complemented by the establishment of a research environment that welcomes and supports grant-funded young scientists (primarily postdocs and research associates) who undertake research in areas that are complementary with those of PCIC's users.

PCIC is a training ground for young professionals and scientists who, we hope, will continue to develop climate services and support climate change adaptation throughout their careers. Our expectation is that most young scientists and practitioners will spend no more than 5 years at PCIC,

ultimately finding employment in organizations where they can continue to develop their careers and serve users, including government organizations, universities and the for-profit consulting industry.

We see this strategic investment in our staff as being a key to PCIC’s continuing success and to our ability to deliver on this plan for our users. It also enables PCIC to serve UVic and the broader community as an incubator of new talent and climate service capabilities.

3. Operational and managerial excellence

In addition to effective and enlightened partnerships and an engaged and empowered staff, a third key strategic requirement is to continually achieve excellence in the management and stewardship of the resources that are entrusted to us.

PCIC has an excellent track record in managing its most important asset, which is its staff. Its human resources management practices achieve a balance between the long-term retention of key senior staff, a motivated cadre of young professionals who often move to new positions outside PCIC within about 5 years of their arrival, and short-term hires such as co-op students. We will continue to manage our staff resources in this way, enabling flexible working arrangements whenever possible, and working to help staff develop and to achieve a suitable work-life balance.

PCIC also has an excellent track record in managing its financial resources, as demonstrated by a long history of “clean” annual financial audits that are performed from the user and stakeholder perspective. PCIC conducts its financial planning annually, and maintains a 3-year budgetary outlook that provides context for all decisions it makes that have resource implications.

PCIC’s key material resources are its computational infrastructure and the data that are stored in that infrastructure. PCIC maintains, regularly updates and improves a significant amount of computational infrastructure that is used to develop and provide its climate services, support its research, and store and safeguard its data resources. These resources are complemented by computational and network resources that are provided by the University of Victoria and Compute Canada. PCIC has a robust data backup scheme with very high reliability and it proactively maintains a high level of system security in concert with the University of Victoria’s informatics security practices.

PCIC will continue to adapt and respond to external and internal changes that influence its operational processes. It will remain flexible and agile by maintaining a balance between the long-term retention of key expertise and leadership, and the engagement of younger professionals who are developing career pathways in climate science and related areas. It will also continue to pursue accountability and transparency to the general public through the maintenance and refinement of corporate systems that adhere to accepted standards, such as the Public Sector Accounting Board standards. Such systems include our project management, financial management, quarterly progress reporting and all periodic reporting required by the users, stakeholders and partners with whom we have formal funding agreements.

Electronic services delivery

PCIC’s website, tools and portals enable the delivery of services to a wide audience, spanning the spectrum from those who are in the early stages of learning about the impacts of climate change to technically sophisticated users who are able to produce their own products from PCIC’s data

resources. Our tools and portals are directed primarily to a regional audience, but also provide wider national access to some types of climate information and data. Most portals have been designed so that they can be used by both humans and machines. In addition, we also provide access to some of our data resources via APIs that allow sophisticated users to develop programs and scripts that interact directly with our data.

PCIC has been successfully adapting to Canada's rapidly evolving electronic climate services delivery ecosystem, which includes the emergence of climatedata.ca and the CFI funded DACCS project. PCIC's tools and portals provide information that is generally complementary to that delivered via climatedata.ca, although some overlap has inevitably occurred as climatedata.ca has developed. PCIC has participated actively in advancing climatedata.ca through the provision of downscaled climate change projections, the development of training materials and sector modules, and the review of content. Redundancy, to the extent that it exists, benefits users in that it offers alternative pathways by which information about projected climate changes can be obtained.

PCIC will continue to participate in the development and governance of climatedata.ca, and will support the integration of its services with PCIC services provided that participation and integration a) continue to be compatible with PCIC's regional mandate, b) strengthen PCIC's reputation and impact, and c) remain feasible and sustainable from a resourcing perspective. One potential pathway for integration that is already being used to a limited extent stems from the development of APIs that provide direct access to our data resources. Another potential pathway is illustrated by our active involvement in the CFI funded DACCS project, has helped to rapidly develop technology that will expand the service capabilities of smaller organizations like PCIC. With DACCS, PCIC will be able to deliver a wider collection of analysis capabilities using a broader base of data than we could only on our own. We see these kinds of integration as being key to the rapid and efficient development and deployment of climate services in the future.

Simultaneously, we plan to continue to develop a modest number of new PCIC hosted information portals and services that target specific niches compatible with PCIC's expertise and capacity, while paying careful attention to the maintenance and enhancement of services already provided and our ability to sustain our complement of portals over the long term. Two near term objectives are to finalize operational versions of the PCIC DVE (which provides future engineering design values for building design) and of an observational climate data portal for Yukon and Northwest Territories users. We are also developing a new climate "dashboard" for BC that will replace our current climate anomaly viewer; the dashboard will provide information about the current status of BC's climate and about recent extreme events. In addition, we are developing a tool in collaboration with scientists at DFO's Pacific Biological Station that will assist fisheries managers in managing the impact of a warming climate on salmon that use BC rivers. The latter will integrate information about projected changes in the freshwater habitat of salmon with an understanding of the environmental requirements and tolerances of salmon during their various freshwater life stages.

Summary

As stated in the Introduction, PCIC's ambition is to serve as THE authoritative climate services provider in our region. The development of the organization over the past decade, which was based on a foundation established between 2008 and 2010, has propelled it strongly towards that goal. This plan, which is structured around three key service objectives, supporting strategic goals and a clearly articulated electronic services delivery strategy, will enable PCIC to continue to advance its ambition

and to serve our region in the best way possible. With this this in mind, and with the support and participation of our users and stakeholders, we will continue to

- curate and make publicly available an extensive collection of historical climate data, and use that collection to document the state of our climate and its changes at as high a temporal and spatial resolution as possible;
- produce and interpret high resolution, state-of-the-science projections of the future climate and its impacts over land areas for municipal, regional, forestry and agricultural planning purposes and for infrastructure design purposes;
- quantify the resulting hydrological impacts on British Columbia, including some related ecosystem impacts, over a substantially widened modelling domain, including all drainage basins with major hydroelectric projects and the vast majority of basins that provide freshwater salmon habitat; and
- maintain and develop a comprehensive and reliable suite of electronic self-service portals for users with a variety of skill levels, and support integration with the national climatedata.ca service where that is judged to be beneficial to our users and to PCIC.

We also continue to develop and strengthen a substantial and active user training and education program, and will seek opportunities and support to ensure that this program is culturally appropriate for the diversity of audiences in British Columbia, including from an indigenous perspective. In addition, we will continue to encourage and enable staff to participate in research that furthers our ability to develop and deliver our services and provide users with meaningful insights that will help them to produce robust climate change adaptation plans.

PCIC's ability to expand into topic areas where it currently does not have expertise and capacity will depend strongly on the availability of resources to develop those areas while simultaneously maintaining excellence in already developed areas. Some potential areas that would have substantial impact and utility where PCIC, in partnership with others, could develop services include:

- extreme event attribution
- additional tools to support infrastructure adaptation via engineering design that accounts for projected climate change
- downscaling a wider range of variables, which will enable impacts assessments previously limited by the availability of downscaled variables (e.g. wildfire impacts)
- considering the impacts historical and future disturbance, land use change and regulation on hydrologic drainage basins to more clearly identify the impacts of climate change
- developing the ability to model water levels (in addition to streamflow and temperature) in developed drainage basins to provide more useful information regarding the potential impacts of climate change, development and regulation on riverine flooding
- sea level rise and storm surge projections and impacts in coastal regions
- partnerships focused on renewable energy climate solutions for which an understanding of projected climate change is a key component
- health impacts, including modelling the projected changes in the distribution and prevalence of disease vectors
- similarly modelling of pathogens affecting ecosystems and crops.

Our strategic plan and continued focus on innovation and excellence should position us well to develop services in these exciting areas as opportunities arise.



Appendix – About PCIC

HISTORY

UVic has hosted a climate services organization of some form for more than 25 years, beginning with the Canadian Institute for Climate Studies (CICS), which was established in 1994. CICS successfully delivered a suite of climate services and managed a comprehensive climate research program on behalf of Environment and Climate Change Canada (ECCC) that involved partners across Canada. In 2005, there was a shift in focus at the federal level, resulting in withdrawal of federal funding to CICS. At the same time, the BC Government was becoming increasingly concerned with the regional impacts of climate change. Recognizing the potential value

of CICS's products, its human capital and the benefits of being able to draw upon the substantial amount of climate expertise that is available at UVic, the University, the BC Ministry of Environment and Climate Change Strategy, BC Hydro, and other regional stakeholders along with a number of regional scientists held a workshop to explore ways to capitalize on CICS' value. The workshop concluded that there was an opportunity to pool resources, focus them on serving climate information needs in the Pacific and Yukon Region of Canada, and that this could best be done through an organization that bridges the gap between the international climate science community and regional users of climate information. This 2005 meeting marked the inception of PCIC as a project within CICS.

PCIC grew in regional importance and built upon its predecessor, creating products such as high resolution downscaled regional climate scenarios and hydroclimate modelling for the major BC river basins. As PCIC grew, it fostered enduring relationships with key stakeholders and partners such as BC Hydro, multiple BC Ministries (Environment and Climate Change Strategy; Transportation and Infrastructure; and Forests, Lands, Natural Resource Operations & Rural Development; Agriculture) and the Ouranos Consortium. PCIC's association with BC Hydro was initiated in 2005, at PCIC's organizing meeting, and continues to this day. BC Hydro formalized its relationship in a four-year research agreement in 2007. PCIC is very grateful that BC Hydro has consistently reaffirmed its commitment to PCIC over the years by renewing the agreement in 2011, 2015, and again most recently in 2019. PCIC's growing regional value and its 2007 Strategy and Plan (Swain et al., 2007) had an influence on the 2008 BC Government announcement of an endowment, granted to UVic, that provides sustained support to PCIC and created PICS. PICS and PCIC both receive funding from the Endowment, share facilities, and work on complementary aspects of the climate change issue, with PCIC providing climate services and related expertise that detail our understanding of the changing climate and its impacts, and PICS providing insights and advice on the development and implementation of potential adaptation, mitigation and policy solutions. In 2019, based on the results of a successful comprehensive 5-year review, PCIC received renewed support and a continuing operational mandate from the University of Victoria.

PCIC's user base has grown steadily over recent years to include an even broader range of stakeholders at all levels of government, publicly- and privately-owned industries and the general public. An increasingly important aspect of PCIC activities is its deepening involvement with the

infrastructure engineering sector, both within our region and nationally. It has also extended its services to partners beyond its regional borders in cases where PCIC's expertise and capacity have allowed such expansion to occur. This has brought considerable impact and recognition to PCIC at a national scale. Also, the broader user base and greater level of implied responsibility has enhanced the value of PCIC's services and information for users within our region. With the development of our expertise, capacity and user-base, PCIC continues to roll-out new products and more powerful tools for the public, the private sector and research communities, and provide ever greater, more detailed and better-documented data. With a staff complement that has more than doubled over the past decade, and currently fluctuates between 25 and 30 people depending upon resources and current project needs, PCIC continues to develop its role as one of the primary providers of climate services for stakeholders in BC and more widely.

CHARACTERISTICS

PCIC is a competent, innovative and reliable climate service provider that works at a very high level of technical proficiency and serves users who require detailed, authoritative information on the past, present and future climate. It also undertakes user training, focusing on the attributes of the climate change information that we provide and our understanding of the degree of confidence that can be held in that information as a function of spatial and temporal scale.

PCIC works with users to understand what information they require and how that information will be applied. It advises users on the suitability of these applications, accounting for both quantified and unquantified sources of uncertainty, and in cases where confidence in the information is insufficient, may suggest alternative types of information and approaches to its use to help users reach their objectives.

PCIC's expertise is, and will continue to be, primarily on the physical aspects of climate change and its impacts, climate data and its statistical manipulation and interpretation, and on climate service delivery via electronic means. PCIC intends to maintain critical mass and deep expertise in these areas so that it can continue to provide leading, authoritative climate information and interpretation. This precludes expansion into areas such as climate change adaptation and climate change mitigation. We hope that our work will support the implementation of a broad range of adaptation and mitigation solutions, but PCIC does not have the capacity to competently develop those solutions. Rather, we view our work as enabling and strongly complementing the portfolio of solutions options that are being developed by our sister organization, the Pacific Institute for Climate Solutions.

CORE VALUES

PCIC is committed to the following core values.

Quality

We ensure that our methods are current and relevant, and that the implications and limitations of our results are clear. We take the initiative to solve problems and eliminate errors in order to produce robust results.

Collaboration

Collaboration is integral to how PCIC operates. We work with stakeholders to target our applied research and with other researchers to provide new solutions for practical problems that arise in meeting the needs of our stakeholders.

Respect

We listen to the needs of others and value their opinions.

Sustainability

We strive to set an example of the wise use and management of the resources entrusted to us.

Professionalism

PCIC's staff is dedicated to its objectives and its members conduct their work in a competent, efficient and professional manner. PCIC recognizes that its staff is its primary asset. It supports the professional development of its staff and compensates its staff equitably for the work that they are asked to do.

ORGANIZATIONAL STRUCTURE

PCIC currently has a staff of about 25 professionals who are organized into five work groups, or themes. Each theme has a Lead who provides leadership and supervision to the theme, ensures coordination and collaboration with the other themes, performs work planning and user engagement, and helps to manage the human and other resources that are required to deliver the theme's objectives. Each theme area is described briefly below.

Regional Climate Impacts theme

The Regional Climate Impacts (RCI) theme is focused on developing fine-scale projections of future climate change, and facilitating the use of projections in assessing possible impacts and risks of climate change. It focuses primarily on understanding impacts over land areas that are relevant for adaptation planning purposes, such as those required by municipal and regional governments, health authorities, forestry and agricultural activities, and for infrastructure design purposes, including roads, buildings, transportation systems, and hydro-electric transmission and distribution systems. The theme is also responsible for the delivery of PCIC's user training and education program and communication and interpretation products. In addition, it is a key point of interaction with the CCCS and climatedata.ca. The theme has extensive expertise in statistical downscaling, extremes and extremes indices, climate data analysis and uncertainty quantification. It currently has 6 staff members, two of whom have PhD's, with the remaining 4 having Masters degrees. A seventh staff member is on secondment to the CCCS until November, 2023. In addition, two postdoctoral fellows conduct research related to extremes that is relevant to this theme.

Hydrologic impacts research theme

The Hydrologic Impacts (HI) theme at PCIC is focused on quantifying the effect of climate change and climate variability on regional hydrology in order to provide analysis and information relevant to water resources management and the management of risks that result from changes in water flow regimes and water properties, such as temperature. Key users of its work include BC Hydro, road transportation and other infrastructure planners, fisheries managers, and municipal and agricultural water users and planners. The theme uses a version of the VIC model (Liang et al., 1994) called VIC-GL that has been updated by PCIC to allow the coupling of glacier mass balance and dynamics

components as its primary hydrologic modelling tool. It is currently making a transition from VIC-GL to RAVEN (Craig et al., 2020), which has a much more modern and flexible computational structure. In recent work the theme has also been developing the ability to model river water temperature and impounded reservoirs, and it has been employing a large ensemble of hydrologic simulations of the Fraser River system to project changes in streamflow extremes. The theme currently has 5 staff members, 3 of whom have PhDs and two having Masters degrees. In addition, one postdoctoral fellow conducts research related to hydrologic model calibration and the representation of impounded reservoirs.

Climate analysis and monitoring research theme

The Climate Analysis and Monitoring (CAM) theme at PCIC is focused on providing reference climate data to users and interpreting recent seasonal weather in light of climatology using climate data available for the province. It also uses this data to produce very high-resolution climate maps, and for purposes such as the determination of climatic design values for infrastructure design. The theme supports users throughout the province, including users in the agriculture and forestry sectors, and it plays a key role in the BC Ministry of Environment and Climate Change Strategy CRMP program as the integrator and host of the PCDS, which contains observations from networks that are operated by numerous partners. PCIC maintains the PCDS and supporting metadata, has established automated near real-time data feeds from a number of observing networks and periodically ingests data in batch mode from other networks. It also has developed an intuitive and flexible web-based data portal that provides convenient user access to the PCDS. As a consequence, PCIC is able to host and make freely available historical meteorological observations from about 7300 locations across BC. The PCDS is, in turn, the basis for a regular, automated, climate monitoring product that PCIC produces and disseminates monthly and provides much of the data that PCIC uses to develop very high resolution (800m) temperature and precipitation climatologies for BC using the PRISM expert system that is developed at Oregon State University and PCIC is licensed to use. The theme also supports applications within PCIC, for example, in the development of updated engineering design values for buildings and in the development of high-resolution meteorological driving data for hydrologic models. The theme currently has two staff members, one with a PhD and a support scientist with a BSc. This is complemented by regular contributions to the theme's objectives from PCIC's Computational Support Group. In addition, the theme has recruited a postdoctoral scientist who will start in September, 2021.

Computational Support

The RCI, HI and CAM themes are supported by a Computational Support Group (CSG) that focuses on electronic services delivery and provides support for the development of efficient and reusable scientific code. In addition, CSG develops and maintains PCICs computational infrastructure, develops and implements strategies to optimally utilize PCIC, UVic and Compute Canada computational resources, and protects PCIC's data resources through the provision of reliable and secure backup systems. CSG has a staff of 5 professionals and currently also employs a co-op student. CSG will shortly be recruiting one additional developer who will be tasked with supporting the development of the salmon risk assessment tool that will be developed as part of multi-year project that is being led by the HI theme.

Administrative Support

Administrative functions at PCIC are provided by a small group consisting of PCIC's Director, our Lead for Administration and an Administrative Coordinator. We also benefit from financial, payroll and other support services that are provided to us by UVic at very modest cost. This small group provides

overall leadership and planning, manages PCIC’s human and financial resources, manages contracts and agreements, ensures that all required reporting occurs in a timely way, manages travel and other types of expenditures, and supports PCIC’s governance processes. It was recognized in PCIC’s recent 5-year review that some additional administrative capacity is required, and thus PCIC has recruited an additional administrative assistant.

GOVERNANCE

PCIC has a transparent, comprehensive and effective system of governance. PCIC is a legally incorporated not-for-profit corporation that is registered with Industry Canada under the *Canada Not-for-profit Corporations Act (2014)*. PCIC is governed by a Board of Directors that is responsible for the strategic review and oversight of the PCIC program. Direction and the operation of the consortium is the responsibility of the President and CEO of the Corporation who is also the Director of PCIC. Board membership includes representatives from the University of Victoria, the provincial government, BC Hydro, the federal government, Ouranos and other organizations. The Director reports to the Board of Directors and is advised by regular meetings of a Program Advisory Committee (PAC), which consists of PCIC stakeholders and climate researchers. PAC membership, which is determined on the basis of programmatic needs, currently includes representation from BC government ministries, BC Hydro, regional governments, industry, the federal government, and the academic research community.



References

- Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444p, <https://changingclimate.ca/CCCR2019/>.
- Craig, J.R. *et al.*, 2020: Flexible watershed simulation with the Raven hydrologic modelling framework. *Environmental Modelling & Software*, 129, 104728, <https://doi.org/10.1016/j.envsoft.2020.104728>.
- Daly, C., M. Halbleib, J.I. Smith, W.P. Gibson, M.K. Doggett, G.H. Taylor, J. Curtis and P.P. Pasteris, 2008: Physiographically sensitive mapping of climatological temperature and precipitation across the coterminous United States. *International Journal of Climatology*, 28, 15, 2031–2064, <https://doi.org/10.1002/joc.1688>.
- Eyring, V, S Bony, GA Meehl, CA Senior, B Stevens, RJ Stouffer, and KE Taylor, 2016: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev*, 9, 1937–1958, <https://doi.org/10.5194/gmd-9-1937-2016>.
- Hausfather, Z. and G.P. Peters, 2020: Emissions – the ‘business as usual’ story is misleading, *Nature* 577(7792):618-620, <https://www.nature.com/articles/d41586-020-00177-3>.
- IPCC, 2014: *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.S. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. <https://www.ipcc.ch/report/ar5/syr/>.
- Liang, X., D. P. Lettenmaier, E. F. Wood, and S. J. Burges, 1994: A simple hydrologically based model of land-surface water and energy fluxes for general-circulation models. *Journal of Geophysical Research-Atmospheres*, 99, 14415–14428, <https://doi.org/10.1029/94JD00483>.
- Moss, R., Edmonds, J., Hibbard, K. *et al.* 2010: The next generation of scenarios for climate change research and assessment. *Nature*, 463, 747–756, <https://doi.org/10.1038/nature08823>.
- Taylor, KE, RJ Stouffer and GA Meehl, 2012: An overview of CMIP5 and the experiment design. *Bulletin of the American Meteorological Society*, 90, 485-498, <https://doi.org/10.1175/BAMS-D-11-00094.1>.
- WWA, 2021: *Western North American extreme heat virtually impossible without human-caused climate change* [Philip et al, including F. Anslow]. Published online 7 July 2021, <https://www.worldweatherattribution.org/western-north-american-extreme-heat-virtually-impossible-without-human-caused-climate-change/>



PACIFIC CLIMATE IMPACTS CONSORTIUM

University House 1
PO Box 1700 STN CSC
University of Victoria
Victoria, British Columbia
Canada V8V 2Y2

Phone: 250-721-6236
Fax: 250-721-7217

pacificclimate.org