



2008-2009



**PACIFIC CLIMATE
IMPACTS CONSORTIUM**



PCIC CORPORATE REPORT





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STAFF March 2009

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Pacific Climate Impacts Consortium

C177 Sedgewick Building
PO Box 1700 Sta CSC
University of Victoria
Victoria BC Canada V8W 2Y2
Phone: (250) 721-6236
Fax: (250) 721-7217
Web site: <http://PacificClimate.org/>



Vision

The Vision of the Pacific Climate Impacts Consortium is to stimulate collaboration among government, academe and industry to reduce vulnerability to extreme weather events, climate variability and the threat of global change. The consortium for climate impacts will bridge the gap between climate research and climate applications and will make practical information available to government, industry, and the public.

Mission

The Mission of the Pacific Climate Impacts Consortium is to quantify the impacts of climate change and variability on the physical environment in Pacific North America.

Scope

The Scope of the Pacific Climate Impacts Consortium is the physical sciences that describe climate, its variability and change, including extreme events, in Pacific North America.

Focus

The Focus of the Pacific Climate Impacts Consortium is on climate stakeholders in industry, government, commerce and communities that require climate information for adaptation to future climate conditions.

Products

The Products of the Pacific Climate Impacts Consortium are analyses of historical trends and climate conditions as well as estimates of future environmental design conditions for the 21st century.

Message from the Chair, Board of Directors

“PCIC’s Board of Directors encompasses a wide range of disciplines, resulting in a balanced and rational strategic vision.”

Governance

The Pacific Climate Impacts Consortium is managed by the PCIC Corporation as a not-for-profit organization incorporated under Part II of the Canada Corporations Act. As a federally constituted organization, PCIC follows the federal standards for governance and legislation and the PCIC Bylaws. The Act defines the management responsibility of the Board of Directors, and the electoral responsibility of the Members. PCIC’s Board of Directors encompasses a wide range of disciplines, resulting in a balanced and rational strategic vision.

The Board of Directors is primarily comprised of ex-officio appointments from the University of Victoria and the BC Government. In addition, Members may elect up to seven persons from either the private or public sector.

This year was critical for the development of the Pacific Climate Impacts Consortium (PCIC). Although the concept of PCIC was envisioned in 2005, it was in 2008 that the vision, funding and opportunity all came together.

This year PCIC received a portion of the endowment given to the University of Victoria by the BC Government to address climate initiatives. The endowment has boosted PCIC’s base funding and creates a public legacy for targeted research on climate variability and change in British Columbia and Pacific North America.

Consequently, the Board of directors took action, and at the June 30 board meeting

- *officially accepted “Pacific Climate Impacts Consortium” as the corporate name;*
- *confirmed the responsibilities of the Board of Directors;*
- *confirmed the membership in the Corporation.*

At the Board meeting in September, I was appointed Chair of the Board, Dave Rodenhuis was appointed President & CEO of the Corporation, and Board committees were established. Gordon Smith, Executive Director of CFGS, was acknowledged and thanked for all his effort and advice in maintaining PCIC under CFGS in the preceding years. I would like to take this opportunity to reiterate our appreciation for Gordon’s work to help make PCIC what it is today.

PCIC is a consortium of research and stakeholder organizations. Consequently, collaborative relationships are of fundamental importance to the work of the Consortium. PCIC collaborates with BC Hydro; the BC Ministries of Environment, and Forests and Range; Ouranos, Montreal; CCCma, a division of the Climate Research Branch of Environment Canada; and academic groups at the University of Victoria.

Work on PCIC’s Strategic Plan is well underway and I would like to congratulate Dave Rodenhuis and his staff on their success at ramping things up so quickly and effectively.

Dr. Howard Brunt

Chair, PCIC Board of Directors

Vice President of Research, University of Victoria



Photo: University of Victoria

Message from the Chair, Program Advisory Committee

“Going forward, the PAC’s priority will be to further strengthen the consortium by expanding stakeholder and outside expert engagement.”

Role of the Program Advisory Committee

The Program Advisory Committee (PAC) is comprised of senior professionals drawn from organizations that provide substantial support for the work of the Consortium. The PAC provides direction and advice to the Director of PCIC on scientific content and priorities, stakeholder needs and participation in projects. They offer oversight through an annual review of the program plans and budget. The PAC also assists the Director in major staff appointments throughout the year.

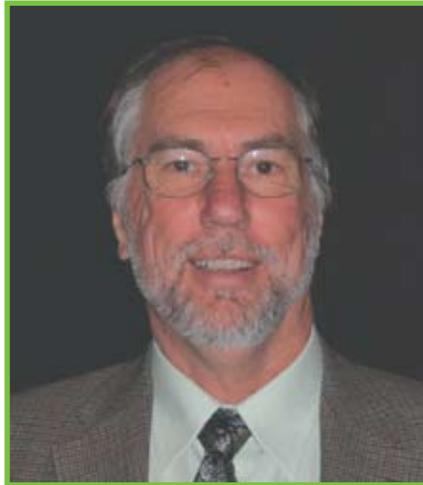


Photo: Ben Kangasniemi

The BC Government has made climate change a top priority. The provincial strategy addresses climate change through a wide range of measures to reduce greenhouse gas emissions and adapt to climate change impacts. Communities, businesses and governments need access to practical information about how the climate of BC is likely to change over the coming decades in order to adapt. The Pacific Climate Impacts Consortium (PCIC) plays a key role in providing this information.

The Board of Directors and a Program Advisory Committee (PAC) shape the strategic direction for PCIC. The PAC includes representatives from several agencies, including the BC Ministry of Environment, BC Ministry of

Forests and Range, BC Hydro, Environment Canada and the University of Victoria. These agencies helped establish PCIC in 2005 and now continue to be engaged on the PAC by guiding PCIC’s strategic and program level decisions, identifying stakeholder information needs and providing advice to the Director on numerous operational matters including staff recruitment, salary review and developing affiliations. The PAC is pleased to see several experts have been recruited recently and a number of important affiliations with other organizations and experts established. Going forward the PAC’s priority will be to further strengthen the consortium by expanding stakeholder and outside expert engagement.

The consortium approach is proving successful. It is clear that PCIC is drawing on numerous sources of data, analytical tools, research and expertise to deliver authoritative information to stakeholders. Over the past year, PCIC has provided information requested by BC Government agencies, BC Hydro, local governments and other organizations. PCIC also provides products and information freely on their web site. PCIC is now on a firm footing and is delivering the high resolution climate change projections and historical climate analysis requested by stakeholders to help them understand and adapt to climate change impacts.

Ben Kangasniemi

*Chair, PCIC Program Advisory Committee
BC Ministry of Environment*

Message from the PCIC Director

I am really pleased to have had the opportunity to participate in the standup of our Consortium—a transition from concept to reality.

Since the initial concept of PCIC was envisioned in 2005, there has been substantial growth in public awareness of the reality of the changes in climate, as well as the importance of climate variability, especially here in Pacific North America. British Columbians recognize the importance of adapting our human institutions to a changing climate, and our need to live in a sustainable balance with our natural resources. The ecological system in which human enterprise is a very recent visitor.

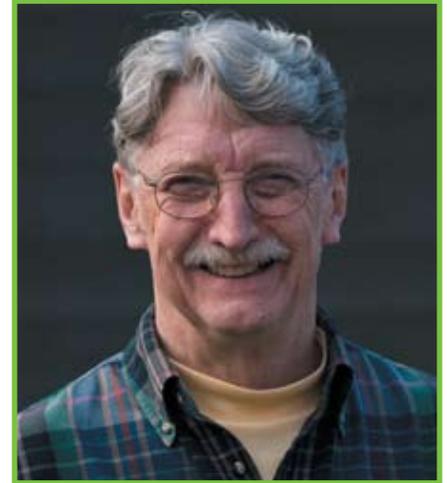


Photo: Paul Nienaber

Dr. David Rodenhuis first came to PCIC in 2006 as Senior Scientist and Acting Director. In 2008, he was appointed President & CEO of the PCIC Corporation and Director of the Consortium. He holds a PhD in atmospheric sciences from the University of Washington (1968) and BS degrees in mechanical engineering from the University of California at Berkeley and in meteorology from Penn State University. Dr. Rodenhuis has a background in climate monitoring and atmospheric dynamics and has worked in climate-related positions in North America, Europe and Africa, as well as other parts of the world. During the 1990s, he served as the director of the Climate Prediction Center in Washington, DC, where he led the National Weather Service in the development of near-real-time monitoring of climate anomalies (El Niño; ozone hole; global temperature and moisture anomalies), and climate forecasting. Subsequently, he was the director of the Aviation Weather Center in Kansas City and Senior Meteorologist at the National Command Center of the United States Federal Aviation Administration.

This is the first annual Corporate Report, and it is a companion to a technical report of our work, Selected Milestones (Nov 2008). Our vision, objectives, mission and scope were hammered out by climate scientists, stakeholders and the resident staff in our offices at UVic. Our Corporate Report presents an integrated view of our themes, projects and staff which are the backbone of our consortium. This year our goal has been to build resident expertise that would strengthen our partnerships with researchers and stakeholders, and our Corporate Report identifies the major collaborators in government, academe and industry.

We have taken these first steps to build the Consortium with support and expectations from BC communities and institutions, including an important endowment from the Province. Our future as a consortium is before us. We must develop the four PCIC Themes and attract both research collaboration and stakeholder support. The resident staff of PCIC at UVic is the catalyst to make that happen. I am grateful to be working with all of you—climate scientists, stakeholders, members of the Consortium, and our technical staff.

Dave Rodenhuis
President & CEO/Director
Pacific Climate Impacts Consortium

www.PacificClimate.org/aboutus/program

A CONSORTIUM FOR CLIMATE IMPACTS

A consortium is an association of two or more individuals, companies, organizations or governments (or any combination of these entities) with the objective of participating in a common activity or pooling their resources for achieving a common goal.

The Pacific Climate Impacts Consortium was formed to allow stakeholders and researchers to join in association and work towards the common goal of understanding and quantifying climate change impacts in Pacific North America. For the Consortium to be successful it requires partnerships, associations, joint projects and agreements with a dynamic selection of organizations interested in climate impacts, from climate research centres, to BC Ministries, to Crown Corporations.

Over the past year, PCIC made an effort to reach out to potential partners and to solidify existing relationships. This effort paid off. Stronger agreements were signed, new partnerships were forged, and joint projects were embarked on. PCIC will continue to grow in the years to come, building on these partnerships as a foundation of a consortium for climate impacts.



Aerial view of the University of Victoria campus

Photo: University of Victoria



Photo: Fotosearch



Photo: PCIC Library



Photo: PCIC Library

BC hydro

FOR GENERATIONS

Public Policy - "BC Hydro is a provincial commercial Crown Corporation and has a role in implementing provincial public policy. The BC Energy Plan provides policy direction and guidance for BC Hydro to produce and acquire power to achieve electricity self-sufficiency. BC Hydro's short-term priorities and long-term goals also align with the plan, which aims to meet the global challenge of ensuring a secure, reliable supply of affordable energy in an environmentally responsible way."

www.bchydro.com/about/company_information/reports/2008annualreport/business_overview/business_overview.html

BC Hydro has an expressed need to understand the impacts of climate change on the topography of British Columbia, especially in regards to streamflow. In early 2008, BC Hydro and PCIC signed an updated Grant Contribution Agreement that authorized the creation of a Technical Advisory Committee (TAC). The main purpose of the three year agreement is to:

- Employ and evaluate climate projections from Regional Climate Models that are suitable for modelling climatic behaviour in the environs of British Columbia for a number of Global Climate Change scenarios.
- Develop suitable hydrologic modelling capability to model the effects of these climate change scenarios on hydrologic behaviour for a representative set of large river basins in British Columbia (see PCIC Milestones 2008, p. 5).
- Conduct diagnostic analysis using modelling tools to quantify climate change impacts in basins of interest and generate representative runoff time series that BC Hydro can use for system impact studies.

Partnering with PCIC is an effective way for BC Hydro to pool its resources with those of other climate stakeholders in order to obtain projections of future hydrologic conditions in BC. Over the next years, PCIC will meet the expectations

of the agreement and work towards a continuation of the collaborative effort. This year a project was initiated by Dr. Daniel Caya of Ouranos to develop a regional climate model diagnostics program. A Climate Diagnostics Research Plan will define the program.



Ministry of Environment

"The BC Government is making climate change a top priority. Its provincial strategy addresses climate change through a wide range of measures, and on two main fronts:

Mitigation: reducing greenhouse gas (GHG) emissions and enhancing carbon sinks (e.g., forests, soils and ocean) that remove carbon dioxide and other GHGs from the atmosphere. This is expected to slow the rate and extent of climate change.

Adaptation: preparing for, and adjusting to, unavoidable climate change and its impacts."

www.env.gov.bc.ca/epd/climate

The BC Government is committed to understanding the impacts of climate change and understands that informed policy decisions must rest on an understanding of the physical impacts of climate on the environment. In early 2008, the BC Government, through the BC Ministry of Environment (BC MoE), announced an endowment that would both create a new multi-university institute, the Pacific Institute for Climate Solutions (PICS), and secure base funding for PCIC. The endowment secured a long-standing collaboration with BC MoE, which is represented on both PCIC's Board of Directors and PAC, and thus helped shape the strategic future of PCIC.

Over the past year, PCIC contributed trends and projections to six reports by the BC Government and other organizations (PCIC Milestones 2008, p. 26). These maps are visual descriptions of the projected temperature change by the middle of the century. At the request

of the BC MoE, PCIC also prepared products that are available freely on our web site: www.PacificClimate.org

The River Forecast Centre (RFC), a branch of BC MoE, partnered with PCIC on a joint project: Fraser River Mountain Pine Beetle VIC modeling project. The RFC contributed a full time staff member, Markus Schnorbus, towards the project as a secondment to PCIC. PCIC contributed the VIC Model as the major resource of the project. The objective of the project is to develop comprehensive knowledge of Mountain Pine Beetle effects on the hydrology of the Fraser River watershed and its major sub-basins (PCIC Milestones 2008, p. 3).

In late 2008, PCIC collaborated with the BC MoE's Climate Change Branch on a Letter of Intent to NRCan for PCIC to host the Regional Adaptation Collaborative for Pacific Canada. The RAC project is now in proposal stage and once approved will help define future collaborations with communities through the BC MoE.



Ouranos' mission is to acquire and develop knowledge on climate change, its impact and related socioeconomic and environmental vulnerabilities, in order to inform decision makers about probable climate trends and advise them on identifying, assessing, promoting and implementing local and regional adaptation strategies.

www.ouranos.ca/en

Ouranos is a consortium that focuses on climate sciences and impacts and adaptation. Located in Montreal, Quebec, Ouranos operates as a network of 250 scientists and researchers and has worked closely with PCIC since 2006. The model of Ouranos has had a great effect on the development of PCIC. In mid 2008, PCIC and Ouranos renewed a collaborative agreement that clearly defined the relationship. For its part PCIC will gain access to valuable regional climate model data and the support of Ouranos scientists. Dr. Daniel Caya,

Director of Simulations, began a six month term as Acting Director at PCIC in the fall of 2008.

PCIC and Ouranos are committed to a collaborative relationship on the joint project, The Development of Hydrologic Climate Change Projections in British Columbia and Quebec. The aim is to evaluate the ability of Regional Climate Models (RCMs), currently being tested on some Quebec watersheds, to reproduce historical series of hydrologic variables in the mountains of BC, experiment with different methodologies for improving predictive performance, and develop expertise in BC and Quebec in the use of regional climate models for hydrological applications.

CCCma

"The Canadian Centre for Climate Modelling and Analysis (CCCma) is a division of the Climate Research Branch of Environment Canada. We conduct research in coupled and atmospheric climate modelling, sea-ice modelling, climate variability and predictability, the carbon cycle, and a number of other areas."

www.cccma.ec.gc.ca/eng

CCCma has developed climate simulation models to better understand the processes which govern our climate system. In 2008 PCIC began collaboration with CCCma, located at the University of Victoria, on a project to assess the skill of seasonal and monthly forecasts. Hindcasts will be produced with four global atmospheric models in the second phase of the Canadian Historical Forecasting Project. PCIC is funding a research assistant to develop statistical methods to improve model forecasts of precipitation over BC (PCIC Milestones 2008, p. 17). Dr. Slava Kharin guides the project and Dr. Greg Flato, Manager and Research Scientist at CCCma, serves on PCIC's Program Advisory Committee. This project is targeted for completion in September 2009 and future collaborative projects are under discussion.



Ministry of Forests and Range

Climate is a strong influence on forest and range lands in BC. It affects tree growth, productivity, and numerous resource values derived from these lands. Managing these resources in a changing climate poses tough challenges for forest and range managers. The Ministry of Forests and Range is responding to climate change through a number of actions, including the Future Forest Ecosystem Initiative.

www.for.gov.bc.ca/mof/Climate_Change

As our climate changes, the BC Ministry of Forests and Range plans to adapt its forest and range management framework so that it maintains and enhances the resilience and productivity of BC's ecosystems. In the past few years, PCIC has worked extensively with scientists at the Ministry on two major projects: (i) to improve the availability of high resolution climate projections on the Regional Analysis Tool and (ii) to assess the impacts of climate change on two tree species and forest pests (PCIC Milestones 2008, pp. 9, 21). A representative from the Ministry of Forests and Range, Gerry Still, joined PCIC's Program Advisory Committee in 2008, confirming an important collaborative relationship between the Ministry and PCIC. In the coming year, PCIC and the Ministry will continue existing collaborative projects and explore linkages.

Pacific Institute for Climate Solutions

The Mission of the Pacific Institute for Climate Solutions is "to partner with governments, the private sector, other researchers and civil society, in order to undertake research on, monitor, and assess the potential impacts of climate change and to assess, develop and promote viable mitigation and adaptation options to better inform climate change policies and actions."

www.pics.uvic.ca



The Pacific Institute for Climate Solutions (PICS) was formed to translate the existing knowledge around climate change into solutions. The implementation of solutions to the challenges presented by climate change means PICS has a strong focus on identifying climate change impacts, and articulating adaptation and mitigation responses. To help achieve their goals, PICS researchers require an effective link to the climate data and applied climate knowledge available through PCIC also located at the University of Victoria. Hence the PICS - PCIC collaboration forms an important foundation for all PICS activities.

University of Washington, Climate Impacts Group



The Climate Impacts Group (CIG) is an interdisciplinary research group studying the impacts of natural climate variability and global climate change ("global warming") on the U.S. Pacific Northwest (PNW). Through research and interaction with regional stakeholders, the CIG works to increase the resilience of the Pacific Northwest to fluctuations in climate.

<http://ces.washington.edu/cig/>

The Climate Impacts Group (CIG) at the University of Washington, like PCIC, works in the 'gap' between climate science and public policy. CIG was formed in 1995 and since then has become a leader in exploring the impacts of climate variability and climate change on natural and human systems in the U.S. Pacific Northwest. Their experience in this work and their knowledge of the VIC Hydrologic Model led to a partnership between CIG and PCIC in 2008. Katrina Bennett went to the University of Washington to undergo training on the VIC Model, and returned with new knowledge and software to run the model at PCIC. With the VIC Model running at PCIC, future partnerships will involve knowledge sharing and data sharing to improve the models functionality.



University of Victoria

The University of Victoria is a Canadian leader in climate change research, and among the top universities in the world specializing in this critical area of study. UVic's internationally respected research expertise in the scientific, social and economic impacts of climate change can play a key role in providing the fact-based foundation for sound public policy and informed, effective solutions.

<http://web.uvic.ca/sustainability/research.php/>

The University of Victoria (UVic) is home to some of the world's leading climate scientists and research centres. This is an ideal host for PCIC. In the past year, PCIC has contributed to UVic's objectives by supporting postdoc appointments and graduate students, and hiring co-op students. Several members of the PCIC consortium are faculty at UVic, and several collaborative agreements are under consideration that will strengthen PCIC's ties with the UVic academic community.

PCIC works with the School of Earth and Ocean Sciences (SEOS), which hosts the principle academic climate group, and the Department of Geography, which is aligned with hydrology interests at PCIC. Closely associated with Geography, the Water-Climate Impacts Research Centre (W-CIRC) of Environment Canada also works in partnership with PCIC. PCIC supports a post-doc at W-CIRC in hydrological modelling under the guidance of Professor Daniel Peters, and Professor Terry Prowse is a member of the PCIC Program Advisory Committee. PCIC is committed to investing in the academic mission of UVic through partnerships with academic units and the possibility of joint-appointed faculty.

BUILDING THE CONSORTIUM: TARGETED RESEARCH

The Pacific Climate Impacts Consortium will achieve its Vision and Mission by focussing on four Themes:

- Regional Climate Impacts
- Hydrologic Impacts
- Ocean Influences
- Climate Analysis

They are the foundation for bridging the gap to each socio-economic sector and supporting their needs for assessment and adaptation. The PCIC staff work within this 'gap' between science and applications. Resident expertise in the physical sciences is needed to engage research scientists in the Consortium. However, PCIC staff must focus on targeted research and understand the needs of socio-economic sectors.

Over the last year, PCIC focused its program and resident expertise around the first two themes. Building the Consortium involved increasing resident capacity, strategic planning, fostering partnerships and outreach to researchers and stakeholders. Though the challenge continues, accomplishments were made through supporting professional development, hosting seminars, recruiting scientists, constant outreach and a willingness to take on new projects and challenges.

Photo: Brian Savage



Theme 1: Regional Climate Impacts

Regional Climate Impacts addresses the demand to explain and interpret potential impacts of global climate change on a regional scale. This includes knowledge of current trends and estimates of uncertainty within the context of climate variability, as well as output from climate models, statistical descriptions, and climate model diagnostics. A significant portion of this work is “downscaling” global scale model results to regional and local climatic conditions. From these results the consequences of climate change in different regions can be estimated, including climate impacts on the most critical sectors of socio-economic activity, ecology and community infrastructure. Product outputs include maps and graphics of future climate projections from global climate models (GCM) and regional climate models (RCM), analysis of historical trends and variability, and published reports.

Stakeholders and partners in this theme in 2008-2009 included City of Whitehorse; BC Ministry of Agriculture; Dawson City; City of Prince George; Raincoast Conservation Society; City of Vancouver; Columbia Basin Trust; Metro Vancouver; and BC Forest Science Program

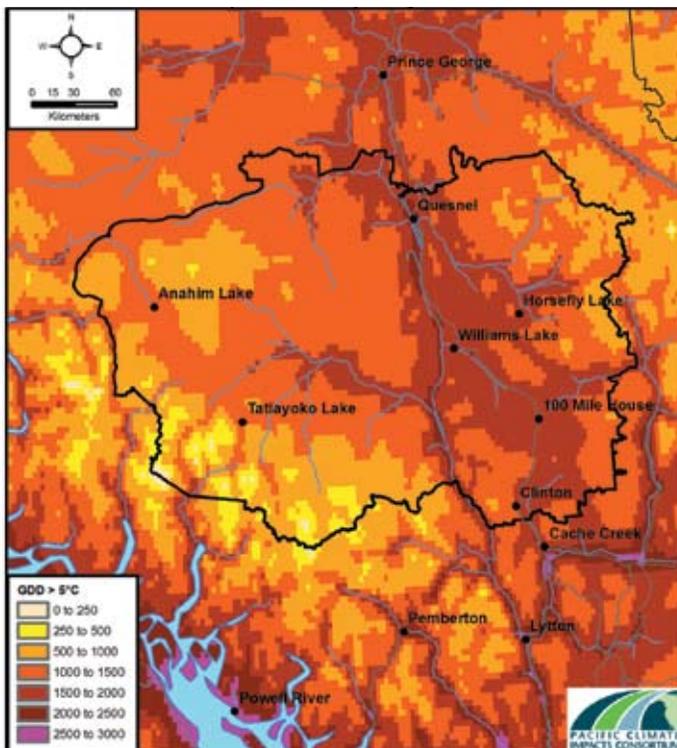


Photo: Morihuis

Trevor Murdock’s technical experience is focused on using climate change scenarios to determine regional and community impacts. His work includes downscaling to high resolution and the consideration of climate variability and historical trends.

“My main focus this year has been to develop a coherent Regional Climate Impacts Plan. The plan will

be used to help PCIC respond to evolving stakeholder needs while ensuring that we focus our efforts in ways that provide valuable information for adaptation to climate change. We are continually trying to improve this by going beyond annual temperature and precipitation averages into seasonal results and biophysical variables and indices, such as degree days, frost free days, and tree species suitability.”

“My expertise in the use of climate model output is used for climate change education and extension services. I also help professionals use the information PCIC generates. This work requires extensive collaboration. In order to provide projected climate impacts information and interpretation to stakeholders, I made several presentations about our results, tools and products.”

A CLIMATE SCENARIO (or climate change scenario) is information about future climate used for decision-making. Use of scenarios in developing policy and resource management plans requires caution because of the significant uncertainty associated with these projections. Although there are many kinds of climate scenarios, the most commonly used are ensembles of GCM projections – and the two terms are often used interchangeably.

High-resolution projection of 2050s Growing Degree Days (GDD) from the Canadian Global Climate Model (CGCM2) following the A2 emissions scenario (run 4) for the Cariboo-Chilcotin region of BC.



Photo: Paul Nienaber

Aquila Flower is an Ecosystem Impacts Analyst, whose research at PCIC focuses on exploring and quantifying the impacts of climate change on British Columbia's ecosystems. Her primary area of research is the impact of climate variability on forests.

"I joined PCIC in April 2008 to complete a BC Ministry of Forests and Range funded project focused on quantifying

the projected impacts of climate change on British Columbia's spruce and Douglas fir forests. This has involved using bioclimatic envelope models to define the range of climatic conditions in which these tree species grow, as well as identifying the climatic conditions under which outbreaks of certain forest pests are more likely to occur. Downscaled climate projections from a suite of global climate models have been used to identify areas that will be climatically suitable for spruce and Douglas fir forests over the next century, as well as areas that will be more vulnerable to pest outbreaks in the future. This research will help foresters adapt to climate change by choosing to replant species that will be better suited to the climate of the future. In a second project, also funded by the BC Ministry of Forests and Range, I have examined the potential impacts of climate change on avian species and their primary habitats in British Columbia."

BIOCLIMATIC ENVELOPE MODELS are statistical models that use historical climate data to define a species' geographic range. These models provide us with the climatic envelope, or range of climatic conditions, in which a species occurs. We can then use climate projections to identify the locations where these climatic envelopes will exist in the future.

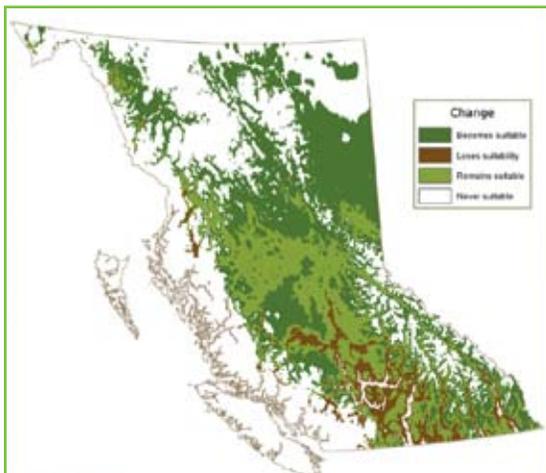


Photo: Paul Nienaber

Arelia Werner is a hydrologist who has been working within two of PCIC's Themes: Hydrological Impacts and Regional Climate Impacts. Her technical experience is in assessing the impact of climate change on water supplies, including groundwater, river basins and reservoirs.

"Over the past year I worked with multiple communities in BC and the Yukon to

increase their knowledge of the impact of climate change on their region. This work involved travelling to several communities and working with a local person, a "champion", who will continue to endorse the transfer of climate change information in their community. We completed analyses for each region and then supported champions in the creation of reports or workshops that moved their communities towards adaptation."

"Working closely with communities gave me the opportunity to help build a name and reputation for PCIC. This work is one factor in the nomination of PCIC as BC's host for NRCAN's Regional Adaptation Collaborative (RAC) program."

"I was also involved in the setting up of the Variable Infiltration Capacity (VIC) macro-scale hydrologic model for the Fraser River Basin and worked closely with Eric Salathé from the University of Washington to provide downscaled future scenarios for input into the VIC Model."

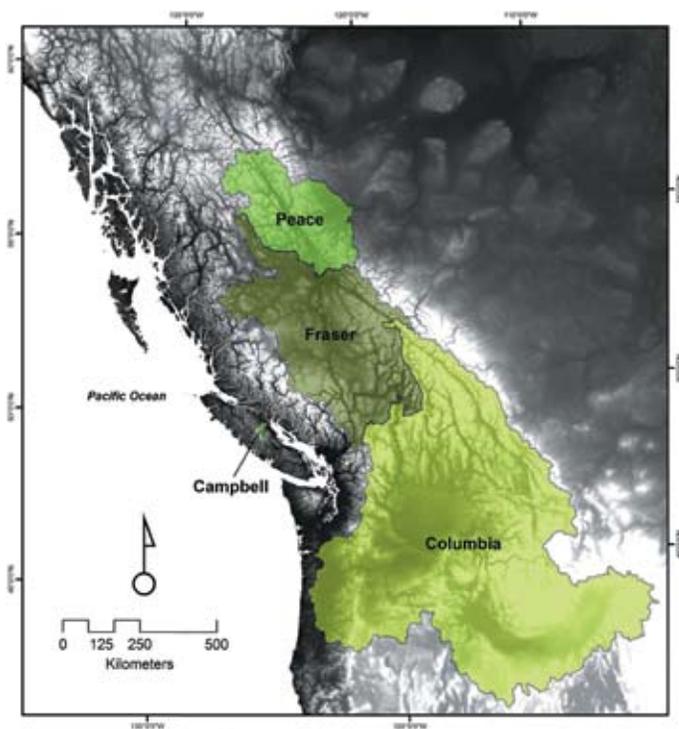
DOWNSCALING is a method that derives local- to regional-scale information from larger-scale models or data analyses. Two main methods are distinguished: dynamical downscaling and empirical/statistical downscaling. The dynamical method uses the output of regional climate models, global models with variable spatial resolution or high-resolution global models. The empirical/statistical methods develop statistical relationships that link the large-scale atmospheric variables with local/regional climate variables. In all cases, the quality of the downscaled product depends on the quality of the driving model.

Change in climatic suitability for Douglas fir trees relative to the 20th century. Results are based on the average of six climate projections for 2080.

Theme 2: Hydrologic Impacts

The objective of this Theme is to estimate the impacts of climate change on water resources in British Columbia watersheds. The major project, Hydrologic Modelling, has four major components: Climate Overview (completed); Hydrologic Model Diagnostics; RCM Diagnostics; and Synthesis. It will involve the Water and Climate Impacts Research Centre (W-CIRC) in the Department of Geography at UVic and hydrologists at other universities in North America to advance this work. The output is a source for related studies within other Themes: Regional Climate Impacts, and Climate Analysis.

Stakeholders and partners in this theme in 2008 included BC Hydro; BC Ministry of Environment; BC River Forecast Centre; Natural Resources Canada (NRCan); ESSA Technologies; and Fraser Basin Council.



Watersheds in BC where the VIC model has been applied.

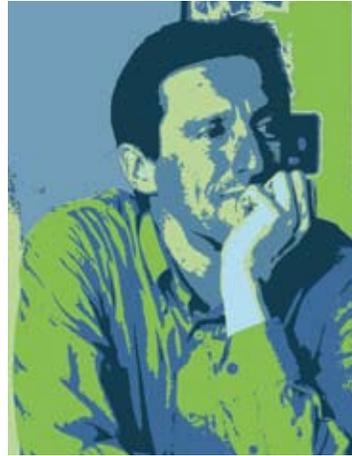


Photo: Paul Nienaber

Daniel Caya is Senior Research Scientist and Director of Simulations at the Ouranos Consortium, in charge of generating national climate-change projections for Impacts and Adaptation studies in Canada. He has been seconded to PCIC for the period November 2008 to May 2009.

"My main contribution has been to draft the section on Regional Climate Modeling (RCM) Diagnostics, using my experience with Ouranos and Hydro-Québec to develop a plan for PCIC and BC Hydro in the use of RCM data. Although the terrains are very different there are similar problems and a toolbox that has been used successfully in Québec can be adapted for BC. My job is to ensure that the BC plan gets the most out of what has already been learned and that no duplication occurs."

"PCIC does not intend to develop its own regional climate model; therefore model data for PCIC is being provided by Ouranos with the results being used for both hydrologic impacts and regional climate impact projects."

REGIONAL CLIMATE MODELLING uses state-of-the-art models of the atmosphere to generate possible future climate for BC. The main advantage of an RCM is its increased spatial resolution that allows better representation of the complex topography of the Pacific Northwest. The concept of RCMs is similar to GCMs and all the important physical processes maintain the atmospheric circulation and are responsible for its evolution over time. They are "virtual reality planets" that are used to infer the consequences of modification of the atmosphere's chemical composition through human activities.



CABBORO BAY, VICTORIA, 2006 Photo: Ben Kangasniemi

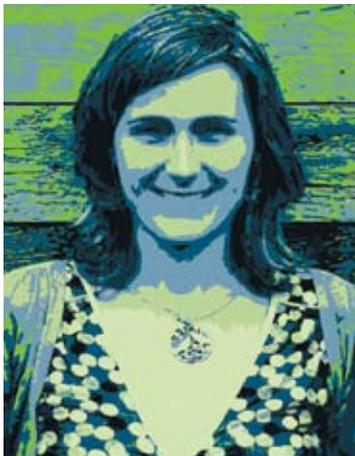


Photo: Paul Nienaber

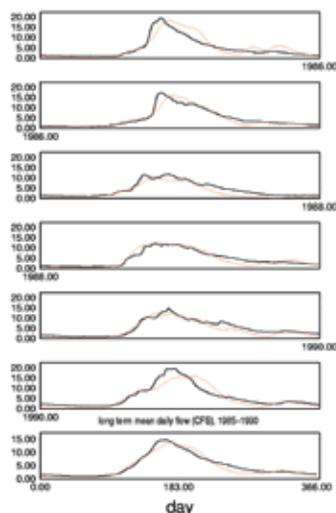
Katrina Bennett is a hydrologist specializing in hydrologic modelling, climate change impacts analysis and the hydrology of remote, mountainous basins. She is responsible for implementing the technical aspects of the VIC Hydrologic Modelling Project at PCIC.

"As a hydrologist working at PCIC, I am responsible for implementing the Variable Infiltration Capacity

(VIC) Hydrologic Model to study the impacts of climate change on streamflow in select BC watersheds. This applied research project involved transfer of the VIC model to the University of Victoria during 2008-2009, and required hands-on-training at the University of Washington with model developers. Key aspects of the model development included: six weeks of off-site training in Seattle; development of the BC-wide gridded climate surfaces; and development of BC-wide gridded soils, vegetation and topographic data layers. Milestones to date include:

- *Base runs of the model in the Fraser Basin on the Mercury Research Cluster at UVic.*
- *Manual-calibration: investigation of manual calibration.*
- *Auto-calibration: setup of a multi-objective auto-calibration tool at UVic and tested Fraser Basin calibration for the monthly and daily timescale, updated and revised codes in conjunction with programmer, and shared results with collaborators.*
- *Preparation for VIC modelling to examine climate change impacts on stream temperatures and fish habitat in the Cariboo-Chilcotin region of the Fraser River Basin (ESSA Technologies)."*

The VARIABLE INFILTRATION CAPACITY (VIC) Hydrologic Model is a macroscale hydrologic model, originally developed at the University of Washington, that solves full water and energy balances. VIC is a research model that has been applied to many watersheds, including the Columbia River as well as other watersheds internationally, to examine the impact of climate change and variability. PCIC will be applying VIC to the Fraser, Peace, Columbia and Campbell River basins.



Markus Schnorbus is a hydrologic modelling scientist with the BC River Forecast Centre who was seconded to PCIC for 2008-2009. He is an experienced researcher and forecaster with a sound knowledge of mountain and forest hydrology and a strong background in deterministic and statistical techniques.



Photo: Paul Nienaber

"In 2008-2009, I was seconded to PCIC to lead the BC Ministry of Environment implementation, calibration and validation of the Variable Infiltration Capacity (VIC) Hydrologic Model for the Fraser River basin. The project has involved investigating deforestation due to the Mountain Pine Beetle and was initiated in collaboration with PCIC to share resources in the setup of the VIC model, receive training, and be able to expand its use to other river basins in BC."

"My operational background with river forecasting has given me a better appreciation of the complexities of hydrology and physiography in BC. I have a good understanding of the river and tributary systems and how they relate together topographically. The large scale of this project has required a different perspective, as well as a greater awareness and understanding of the difficulties and challenges involved in investigating a much larger system, i.e. the whole of the Fraser River basin (234,000 sq km)."

WaSiM-ETH

Next year, PCIC hydrologists will have the opportunity to work with another hydrologic model, the grid-based Water Flow and Balance Simulation (WaSiM-ETH) Model, which is a well-established tool for investigating the spatial and temporal variability of hydrological processes in complex river basins. Up to this point the WaSiM-ETH model has been used primarily in Europe and PCIC will be working to use it in a BC context.

Sample Hydrograph (calibrated) from 1985-1995, Fraser River Basin PCIC

Theme 3: Ocean Influences

British Columbia lies directly in the path of wintertime Pacific storms. The objective of this Theme is to recognize this unique position and analyze climatic changes and impacts on the Pacific coast. In particular, Pacific storms are responsible for a major fraction of water resources, they are the source of storm surges in the estuaries of the coast, and they contain extreme weather events and explosive wind forces that draw their energy from the climatic state – either variable or persistent. The proximity to the Pacific Basin exposes BC to major climate fluctuations from El Niño (ENSO) and the Pacific Decadal Oscillation (PDO). Throughout the year, the Pacific Ocean and surface winds influence local coastal climates and both estuarine and terrestrial ecosystems. This topic includes historical analysis as well as future projections on sea-level rise, storm surge, damaging wind events, coastal community adaptation, and monthly/seasonal climate prediction.

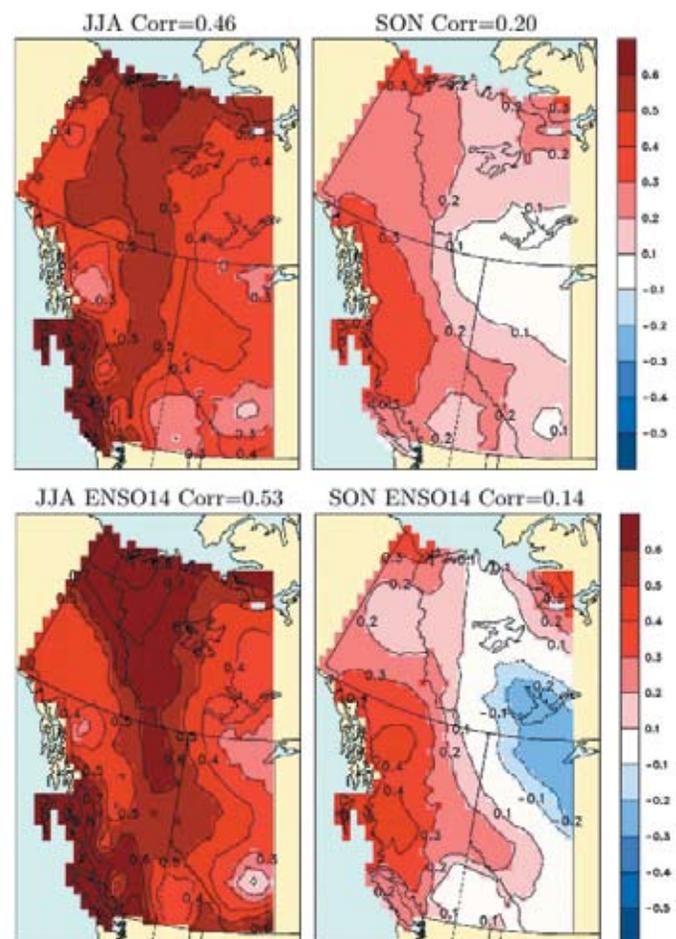
This Theme is not yet fully developed. Stakeholders and partners in this theme in 2008-2009 included the Canadian Centre for Climate Modelling and Analysis (CCCma).

Tests of seasonal forecast skill of surface temperature for the four seasons of the year (winter (DJF), etc), and for selected years of the warm phase of ENSO (El Niño-Southern Oscillation). Ref: M.Fyfe, CCCma, Environment Canada.

Theme 4: Climate Analysis

The foundation of almost every climate centre involves the collection of hydro-meteorological data, construction of climate information, climate analysis, and monitoring of the climate system. The objective of this Theme is to monitor the regional climate in near-real-time. A Provincial Climatologist at PCIC would produce routine analyses from current, regional climate monitoring of essential climate and impact variables—within the context of climate change and variability, including summaries explaining current climate anomalies.

This Theme has not yet been initiated.



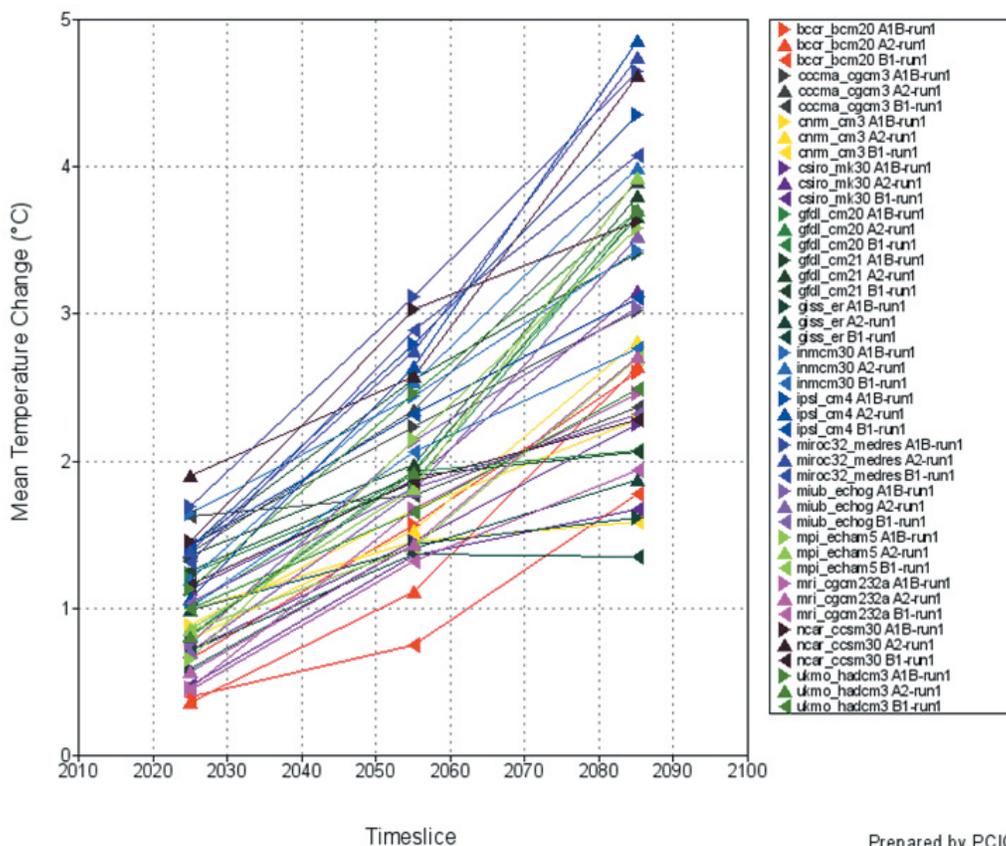
Products and Services: Bridging the Gap

Products and Services from PCIC are the natural result of project accomplishments in the above Themes. PCIC is a service driven organization whose goal is to make climate information available to decision makers. The primary resource for achieving this goal is PCIC's web site. PCIC staff are also committed to giving presentations and producing publications on their targeted research. Finally, PCIC made a commitment to the UVic community in 2008 to bring leaders in climate research to the campus for public presentations.

Products and Services available at www.PacificClimate.org include the Online Interface-Regional Analysis Tool; Planners Interface (in progress); Trends and Projections for BC publications; Seminar Series; Publications; and Presentations.

For summaries of the major projects in each Theme refer to Milestones 2008 - visit:

www.PacificClimate.org/docs/aboutus/projects/Selected.Milestones.2008.pdf



Annual - Mean Temperature Change - SRES AR4 - IPCC A2+B1+A1B - Canada: British Columbia



Photo: Paul Nienaber

David Bronaugh is PCIC's programmer/analyst. He developed the PCIC Regional Analysis Tool and improved its interface and capabilities. He also develops and assists with implementation of new software tools.

"My focus over the past year has been on developing PCIC's Regional Analysis Tool (RAT) and the ZYP trend package. The RAT displays scenarios from global climate models and provides a capability to analyze regional results."

"The ZYP trend package is used to analyze linear climate trends using a statistical technique known as pre-whitening and gives options for two different methods of computing trends: (1) after Zhang 2000; (2) after Yue and Pilon 2002."

Projected future temperature change from fifteen different Global Climate Models following three different emission scenarios.

Outreach

Pacific Climate Seminar Series

The Pacific Climate Seminar Series was launched in 2008 to foster collaboration between climate research, applications and stakeholders. In addition to the Seminar Series, PCIC hosts visitors from other academic, research and stakeholder organizations. For a complete listing of PCIC Seminars visit:

<http://PacificClimate.org/aboutus/seminars/>

PCIC Update Newsletter

PCIC's quarterly newsletter, PCIC Update, was circulated provincially, nationally and internationally in 2008-2009 to a distribution list of 270 individuals from almost 100 different organizations. For copies of PCIC Update visit:

<http://PacificClimate.org/aboutus/news/>



Photo: Paul Nienaber

Publications and Presentations

PCIC staff made over 30 presentations in 2008-2009 to a cross section of community, government and climate groups in British Columbia and Washington State, as well as at conferences in British Columbia, Alberta, California and Nevada. Publications included an update to the BC Climate Overview, a climate impact assessment for the Cariboo-Chilcotin area of British Columbia, two articles in the FORREX journal, Link, and contributions to two articles in the FORREX watershed management bulletin, Streamline.

<http://PacificClimate.org/resources/publications/>

<http://PacificClimate.org/resources/presentations/>

Financial Picture

Treasurer's Report

The following summary is based on the Pacific Climate Impacts Consortium's unaudited financial statements for the fiscal year ending March 31, 2009. Audited financial statements for the 2008-2009 fiscal year will be available after July 2009. Copies of the most recent audited financial statements are available from the PCIC office.

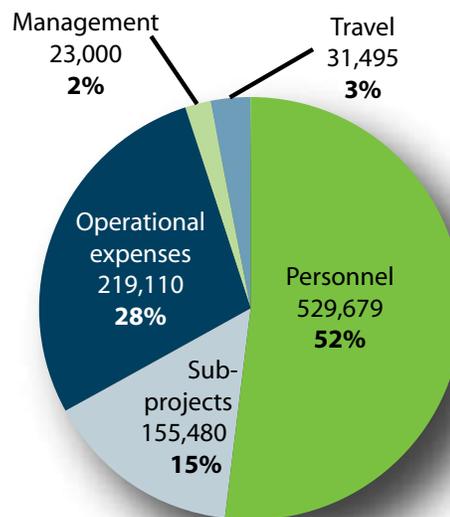
This was a successful year for PCIC; the announcement of secure funding through a Provincial endowment created security for the Consortium's future, which has allowed for significant investments in human resources and collaborations. In 2008-2009, PCIC invested 50% of its expenditures in personnel and another 16% in collaborative research projects.

PCIC's primary source of funding over the period was through the Provincial endowment (base funding). In addition, several long-standing collaborations were maintained this year. BC Hydro continued its investment of \$200 thousand annually, and contracts with BC Ministry of Forests and Range as well as several communities provided support for PCIC's Regional Climate Impacts Themes.

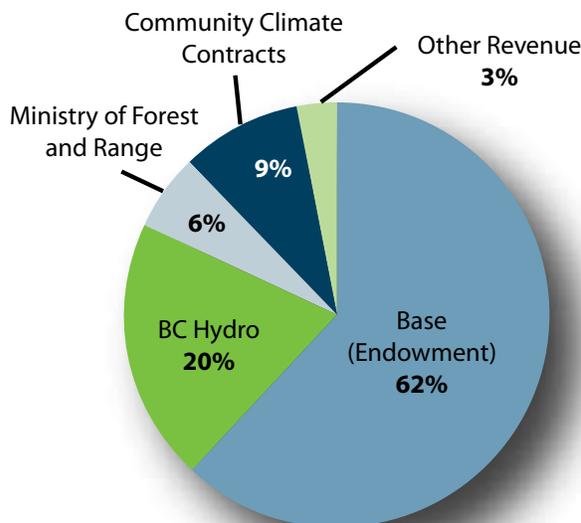
Looking forward to next year, PCIC will continue to invest in personnel. PCIC plans to hire several new staff members to further the Vision and goals of PCIC. PCIC will continue to invest in collaborative projects, through funding and in-kind support. Once approved, PCIC will host the NRCan-funded Regional Adaptation Collaborative for Pacific Canada. This project will focus on PCIC's regional work in hydroclimatology for communities.

Expenditures 2008-2009

(Canadian dollars)



Revenue by Source 2008-2009



Research Assistants

PCIC is hosted by the University of Victoria and works within an academic research environment. Among the traditional responsibilities of the University—teaching, research and service—PCIC contributes primarily to the service objective. As one component of its service to the University, PCIC is committed to employing Research Assistants to work with our resident staff on various projects. Research Assistants are drawn from UVic undergraduate and co-op student populations. PCIC research assistants are given an opportunity to use their academic training in the unique area of targeted climate research.

Recruitment

In 2008-2009, PCIC actively recruited three new staff members to join project teams in regional climate impacts and hydrologic impacts:

Markus Schnorbus, Hydrologist, is a hydrological modeler. His recent experience was as an operating forester with the River Forecast Centre, BC Ministry of Environment, Victoria. More information can be found on page 13 of this document.

Dr. Gerd Bürger, Downscaling Analyst, is currently Senior Scientist in the Institute of Geocology at the University of Potsdam in Germany. In 1996, he developed the expanded downscaling (EDS) method, which originated from the need to reconcile the large-scale information provided by climate simulations with the small-scale requirements of hydrologic models.

Dr. Jörg Schulla, Hydrologist, is an expert on hydrologic modelling software and hydrological data. He is the developer of the grid-based Water Flow and Balance Simulation Model, WaSiM-ETH.

Photo: University of Victoria



Photo: Cassbreea Dewis



Photo: Morihuis



Photo: Paul Nienaber



Photo: Morihuis



Photo: Paul Nienaber



Photo: Paul Nienaber

Outlook

Strategic Plan

The 2009-2013 Strategic Plan builds on the successes at PCIC over the last four years. In the next five years PCIC will:

- Address the expectations of its Vision and seek to become a premier climate centre in British Columbia within a network of centres in Pacific North America and Canada.
- Strengthen the work already underway on the two Themes of Regional Climate Impacts and Hydrologic Impacts.
- Initiate plans and build resident expertise for the two other Themes of Ocean Influences and Climate Analysis.
- Increase collaboration within the Consortium, with the University of Victoria, and with extramural experts and affiliates of the Consortium.
- Build capacity in British Columbia to support adaptation to climate change in Pacific North America.



Photo: Morihuis

www.PacificClimate.org/aboutus/program







C177 Sedgewick Building
PO Box 1700 Sta CSC
University of Victoria
Victoria BC Canada V8W 2Y2
Phone: (250) 721-6236
Fax: (250) 721-7217

Website: <http://PacificClimate.org/>

Graphic Design: Morihuis <morihuis@shaw.ca>