



## Three years later, lessons being learned from the 2013 flood

Colette Derworiz, Calgary Herald: 18<sup>th</sup> June, 2016

[cderworiz@postmedia.com](mailto:cderworiz@postmedia.com)

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*As the Bow River runs through the Rockies, it moves from a lake at the bottom of a glacier high up in Banff National Park through a steep valley, winding through stands of century-old Lodgepole pine.*

*By the time it leaves the park, it veers east and passes through the foothills, widening as it meanders through Calgary - a city at the confluence of the Bow and Elbow rivers.*

*Leaving the city, the Bow winds through another valley across the prairies to meet the Oldman, where it becomes the South Saskatchewan River, continuing across the wide-open prairies to Hudson Bay, and into the Arctic and Atlantic oceans.*

*For a large swath of the Prairies, the rivers are a source of life and fertility. Three years ago, they brought death and destruction.*

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KANANASKIS COUNTRY - It's what locals call 'monsoon' June - the deluge of rain that hits the Rocky Mountains every year.

In the days before the rain started pounding down in late June 2013, however, John Pomeroy began to notice signs that this would be no normal spring storm.

Six days earlier, the renowned hydrologist and his colleagues had surveyed the snowpack high in the mountains and discovered it was deeper than usual for that late in the spring. Moreover, the prairie below was already saturated, and the weather forecast showed another heavy bout of rain moving in.

Pomeroy and his fellow researchers knew "we were in really big trouble."

By the time he left his lab in Kananaskis Country on June 19, 2013, the torrential rains had started. As he walked out the door, he told his colleagues not to come in the next day since it would be too wet to conduct field research.

Driving home to Canmore, he and a co-worker noticed a campground outside of town starting to fill up with water. They mused aloud that it should probably be evacuated.

Around midnight, Pomeroy's curiosity got the better of him. He and his 15-year-old daughter, Emily, went to check on Cougar Creek and the Bow River running through the mountain town. The waters were rising by the minute.

"The noise was incredible," he recalled.

By now, it was flooding in Canmore, but the public wasn't alerted until 3 a.m. when firefighters knocked on doors and evacuated 1,200 people in the town of about 12,000.

The next morning, Pomeroy and his wife took two cars to the evacuation centre and brought 11 people - mostly out-of-town researchers and stranded motorists - to their home, which had become a quasi-emergency operations centre.

Three computers sat on the dining-room table, downloading data from weather gauges across the Rockies, as well as from real-time stations run by Alberta Environment.

By now, the stream flow gauges had washed out, but the stations were still operating and they showed that there had been more than 100 millimetres of rain - five times the typical summer rainfall in the area - in the first twenty-four hours.

“It was extraordinary,” said Pomeroy. “Over the top.”

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It’s been three years since the deadly floods of 2013 - an event that changed the course of Pomeroy’s research, which has already uncovered results about how the storm developed, why it was so bad and its relationship to climate change.

Researchers have confirmed that the three-day rainfall, which fell on a late-season snowpack, was the result of a prolonged convergence of two large weather systems over the Eastern Slopes of the Rockies.

“How it came in was very complex,” said Pomeroy. “There was moisture off the Pacific, but there was also moisture coming off the Prairies - southern Alberta, southern Saskatchewan and Montana.”

Pomeroy said there was nothing unusual about the Pacific front coming into Alberta, but to have it come at the same time as an ‘upslope storm’ from the Prairies was rare.

An upslope storm comes in from east to west, forcing it upwards at the mountains where it cools and squeezes water out.

Its size was also exceptional, stretching to Jasper National Park from the United States border, and to Calgary from Elk Valley.

Added to all of that, there were record high temperatures up in the Yukon and down in Colorado just before the heavy rains in Alberta began.

“It sandwiched these things in,” explained Pomeroy.

It had also been a wet spring, which led to precipitation recycling (a situation when rain falls and is evaporated back into the atmosphere) that strengthened the storm.

As a result, there were thunderstorms in southern Alberta from the foothills to the Cypress Hills near the Saskatchewan border.

When the two systems converged over an area known as Burns Creek, now known as the eye of the storm, a total of 345 millimetres - nearly 35 centimetres - of rain had fallen.

“It’s at the headwaters of the Highwood and the Elbow and the Kananaskis Rivers,” said Pomeroy. “That’s the bull’s-eye.”

The Highwood, already known to have a troublesome reputation as a river prone to flash flooding, flows toward High River; the similarly worrisome Elbow goes through Calgary; and the Kananaskis River flows into the Bow River, which winds through the city’s downtown.

Within a few hours, the deluge made its way to the communities of Black Diamond, Turner Valley, High River and Calgary.

It forced the evacuation of about 75,000 people in the city and another 13,000 from High River, where the flow of the Highwood sped through the town faster than the water pouring over Niagara Falls.

Along the way, the floods washed out dozens of bridges and culverts, destroyed more than 1,000 kilometres of highways and left communities in total disarray, with flash flooding requiring some people to be rescued off their rooftops by helicopters.

The rain stopped late on June 21, but not before killing at least five people across southern Alberta and leaving behind a \$6-billion repair bill.

It was the largest natural disaster in Canadian history.

Scientists now know exactly how much rain fell and why it flooded but, three years later, the lessons from the 2013 flood are still being learned.

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In Colorado, where [similar flooding](#) hit in September 2013, officials with the federally funded National Centre for Atmospheric Research have already determined through quantitative research that the U.S. flood was a direct result of climate change.

Similar climate models are being run in Canada, but Pomeroy said the 2013 flood in Alberta shows all the signs of climate change.

“The highs and lows, the weather pressure system was extreme,” he explained. “It was also a very large event and a very long event.

“Trends like that are associated with a changing climate.”

For Pomeroy, who started his career as a water expert more than three decades ago after a flood in Montana, the 2013 flood once again changed the course of his research.

“I wasn’t someone who paid that much attention to floods,” said Pomeroy, the Canada research chair in Water Resources and Climate Change at the University of Saskatchewan.

Leading up to the storm in 2013, Pomeroy had been studying the effects of climate change on water resources in the Prairies out of a small lab near Barrier Lake, in the heart of K-Country.

“Our research basin, Marmot Creek . . . turned out to be near the epicentre of the storm, so we had a lot of detailed measurements going on at the time and a lot of people in the field to observe what was happening,” he said.

There are actually a series of weather stations set up throughout the Rockies, starting at the glaciers at the Columbia and Wapta Icefields and dotting the landscape throughout the Prairies.

At the glaciers, it’s easy to see the effects of climate change as they retreat - a fate that’s been documented in several ways: through the markers beyond the toe of the Athabasca Glacier, through photographs over time and through the work of scientists for the federal government and various universities.

Some models have suggested 90 per cent of glacier ice in the Rockies could disappear by 2100 due to warming temperatures.

The Bow Glacier - located southeast of the Athabasca Glacier - feeds the Bow River, the source of Calgary’s drinking water, in August once the snowpack disappears.

Pomeroy’s team has been studying how climate change affects snowmelt and the glaciers, but their work over the past three years has expanded to include the floods in the same watershed.

“Sometimes when you are dealt a lemon, you make lemonade,” he said. “We had this terrible natural disaster so we thought we need to learn something from this rapidly.

“Fortunately, there were 15 scientists - either students or professors from the University of Saskatchewan - in this area at the time, all trapped in different places but all observing what was going on and we were able to keep our weather stations going throughout the event.

“That helped us learn quite a bit,” he said.

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Several posters hang in Pomeroy’s office back at the Coldwater Laboratory, a rundown building that was repurposed for the University of Saskatchewan’s use in 2009 at the nearby University of Calgary’s Barrier Lake Field Station.

The posters, which highlight some of the scientific research from the flood, serve as daily reminders about what took place in 2013.

According to one paper released in January by Pomeroy, along with several other authors, flooding is the most common and costliest natural disaster for Canadians.

It can include snowmelt runoff, flash flooding due to intense rainfall, ice jams, failure of natural or built dams, or storm surges at any time of year.

“Progressive warming has meant a shift from snowmelt-dominated flooding to rain-on-snow or rainfall-runoff flooding in some areas, and these changes have challenged local authorities who manage infrastructure or predict flooding,” concluded the paper. “Rising sea levels and changes in storm frequency suggest the storm-surge flooding may increase in coastal areas. This prospect needs to be addressed.”

Back on the prairies, the paper also suggested there’s a need to consider changes to wind redistribution, winter snowfall, snowmelt and runoff over frozen soils.

It’s believed the intensity of floods in the Prairie Provinces is being affected by climate change.

“Multiple-day rain events have significantly increased in the Prairie Provinces and in the Rockies,” according to a report to the parliamentary budget officer in January.

The increase comes with questions about how governments plan for those events.

The same report, released in February, shows that the cost of floods is rising for the disaster assistance program - particularly in the three Prairie Provinces, where floodplain regulations are different than Ontario.

Because of extreme damage and 81 deaths from hurricane Hazel in and around Toronto in 1954, the flood zones are mapped to a one-in-100-year flood standard.

In Manitoba, the Red River flood in 1950 led to the creation of a flood control project that includes the floodway around Winnipeg. It was completed in 2010 to withstand a one-in-700-year flood.

Both provinces have strict and enforced building regulations in the flood plains.

There’s hope that the southern Alberta flood of 2013 will change the way this province prepares for future events - a series of policy decisions that would be made after five major flood hazard studies are completed next spring.

“It’s a pretty significant piece of work,” said Jason Penner, a spokesman for Alberta Environment and Parks.

The mapping project on the Bow, Elbow, Sheep, Highwood and Peace rivers will include a hydrology assessment on the rivers, including scenarios for one-in-two-year floods to one-in-1,000-year floods.

Until then, some of the mitigation measures being considered include looking at how forests are managed, reintroducing beavers on the landscape, building large dams to protect important infrastructure, improving flood forecasting systems and restoring flood plains to their natural state.

Conservationists have suggested the best way to manage for future flooding lies upstream in the headwaters, the area along the Eastern Slopes of the Rockies.

It's the same area where the storm hit hardest - the bull's eye.

Some have maintained that limits need to be placed on development in the Eastern Slopes, which are also key for watershed health.

"There's a lot of forests where you can get wood," said Kevin Van Tighem, a conservationist who was the chairman of a forest monitoring agency from 2002 to 2005. "The priority in our thinking should always be around water security."

Forestry, disturbances such as roads and seismic lines, and off-road vehicle use can all have effects on flooding.

Pomeroy agreed that healthy watersheds are important for water quality, but noted that they've discovered an intact forest may not prevent future flooding.

"The rain doesn't care whether it falls on a healthy or unhealthy watershed," he said. "It's what happens when it hits the ground."

In simulation exercises, they've removed all of the forest cover and there was no effect on the level of flooding. Another experiment, however, included compacting all of the soils in the forest.

"The flood peak doubled," said Pomeroy, noting soil management appears to be more critical than forest cover - something they will research further in the coming years after receiving a grant from the provincial government.

"The trees themselves aren't that important," he said. "It's the soils under the trees that are important."

They've determined that it bought some time in the 2013 flooding.

Another way to protect communities downstream from future flooding could be the reintroduction of beavers on the landscape.

During the 2013 flood, Cherie Westbrook, a professor in wetland ecohydrology at the University of Saskatchewan, was studying beavers in the Sibbald area of Kananaskis Country.

"For the majority of the event, we actually had a lot of storage in the system," she noted. "There was actually quite a lot of ability to retain the flood waters and slow them down as they were moving down the valley bottom."

Van Tighem suggested reintroducing beavers on the landscape could be one way to mitigate future flooding.

"Something as simple as instituting a prohibition on the trapping of beavers west of Highway 2 would cost no money at all, after all, and yet deliver marked improvements in headwaters health over time," he suggested.

Instead of relying on nature's engineers, the province has provided \$21 million in funding for a series of watershed resiliency and restoration projects that will create wetlands and restore riparian areas.

It's also in the midst of an environmental assessment on a dam near Springbank to protect Calgary - including the multimillion-dollar homes along the Elbow River.

The province is billing it as the most cost-effective, environmentally sound and least disruptive option for Calgary flood mitigation, but the affected landowners and Rocky View council question its timeline and \$250-million price tag.

The proposed 'dry' dam would sit in a low-lying area south of the Trans-Canada Highway, east of Highway 22 and north of Highway 8 with a diversion canal from the Elbow River.

It would sit empty unless there was a risk of flooding, working with the Glenmore reservoir in Calgary to accommodate water volumes equal to the 2013 flood.

“You can defend the Elbow all you want, but what if it moves to another one?” said Pomeroy, referring to a flood on the Bow River. “It’s a really big problem.”

In addition, the size of the dam assumes future storms would have to be equal or less than the one in 2013.

Although weather forecasting is getting better, Pomeroy said there’s still some unpredictability with precipitation in climate models.

“It’s still a big challenge to bring these advances in weather models and make sure they are showing up in climate models as well,” he noted. “Right now, there’s no way you can say in 2040, in July, it’s going to rain this much. Unfortunately, you also really can’t say with great certainty whether July 2040 will be any wetter or drier than it is now. They all say it’s going to be warmer.”

Indeed, most scientists agree that the climate is already warming - often in the winter and at night when it isn’t noticed as much.

Precipitation is also going up in the winter and in the spring.

“The problem is in any individual year seeing what is happening is really difficult,” explained Pomeroy, noting any dam the province builds would have to be large enough to withstand the most extreme event. “All they can say is build it higher.”

In many ways, a dam would only serve as a security blanket.

“A dam can allow people to feel safe,” he said, “but, in a very extreme event, the dam can be overtopped and fail.”

So, even though it could protect those communities in a smaller event, it doesn’t put an end to the risk.

“It’s like having a better lock on your door, but not a really good lock on your door, so someone could still get in,” he said. “So how safe should you feel? You’re safe against teenagers but not against professionals.”

There are also environmental and social costs of building dams, which could have effects both on the water quality and biodiversity around the sites. It includes effects on the fisheries and recreation, as well as the overall ecology of the area.

Pomeroy said there’s no doubt Calgary needs to be protected from future flooding due to the location of its downtown.

The big question is how.

“It’s a century of urban planning decisions,” he said, noting international studies have shown municipal politicians should not be making those decisions because they can’t withstand the pressure from developers.

Back in 1910, when the city built the Stampede grounds that are only used for a couple of weeks each year, it made sense.

“What a great use for the flood plain to put in a temporary fair,” said Pomeroy, noting the area kept being developed over the years and now houses the Saddledome, home of the Calgary Flames. “What an unfortunate place to put a hockey arena.”

The arena, situated along the Elbow River, was under three metres of water, destroying everything below Row 8 of the lower fan seating area.

In defence of former city planners, Pomeroy noted that floods in Calgary didn’t happen much between 1932 and 2012.

Still, Pomeroy said building a dry dam to protect the city doesn’t make sense.

“Most dams have more than one purpose,” he said. “If you are going to go to the trouble of building a dam, you might as well operate it year round and use it to moderate the river for droughts.”

“That’s part of why that idea seems like a strange idea to me.”

Managing a dam for droughts, as well as floods, could help the irrigation districts downstream that rely on the water for agriculture and the provinces of Saskatchewan and Manitoba that rely on the same waterways for water and electricity generation.

Not to mention, he said, most droughts statistically end in floods.

Pomeroy said it’s a good move for the province to improve its flood-mapping systems.

It would then make sense for policy - particularly in places like Calgary and High River - to look at the development in their flood plains, including the removal of high-value property.

“That’s what works,” said Pomeroy, commending High River officials for showing “brave and strong” leadership in buying out some homes along their floodplain.

He’s still a little frustrated, however, when he looks at Calgary.

“We had a chance right after the flood,” he said. “People were willing to move away from those areas that were flooded and they would have happily done so, and that wasn’t pushed very hard. You lose that opportunity over time.”

Pomeroy acknowledged that the solution is tougher in downtown Calgary, where there are some really high-value buildings.

Still, he doesn’t see it as an impossible solution.

“We got into this problem over a century,” he said. “It doesn’t mean we’re going to get out of it in a century.”