



**Executive Report on the CCRN Workshop on Extreme Weather and Hydrology**  
***“Lessons Learned from the Western Canadian Floods of 2013 and Others”***  
**11–12 February, 2014**  
**Grande Rockies Resort, Canmore, AB**

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**Workshop Summary**

The CCRN held a two-day workshop in February 2014 to evaluate, analyse and synthesise a case study of extreme weather and hydrology with a focus on the Western Canada Floods of 2013. This workshop was attended by nearly 50 participants, including academic and government scientists, water managers, and engineers from multiple universities and government agencies. In addition to the CCRN partner universities, the agencies represented included:

- Alberta Environment and Sustainable Resource Development;
- Environment Canada;
- International Arctic Research Center, University of Alaska, Fairbanks;
- Kananaskis Country Park Research and Management;
- Parks Canada;
- Saskatchewan Water Security Agency;
- Town of Canmore, AB;
- UN Water Decade for Life;
- US Department of Agriculture, Agricultural Research Service;
- US National Center for Atmospheric Research;
- US National Oceanic and Atmospheric Administration; and
- Yukon Department of Environment.

The workshop first compiled a hydrometeorological diagnosis of the June 2013 floods in western Canada and then related this to broader atmospheric and hydrological dynamics and change and to extreme hydrometeorological events in North America. It synthesised descriptions of hydrometeorological processes and statistical properties, hydrological and atmospheric modelling and water management implications as they relate to the Western Canadian Flood of 2013 and related events.

The workshop included five main topic-based sessions with presentations and open discussion, and a final breakout session for participants to discuss key issues and identify priorities for further work. It opened

with a welcome by John Borrowman, Mayor of Canmore, an introduction to CCRN by Professor Howard Wheater and a review of the workshop objectives by Professor John Pomeroy. The sessions included talks by 1) Ronald Stewart, John Pomeroy, Colleen Walford, Bill Duncan, Sean Carey, Masaki Hayashi and Julie Theriault addressing observations and diagnosis of the 2013 extreme events in western Canada; 2) Xing Fang, Bruce Davison and Yanping Li on modelling the flood; 3) Don Cline on NOAA's Snow Data Assimilation System (SNODAS); 4) Danny Marks, Paul Whitfield and Al Pietroniro on learning from the flood; and 5) Katrina Bennett, Ric Janowicz and Roy Rasmussen on related events and scientific insights on the processes involved. There were breakout groups facilitated by Paul Whitfield, Graham Strickert and Bob Sandford which produced summary reports from Kevin Shook, Bruce Davison and Amin Elshorbagy as rapporteurs. In addition, the workshop included several special presentations to broadly inform participants of flood simulation prediction, and management in the United States and of the municipal response to the situation in Canmore, AB, during the June 2013 flood. These presentations were a talk over lunch by Dr. Don Cline, Chief of the National Weather Service Hydrology Laboratory, National Oceanic and Atmospheric Administration describing extreme hydrology prediction methods in the US; a presentation over dinner on the first day by Andy Esarte and Greg Burt of the Town of Canmore describing the Town's response and efforts as the events unfolded; and a public forum on the evening of 12 February at the Canmore Collegiate High School, including a talk by Dr. Roy Rasmussen of the National Center for Atmospheric Research on the September 2013 Colorado flooding event, followed by an expert panel open discussion that included Dr. Rasmussen, Dr. Kevin Shook, Professor John Pomeroy, and Professor Ronald Stewart.

The workshop went well and had lively discussions that provided valuable input to CCRN partners, generated responses to the network, helped to suggest coordinated research within CCRN, and catalyzed a dialogue with the public and user communities. The following link provides a number of news articles published in the Calgary Herald before and after the workshop: <http://words.usask.ca/chnewsevents/2014/02/15/calgary-herald-reports-on-ccrn-canmore-workshop/>. The talks from network investigators and their students were informative and there was a good survey of capabilities and recent events both locally and internationally with respect to recent flooding. The focus on a single event was a very powerful tool to link the CCRN themes and engage collaborators.

An accompanying report by Robert Sandford summarizes the content of the individual presentations and details the points made by participants during the breakout sessions. The presentations given at this workshop are available on the CCRN webpage at the address: <http://www.ccrnetwork.ca/science-programme/workshops/workshop-on-extreme-weather-and-hydrology/index.php>. Below, the key points raised during the workshop are summarized along with the primary workshop outcomes.

### **Workshop Outcomes**

Breakout session discussions were held to address how to describe, model, manage and mitigate the flood. Describing the flood was first seen being based on classifying the processes generating the flood.

How weather interacts with climate needs further comparative study – the same weather will produce a very different flood in differing climates. Conventional flood frequency analysis was seen as deficient because of: i) clustering of extremes, ii) lack of consideration of all precipitation and discharge data including paleodata and daily values, iii) lack of consideration of antecedent conditions and flood generating processes, iv) spatial associations of extremes and v) lack of consideration of changes in large scale precipitation events. Better modelling of the flood was seen as including more observations (gauge and radar), continuous flow simulations, process-informed physically based modelling, ensemble forecasting, and water management considerations. For the short term, a coupled atmospheric-hydrological model intercomparison between the Canadian Rockies and Colorado Front Range Floods of 2013 was proposed (CCRN-NCAR), as was the urgent need to develop a legacy dataset of the Western Canada flood and to tailor numerical weather model products for flood forecasting agencies in the provinces and territories. For the longer term, more coupled and ensemble modelling, better risk communication, transfer of newer models to flood forecasting agencies, continuous simulation of both drought and flood modelling, and analysis of extreme weather events in a climate change context were proposed. Managing the flood requires translating science into improved water management, mitigation and environmental impact assessments. Engineers need updated design storms and peak discharges, municipalities need peak water and inundation levels and water managers need information to help in reservoir operation. Reservoir operations are challenged by attempting to balance the need to provide resilient water supplies in droughts and flood protection, this balance could be evaluated with improved water resource models that incorporate flow routing, daily timesteps and quantification of uncertainty propagation. Flood mitigation requires future flood extents from models and statistics to underpin stricter zoning in communities, engineering risk management solutions, social solutions, environmental management and public education programs.

General discussion at the workshop suggested interest in moving towards a journal special issue with submissions in December 2014, devoted to synthesizing the flood and its meteorology, hydrology and water management aspects along with consideration of how its dominant processes related to similar events (tropical rainfall genesis, rain-on-snowmelt, trends in extremes). This issue would include a synthesis article on the flood by CCRN investigators. There was some interest in a Canadian venue for this special issue and the *Canadian Water Resources Journal* and *Atmosphere-Ocean* were two viable suggestions. John Pomeroy has offered to contact authors and journals regarding such a special issue. There was also discussion about a 2014 AGU session to tie this in with extreme events around the world and contributions to international and national flood scientific assessments. Professor John Pomeroy and Dr. Danny Marks will propose to AGU a session on “extreme rain-on-snowmelt events” that will involve presentations from the atmospheric sciences, hydrological sciences and cryospheric sciences and a synthesis discussion. Plans for joint field experiments, enhanced modelling, coupled modelling and model intercomparisons were developed at the workshop and stronger linkages to NCAR, NOAA-NWS and USDA-ARS and between investigators have ensued to CCRN’s advantage.