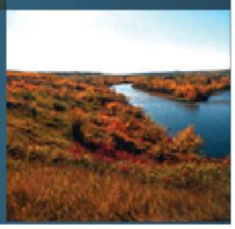



The 2013 Great Alberta Flood: Actions to Mitigate, Manage and Control Future Floods Feedback Compendium

Additional Feedback from Water Experts and Albertans

ALBERTA waterSMART
Water Management Solutions

August 2, 2013


info@albertawatersmart.com

WaterSMART Solutions Ltd.
#200, 3512 - 33 Street NW
Calgary, Alberta T2L 2A6
www.albertawatersmart.com

Introduction

This document catalogues the additional feedback from water experts and Albertans regarding "The 2013 Great Alberta Flood: Actions to Mitigate, Manage and Control Future Floods." This document includes input from water experts that, because of its level of detail and length, could not be included in the white paper (see Section I). This input is valuable and relevant, and should be consulted to gain a deeper understanding of some of the issues related to flooding.

Also included is feedback from Albertans who responded to the question posted on the Alberta Water Portal (www.albertawater.com) "How can Alberta prevent future flooding?" Albertans were encouraged to read a working draft of the white paper, which was publicly posted on the Portal, and submit their comments via Facebook, Twitter or email (see Section II).

Finally, contributors to the white paper identified several articles and resources that they felt were relevant to this discussion and that would be of value to the Government of Alberta as flood and drought preparation and planning is considered now and in the future (see Section III).

SECTION I: ADDITIONAL FEEDBACK FROM WATER EXPERTS

Carolyn Campbell
Conservation Specialist
Alberta Wilderness Association
Submission 1: Email comments on Discussion Draft v08

Comments on 'The 2013 Great Alberta Flood: Actions to Mitigate, Manage and Control Future Floods Discussion Draft v08'
July 30, 2013
By Carolyn Campbell, Alberta Wilderness Association, ccampbell@abwild.ca

Thanks for circulating this draft and providing this opportunity to comment. Overall, we urge focus on recommendations and actions that will restore and sustain watershed ecology

Prioritize headwaters land uses for watershed integrity, biodiversity and low impact recreation. This would include:

- reducing the existing network of linear disturbance (including seismic lines, logging roads and OHV trails) that reduce water absorption in rocky and vegetated surfaces and increase sediment transport. Do this through focused reclamation and serious efforts to relocate and regulate OHV recreation into less sensitive areas; flood disruption to existing trails represent a good opportunity to re-manage damaging motorized access
- replacing the current timber-supply oriented forest management with ecosystem-based forest management that buffers wetlands and tributaries, sustains rare plant communities, and yields a more natural age-class structure
- restoring and protected habitat for threatened native bull trout and westslope cutthroat trout as important indicators of water quality, healthy hyporheic (groundwater-surface water) interface zones, and overall stream ecology

We strongly disagree with the recommendation to utilize more on-stream storage for flood control. These structures are most disruptive of aquatic ecology; other solutions need to be pursued.

Expand recommendation #3 on natural infrastructure

- good to see reference to wetlands
- other important physical or natural infrastructure to emphasize include alluvial aquifers (shallow groundwater-bearing channels connected to surface water bodies such as rivers), which should be better mapped and better protected from gravel mining and other land uses that deplete their capacity to store high-flow waters

Improve watershed monitoring network for gathering management-oriented data on water quantity and quality, groundwater stock and flows, wetlands and riparian habitat, land cover and uses.

Manage cumulative impacts of human footprint on land and water with biodiversity as well as water quantity and quality in mind.

- Include biodiversity management frameworks and land disturbance limits to complement anticipated water management frameworks in regional plans

Call for stronger measures to reduce Alberta's greenhouse gas emissions

- as part of our obligation to future generations to reduce the risks of more frequent extreme weather events from climate change
- paper refers to reducing effects of future extreme weather events. Mainstream, credible scientific consensus is that man-made greenhouse gas (ghg) emissions are leading to climate change that will increase the risks of more extreme weather events in the future
- it is time for Albertans to discuss and develop serious plans to reduce our absolute ghg emissions

These recommendations are brief and informal. Please contact us for further information or clarification. Thanks again for the opportunity.

Carolyn Campbell
Conservation Specialist
Alberta Wilderness Association
Submission 2: Email comments regarding on-stream storage

Concerns with On-stream Storage for Flood Control
as further comments on 'The 2013 Great Alberta Flood: Actions to Mitigate, Manage and Control Future Floods Discussion Draft v08'

August 2, 2013
By Carolyn Campbell, Alberta Wilderness Association, ccampbell@abwild.ca
Many of these points are excerpted or paraphrased from Dave Mayhood (2010). "An Overview of River Ecology and its Implications for Simplified Hydropower Approvals in Alberta." 38 pp.

The effects of on-stream storage reservoirs depend on what is installed, where it is installed, and how it is operated, but some generalizations are possible: reservoirs replace productive flowing water habitat and riparian habitat with less productive silty, standing water habitat. They also block movement of materials downstream and movement of organisms upstream and downstream. The reservoir habitat is even poorer and downstream impacts are greater if reservoir levels fluctuate frequently.

Food webs in Alberta's Rocky Mountain and foothills headwaters rely on organic debris that enters streams from land runoff, is trapped by log jams and rocks, and is processed by bacteria, fungi and macroinvertebrates. The relatively steep gradients move sediment downstream and scour stream beds, which among other benefits provide trout with clean gravels to aerate their incubating eggs. In the middle reaches of rivers, where channels broaden and gradients decline, photosynthesis by attached algae, and processing of the fine particulate carbon produced by the coarse processors upstream, becomes more important for habitat productivity.

Within reservoirs, the gradients are flattened, sedimentation rates are high and much of the organic material is sequestered in the bottom sediments. Plankton photosynthesis is limited by turbidity. With reduced organic materials processing, there are fewer organisms to support fish in the reservoir and fewer flying adult insects for upstream sites. If the reservoir use includes hydroelectric generation with high flowthrough rates, or if the reservoir is drawn down over fall and winter, then shoreline erosion is common, which increases water turbidity and siltation. High flowthrough rates deplete plankton, while a drained reservoir bottom reduces or eliminates organisms in the bottom sediments, leaving little to support fish production.

On-stream storage also degrades upstream habitat by reducing numbers of migrant fish from downstream. These adults no longer spawn upstream, and their bodies do not enrich the upstream food web. Fish passage efficiencies rarely exceed 70%, commonly do not exceed 50 percent and often are much lower.

On-stream storage reservoirs also destroy riparian habitat, particularly if fluctuating levels do not allow functioning wetlands along the shore. Riparian zones have a disproportionate ecological importance in their watersheds: they contribute nutritional resources to the aquatic community, they help retain those resources in the channel, and they provide productive habitat for many other terrestrial plants and animals.

Changes to downstream 'productivity', in terms of biomass, are harder to generalize with on-stream storage, but there are significant changes affecting streams and aquatic communities. Peak stream flows and sediments that scour out and reshape stream channels are greatly reduced. Reduced stream flow variation possibly favours *Didymosphenia* invasive algae blooms, which are associated with reaches below dams. There are fewer migrant fish from upstream because of lower efficiency of fish passages. Winter ice cover is compromised by release of warmer reservoir water, and by breaking up ice with fluctuating water releases.

Depending on the amount of land flooded, and whether soils contain mercury in any significant quantity, reservoirs can mobilize mercury, a potent toxin that bioaccumulates. Organic decomposition can mobilize mercury, allowing it to enter the open water and the aquatic food web. Migratory fish in the reservoir can spread the contamination upstream, while water outflow and fish (depending on fish passage) can spread the contamination downstream.

The track record in Alberta for mitigation of riparian and fish habitat destruction from dam reservoirs has been poor. In the case of the Oldman River Dam, there was high motivation to accomplish effective mitigation. Significant resources were devoted to creating deep water fish habitat in the upper Crowsnest River. However, most of these sites were undermined by river flow dynamics. Efforts then shifted downstream where there was little baseline information. Overall, fish populations do not seem to have increased in proportion to habitat creation efforts. Shelter belt tree plantings have also fared poorly in effectively replacing cottonwood riparian forests (Fitch, 2008).

Alberta should avoid further degrading aquatic and riparian ecosystems by pursuing alternatives to on-stream dams and reservoirs.

Other References in addition to Mayhood (2010) cited above
Lorne Fitch (2008). “Mitigation – Cosmetics or Compensation?” in *Wild Lands Advocate*, volume 16, No. 3, pp. 4-9.

Roger Drury, P.Eng.
Hydro Project Developer
TransAlta Generation Partnership

Anticipate and plan for more extreme weather events.

In this section [of the white paper] there is an extensive discussion about the flood hydrology of the Bow River and the fact that there has been a long period (1933 – 2004) with no large floods. Several possible explanations are posed and there is a recommendation to investigate the causality of the 2013 flood. In order to do this properly, it will be necessary to look outside the geographic confines of the Bow River basin.

The big floods such as June 2013 are caused by a phenomenon known as a “Cold Low” or “Blocked Low” system. These involve a strong low pressure system moving eastward from the Pacific coast occurring in conjunction with a large high pressure system sitting in the south-central US which is circulating warm, moist air from the Gulf of Mexico up into the path of the oncoming Low. These are huge weather systems and the track they follow eastward determines where the maximum precipitation occurs. The track, or “path” is heavily influenced by the course of the jet stream at the time. The storm center can occur anywhere from northern Wyoming, up through Montana and all the way to Jasper.

In order to study this properly, you have to look at all of the major river basins with headwaters along the east slope of the Rockies (including Montana) to get the full picture. I just scanned the WSC [Water Survey of Canada] records and what you see is that some very large floods have occurred in the Oldman, North Saskatchewan and Athabasca rivers in recent decades, whereas hardly any have occurred in the Bow and Red Deer during the same period. There is also commonality. The same 1915 flood that occurred in the Bow at Calgary also resulted in the annual peak flow in the Oldman at Lethbridge, the North Saskatchewan at Edmonton and the Athabasca at Athabasca. At Edmonton, this 1915 event is the largest flood on record and the famous photo of a train sitting on the Low Level Bridge to keep it from being lifted and washed away is from this event. The point being that this commonality emphasizes how huge these storm systems are. Had this event tracked farther south, it would have been a different story.

All of these big floods are caused by Cold Low events. A preliminary theory might be that some type of atmospheric circulation pattern is determining which basin gets hit at what time. To say that there have been no big floods in the Bow recently, although true, is not a complete assessment. A more correct statement would be that the big storms that cause these floods have not tracked through the Bow Basin recently. I think it will be critical to look at flood history for all of these river basins to get a complete view of the frequency and magnitude of potential floods along the eastern slopes. If the hydrology assessment simply looks at each river basin independently, it misses the fact that these storms occur on a regional basis, not a basin specific basis.

Improve our operational capacity to deal with a variety of potential extreme weather scenarios through better modelling and data management.

I agree in general with the points raised in this section but it is important to recognize that all the modelling in the world does not help you when real-time data fails. During the 2013 flood, every single WSC gauge between Banff and Calgary went out of service prior to the peak flows occurring.

I think an important action item would be to investigate backup systems at gauging stations to try and maintain data continuity during large events. A standard stream gauging station is built on the bank of the stream and is prone to being damaged or flooded just like any other infrastructure along that stream. It would be really valuable for real-time operators like TransAlta if some research could be done on alternate systems that could kick into operation when the standard gauge went out of operation. Sonic systems don't work because of all the sediment transport in the water but possibly an array of laser water level sensors located outside the active stream channel? I don't know the answer but this would be a valuable item to pursue.

Wendy Francis
Program Director
Yellowstone to Yukon Conservation Initiative

The actions and recommendations appear to be weighted toward predicting and responding to future flood events, rather than preventing them or minimizing their severity. Of the six recommendations, only numbers 3 and 4 include actions that would improve nature's ability to modify future flood impacts. And while there are sometimes extremely specific recommendations regarding flood preparedness (e.g., testing sump pumps in office buildings) those regarding land use planning and management are extremely general and brief. At the Yellowstone to Yukon Conservation Initiative (Y2Y), we think there are practical, cost-effective measures that can be taken to mitigate the severity of future floods. Indeed, we think this should be the first priority.

It is highly likely that the way our forested headwaters are managed (with a priority given to timber harvesting, energy exploration and development, and motorized access) contributed to the severity of last month's floods. We currently have an unprecedented opportunity to influence the way in which Alberta's headwaters are managed. The government currently is putting the final touches on the draft South Saskatchewan Regional Plan (SSRP), anticipated to be released by this fall. It will set the stage for land management policy and practices throughout southern Alberta for years, if not decades. The SSRP will provide the foundation for management decisions that will have a significant impact on whether or not Alberta's headwater forests provide flood prevention, reduction and mitigation services. When forested headwaters are clear-cut, they lose their ability to absorb and hold back water, just as if they had been burned or killed by beetles.Y2Y believes that the SSRP must require a change in forest management policy to require forestry practices to preserve natural flood prevention and minimization services. Some specifics include a reduction in the number and size of clear-cuts, with a move toward practices that maximize the ability of forests to capture and retain precipitation, and reducing densities of access routes into headwaters (which contribute to erosion and whose hard surfaces are unable to absorb as much moisture).

I should add that I have read Kevin Van Tighem's suggestions for the white paper, including more specifics with regard to headwaters management, and concur in the entirety of his comments.

It would be extremely timely for the white paper to include reference to the SSRP and the opportunity that it presents to enhance flood avoidance and mitigation through the appropriate management of headwater forests. The opportunity to refer to the SSRP exists in the second bullet on page 13, which mentions pine bark beetles and forest fires, but not logging practices, and also mentions land use planning, but not the specific and imminent opportunity of the SSRP. The SSRP also should be mentioned in the short-term opportunities at the conclusion of the paper.

Brad Stelfox
Landscape Ecologist
ALCES Group

Living at the River's Edge: Some Context of the 2013 Bow River Basin Flood

The 2013 flood of the Bow River basin has triggered a long-overdue conversation about the natural and man-made factors that caused or contributed to these types of events. Across society, people are now asking pointed questions that relate to mitigation, prevention, headwater management, overlapping land uses, floodplain infrastructure, climate change, and flood proofing.

The WaterSMART White Paper provides an excellent broad overview of the complexity of this watershed issue and makes clear that integrated solutions are required to meaningfully address this challenge. Appropriately, the WaterSMART report identifies that both engineering and landscape management approaches are required if watershed integrity of the Bow River basin is to be conserved and risk to infrastructure is to managed at an acceptable level.

As a resident of the Sunnyside community in Calgary, our neighborhood was extensively flooded and most families experienced serious damage to their basements, and in some cases, structural damage to their homes. In comparison to the residents of lower Benchlands, High River, and many other communities, we escaped relatively unscathed. In the aftermath of these events, we are told that those who have experienced flooding are expected to go through the emotions of anger, denial, depression and acceptance. For most affected by the flood, there is a basic need to understand what happened and what factors contributed to an event that so forcefully changed our lives. Over the next several months, more information will certainly come forward to help residents better understand the weather, landscape, and land use dynamics that shaped this massive event, but a few thoughts are respectfully offered below to help put some of these dynamics into context.

During the past five years, the ALCES Group has completed two Bow River basin watershed studies examining the effects of land use (forestry, energy, agriculture, residential, transportation, recreation) and climate on watershed integrity. One of these studies (the Upper Bow Basin Cumulative Effects Study) examined the entire basin upstream of Calgary. The other study focused on the Ghost River watershed, an important headwater basin within the Bow River system. For those wanting to understand the detailed findings, these reports can be downloaded from the ALCES website (www.alces.ca).

These studies underscore the large amount of natural variation in environmental conditions that characterize the headwater landscapes of southwest Alberta. Year-to-year and decade-to-decade change in precipitation, temperature, and fire create a wide range of natural variation in levels of groundwater saturation, river flow, and water quality. The episodic nature of this natural variation is such that rare events (massive floods or sustained drought) are not commonly observed in any given year and may take multiple generations to witness the full variation of Mother Nature. But we must be careful not to confuse uncommon with unimportant, for it is these relatively rare events that define the form and function of the Bow River and its tributary basins. Many of us witnessed one of these infrequent events firsthand this June. The improbable combination of a large moisture-laden low-pressure system, stalled against a high-pressure ridge created by a fold in the jet stream, lead to a massive precipitation event that fell extensively throughout the Bow River basin, including the drainages of the Ghost, Elbow, Sheep and Highwood rivers. This hydrological event was made even more impressive because some of the rain fell directly on a deep snowpack (which melted rapidly) while in other areas the rain fell on frozen or saturated groundwater. With limited capacity of the landscape to absorb the billions of cubic meters of water flowing downhill under the force of gravity, the outcome was a foregone certainty. All watercourses, from the smallest of tributaries to the largest mainstem rivers, quickly swelled, overtopped their banks and spread waters across their floodplains in a fashion that has re-occurred hundreds of times since glacial ice sheets retreated several thousand years ago.

What made this 2013 event of immense interest (and anxiety) was the magnitude of physical and economic damage to infrastructure it caused. Long-term river flow records indicate the

2013 flood was about the largest recorded for the Ghost River and 5th largest flow on the Bow River - yet it caused, by far, the greatest economic loss. The obvious point here is that a vast amount of infrastructure (houses, roads, schools, business complexes, industrial facilities, recreational facilities) has been constructed on floodplains and riverside benches in the past several decades. As Alberta's main economic urban engine, Calgary and its surrounding communities have converted vast investment dollars into physical infrastructure – much of which is located directly along waterways. As these communities have sprawled outward, much of this growth has occurred along the very mainstem rivers (Bow, Ghost, Elbow, Highwood) that originally attracted Alberta's pioneers and gave birth to the initial settlements. It has been the inevitable collision between high floodwater volume and dense floodplain infrastructure that lead to this unprecedented economic disaster.

While one does not need to invoke climate change scenarios to explain a single large flood event (such as the 2013 flood), the science of climate change universally points to these types of events becoming more frequent and of greater magnitude. Ignoring the role of climate change in the dynamics of current and future water flow in the Ghost River and the Bow River basin has immense risk to all land uses and citizens. Perhaps the 2013 flood will catalyze a more mature and science-based conversation about, and appreciation for, the critical "driver" of climate change. We ignore this conversation at great peril.

The findings of the ALCES projects in the Bow River and Ghost River basins highlighted the importance of land use in affecting the flow and performance of water quality, landscape integrity, and wildlife to the residents and users of these watersheds. Were these land uses responsible for the flood and the destruction it caused? Our analyses revealed that the portion of these basins allocated for logging, agriculture, transportation, residential, recreation, and the oil and gas sector can profoundly alter surface and subsurface movement of water and the amounts of nutrients and sediment entering water. In addition, the extent to which best management practices are adopted can mitigate risks caused by land use and water. Key management practices that reduce flood risk include protecting riparian forests (including those along small tributaries), leaving more live trees within cutblocks, improved cattle grazing practices, and careful selection of road/trail networks for forestry, oil and gas, and recreation. When all of these best management practices are deployed collectively, headwater landscapes can provide Albertans with improved performance of ecosystem services and significantly reduce the frequency and cost of floods that cause economic disruption. Would these improved land use practices, if fully deployed, have prevented the events of June 2013? Not likely! The magnitude of this foothill and mountain rainfall event was so extreme that it would have likely generated extreme surface water and sediment runoff even under conditions of progressive land management. That said, society must not lose sight of the long term importance of sustainable watershed management. It would be unwise to use the volatility of natural systems as an excuse for poor land management practices. In hindsight, the most relevant "best management practice" would have been to avoid construction of new infrastructure within flood plains and lower benches, and to relocate, where possible, existing infrastructure away from these features. The carnage observed by those who live and work in these basins can be viewed as a reminder of the raw power of natural ecosystems. It is also a wake-up call of how these "rare" events can become more frequent in a climate change world, especially if society continues its historical preference to building infrastructure so close to waterways.

During the extended periods of time, often measured in multiple decades, that occurs between flood events, it is all too easy for generations living in the “gentle times” to forget the lessons learned by past flood survivors. Societies in general, and governments specifically, have a responsibility to remember these lessons, and to build policies and infrastructure that intelligently reflect the force and destructive potential of natural systems.

As long as there has been people, they have been drawn to water for food, industry, recreation, and viewscapes. Our challenge is to balance these amazing benefits with the flood risks that inevitably accompany “living at the river’s edge”.

Brad Stelfox, Landscape Ecologist, ALCES Group; bstelfox@alces.ca

Steward Rood
Professor and Board of Governors Research Chair in Environmental Science
University of Lethbridge

We've been undertaking analyses of floods along all of the rivers in the SSRB and I'm attaching our prior paper relating to flood-flow attenuation of the Bow River [see Appendix D]. The historic river flows do indeed indicate that the dozen dams and reservoirs upstream of Calgary attenuate at least minor and moderate floods. An unfortunate consequence is that this leads to a false sense of security and expanded development in the lower elevations. Consequently when a major flood inevitably happens, the economic cost is vastly increased.

Relative to this, the Elbow valley through Calgary is a classic case. A half-century ago there would have been simple cabins along the river and flooding would have caused only slight damage. Over time, and especially following the Glenmore Dam, the cabins were expanded into homes and basements were excavated, vastly increasing the vulnerability. The next unfortunate step was that the modest homes were replaced by river-side mansions and this further increased the vulnerability and especially the cost.

I'm not convinced by the first point in the report recommendations and this is a suggestion that repeatedly arose after the floods. This is the prospect that floods will be more common and/or more severe. While this is indeed consistent with the 'climate intensification' model, there are actually opposing factors, which are shown in the historic record. With winter warming (which is certain), there are changes in the rain vs. snow patterns and subsequent snow-packs and melt. Annual mountain snow-packs may thus be declining and more confidently, spring melt is earlier. The consequence may actually moderate flooding since earlier melt is more gradual. Rains may or may not be getting more severe, but the timing may also be critical. Major river flooding in the SSRB requires the convergence of two conditions: (1) saturated water-sheds, and (2) intense rain. Even if '(2)' changes, I think that the earlier melt might slightly uncouple the two factors.

This is somewhat speculative but consistent with the historic records. Further, as indicated in the flood report, there has apparently been a recent decrease in flooding along the Bow River. This opposes the proposal that floods are getting worse and from the historic record my view is that 'Calgary has been overdue for a major flood'.

The High River case is discouraging since there's such a clear and extensive history of flooding. If you sort through the archival photos at the museum in High River and then coordinate photos with river flows, the conclusion is that it's possible to float a canoe down main-street about once a decade. This town is unfortunately situated in a natural overflow zone, in which the very dynamic Highwood River regularly overflows its shallow banks and the flood water flows overland into the Little Bow River, which commences right in the Town.

Flooding in High River was major and costly in 1995 and 2005 brought three smaller floods that also led to considerable property damage. While the 2013 flood was indeed more severe, the largest reason that the 2013 event will be much more costly than the 1995 event is that the town population has doubled (around 7K to 14K). And very unfortunately, some of the newer subdivisions are east of the older town and in a low-lying basin where the massive pond formed (and persists). There might have been the view that this area was less vulnerable since it's further from the river but this neglects the key aspect that 'water flows downhill'. If one looks at older air photos and early survey maps, we find that that area was commonly a complex of wetlands and thus it was naturally very low and wet, and with limited drainage.

These are the types of things that should be sorted through and I thus strongly support the initiative.

Finally, I've got 2 MSc students analyzing the flood history for the rivers draining the central Rocky Mountains region of AB, BC and MT, including those of the SSRB. Our intent is to better understand prospective impacts of climate change and to test the 'climate intensification' theory. This task fits nicely with our Functional Flows research program and we should have the key analyses by the end of 2013. We will be glad to learn more about what others are up to.

Dave Sauchyn, Ph.D., P.Geo.
PARC, University of Regina
Submission 1: Email regarding Discussion Draft v08

Comments on "The 2013 Great Alberta Flood: Actions to Mitigate, Manage and Control Future Floods - Discussion Draft v08"

This report is an excellent platform for launching a wider, more inclusive discussion the causes and mitigation of the impacts of climate extremes in Alberta and the 2013 floods in particular. WaterSMART deserve thanks for taking the initiative. As with any draft report from a single source, especially when timing is critical, it reflects the expertise of the authors and advisors who in this case have an engineering and hydrology orientation. This certainly is an appropriate expertise, but the associated biases provide minimal space for a review of non-structural strategies for mitigation and management of the impacts of extreme weather events. Specifically the report could benefit from the input of scientists and practitioners with an interest in source water protection, rural land use planning, landscape conservation, and watershed (versus river) hydrology. The report is not devoid of this perspective, for example, there is the recommendation to "Incorporate natural infrastructure such as wetlands, riparian areas, natural storage conditions and land cover into flood and drought mitigation planning." However, there is more scope for softer watershed-scale planning and ecosystem-based approaches in the context of recommendations1, 2 and 6.

The report is tactical with the multiple references to drought, as for example "ensuring that drought and flood planning receive equal attention from policy-makers will help us be better prepared for increased weather variability ". Besides common issues and mitigation strategies, most scholars and practitioners recognize that drought is the more serious problem in western Canada (although now is not a good time to admit this). While flooding has immediate and severe consequences, it is confined to floodplains and adjacent areas; drought impacts are creeping and widespread and much more costly. Financial losses from the drought of 2001-02 in the Prairie Provinces (mostly AB and SK) were estimated at $3.8B almost 4 times the projected cost of the Alberta 2013 flood.

Regarding the recommendations

1. Anticipate and plan for more extreme weather events, including both flood and drought.
2. Improve our operational capacity … through better modeling and data management.

These refer to the work of my research group and thus I naturally concur with this advice and the more specific recommendation

- Conduct a study to analyze the confluence of events that resulted in the 2013 flood.

However, in my opinion, before we proceed with more research, we need to do a better job of defining the broader scientific context. Remarks like "Alberta should be planning for even more extreme weather events - both in frequency and in cost" strongly imply that Alberta's climate is changing, and yet nowhere in the report can I find the terms "climate change" or "climatic change" (nor would I expect to find "global warming"). Does the avoidance of this terminology reflect a sensitivity when dealing with the GoA or is it simply that authors chose not to explicitly refer to climate change? The report wisely suggests that "More work needs to be done to understand any other factors that are influencing the weather, resulting in more extreme events. This analysis can then be used to signal how frequently we can expect these events in the future and their potential magnitude, allowing for better planning." And yet language in this report, and other reporting (media) of the floods, implies that the link between global warming and extreme weather is a given, a scientific fact. To maintain scientific credibility we have be very careful with statements that suggest, or can be interpreted to mean, that the flood of 2013 was the result of global warming. I would be pleased to provide the authors of this report, or anyone else, with a plain language summary of the evidence and uncertainties regarding the link between a warming climate and extreme events.

Dave Sauchyn, Ph.D., P.Geo.
PARC, University of Regina
Submission 2: Contribution regarding global warming and extreme weather events

Global warming and extreme weather events: The scientific evidence and uncertainty

The Problem

In their wake, weather disasters, like Hurricane Katrina, super storm Sandy, the Russian Heat wave of 2010, and the Alberta flood of 2013, are often attributed to global warming, at least by some journalists and government officials. Most scientists, however, would regard a connection between global warming and extreme weather as a hypothesis, and point out that a single event is simply weather. There is a strong temptation to attribute extreme weather to a changing climate, for at least three reasons:

1. Humans inherently and consistently discount the future, including the longer-term consequences of a changing climate. Floods and storms are an effective reminder of the impacts of unexpected weather conditions; it's a wake up call and convenient device for leveraging action from government to prevent the emerging impacts of climate change.

2. Because weather and climate are driven by energy from the sun, it follows that extra heat trapped by greenhouse gases should speed up the climate processes that produce excessive and damaging water and wind.

3. With each weather disaster, governments react with relief but also programs and structure to reduce damage from future events. In western Canada, much adaptation, "the process of adjustment to actual or expected climate and its effects", has occurred in response to flooding and drought (e.g. the Winnipeg floodway, PFRA, changing land use patterns and farming practices), even though only recently has the link been made between extreme weather and climate change. Weather disasters and global warming require a similar adaptive response to prevent adverse effects, whether or not they are linked geophysically. Dealing now with extreme weather is good preparation for the adaptations that will be required to sustain economies and communities in a changing climate; and especially if weather events become more severe as a consequence of climate change.

Attributing a single extreme weather event, or even several events, to climate change is contrary to the definition of weather and climate, and the important distinction between them. Mark Twain said it best: "weather is what we get, climate is what we expect". On any given day in Alberta, we can get almost any type of weather; snow has occurred in every month and mid-winter warm spells are not uncommon. But we expect certain types of weather in each season based on our past experience with weather over a number of years. For a climate scientist that number of years is 30; climate 'normals' are the summary of 30 years of weather data. This statistical summary includes not only monthly and seasonal averages, but also the range of extremes. In late June 2013, the residents of Canmore did not expect more than 220 millimeters of rain in 36 hours, nearly half of the annual average rainfall, but that's what they got. If climate is 'the weather we expect', then unexpected weather is an indication of either climate change or a larger range of natural climate variability than we've previously experienced.

If climate is the statistics of weather, then climate change is change in weather statistics. A change in the mean, variability or extremes has to persist for decades or longer before it can be declared a climate change. Average weather occurs often and thus trends in average conditions can be identified with a few decades of weather data. Extremes, on the other hand, are rare occurrences and thus many years would have to transpire before there are enough storms or floods to describe their statistical characteristics and many more years before a change can be detected in their frequency or magnitude.

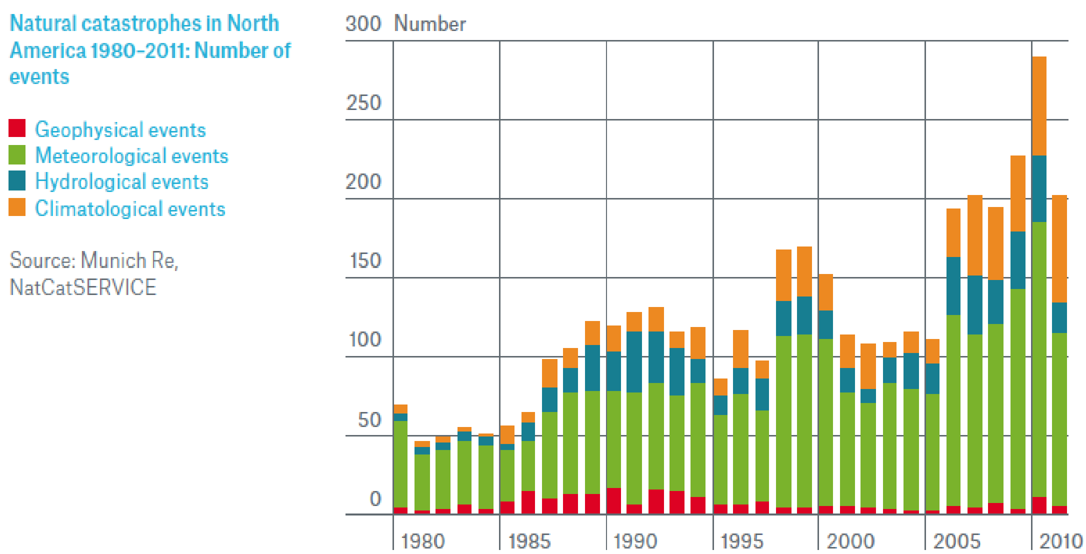
The relevant question about the Alberta Flood of 2013 is not 'was it caused by global warming' but rather 'is it part of a pattern of weather extremes of increasing frequency and severity'. There is a growing body of scientific evidence to address the question of whether a warmer climate is more volatile. This brief report is a summary of this evidence, which comes two sources: the direct observations of weather and the modeling of the climate system. The uncertainties also are considered. They are large. The most challenging climate variable, spatial scale and type of region for climate change research are precipitation, regional scale, and regions with high climatic variability. This describes southern Alberta and the problem of flooding and drought.

The Evidence – Observations

The expectation that a warming climate will include more frequent and severe extreme weather is supported by the direct observation of historical weather events. However, because extreme events are rare, there are relatively few observations to identify changes in their frequency or intensity. The most robust analyses are global in scope using data from a large number of sources and locations.

For obvious reasons, some of the best record keeping for natural disasters is by major insurance companies, including the German-based Munich Reinsurance. In a 2012 report 'Severe weather in North America', Munich Re documented the number of natural catastrophes in North America from 1980 to 2011. The graph below from that report shows a significant increase in the number of damaging meteorological (weather), hydrological and climatologically events. This trend, which also exists in other parts of the world, could simply reflect rising global population and increasing exposure of communities and infrastructure to climate variability and weather extremes. With expanding population, people have built in more vulnerable settings such as coastlines, floodplains, and mountain slopes. If these social and economic factors accounted for the increase in the number of weather disasters, then the same explanation should apply to all natural catastrophes irrespective their cause. But Munich

Re also plotted the number of geophysical events (earthquakes, volcanic eruptions, tsunamis) each year, and there has been little or no change, even a slight decline since the mid 1990s. If populations are expanding, especially into mountains and along coastlines, they are more exposed to these geophysical events that are unrelated to weather and climate. Munich Re therefore reached the conclusion that North America is suffering increasing damage from floods, drought and storms as the result of global warming. Some commentators have suggested that insurance companies may be subject to some bias; weather disasters are escalating their liability and they are compelled to document this and find a cause.



A review of scientific literature by the Intergovernmental Panel on Climate Change (IPCC, 2012 – see Further Reading) suggests that the statistics of most weather variables are changing. However the statistical significance of these trends, and the agreement among studies, depends on the climate variable and in particular its geographical uniformity. Whereas heat is always present to some degree, precipitation is episodic in time and space. Therefore trends in temperature-related extremes are more reliable than for precipitation-related variables and global-scale trends are more reliable then those at a regional scale. The most robust trends in climate extremes are global observations of a decrease in the frequency of cold days.

Researchers have medium to low confidence in the interpretation of trends in hydro-climatic extremes. Only at a global scale can there be some confidence that anthropogenic effects contribute to an intensification of extreme precipitation. Large-scale ocean-atmosphere oscillations strongly influence the timing and amounts of precipitation and stream flow. This influence or teleconnection is manifest as inter-annual to decadal variability that tends to mask any regional trends imposed by anthropogenic global warming. It prevents robust conclusions about changes in atmospheric circulation that control the global redistribution of water. One change in atmospheric circulation that is detected with some confidence is a latitudinal shift in circulation features (storm tracks and jet streams) towards the poles. This has implications for Canada. The analysis of weather records from across Canada has revealed that, in general, precipitation is increasing across the country. The one major exception is southern Alberta and western Saskatchewan, where there has been a small decrease in annual precipitation. At the same time, however, the intensity of rainfall seems to be on the rise, with fewer storms producing less annual precipitation but with greater intensity (mm/day). An increasing number of heavy precipitation events, notably in North America, is the precipitation-related trend that is detected with the greatest confidence. There is still insufficient evidence to draw conclusions about global trends in drought and severe local storms, including tornadoes and hail.

Because there are statistically significant and consistent trends in heavy precipitation events and changes in temperature-driven snowmelt processes, there is some evidence that suggests flooding has increased in magnitude and frequency. However, the evidence differs among regions according to the causes of flooding, including snowmelt but also land use and engineering structures, and the availability of data from gauging stations. Therefore there still is low confidence and agreement for observations of flooding.

Evidence – Model Simulations

Weather and water observations are the basis for understanding recent climate variability and are the baseline against which future climate changes are measured. However, instrumental records tell us little about the climate to expect in the future, unless there is a very good understanding of the causes of the observed variability and proof that it will continue to occur in a climate modified by human activities. A theoretical understanding of the climate system, and all projections of future conditions, comes from climate models "the only credible tools for simulating the response of the global climate system to increasing greenhouse gas concentrations" (IPCC).

Most of the theory behind an increasing severity and number of extreme weather events is related to the intensification of the hydrological cycle. Because about three-quarters of the earth is ocean, and water has a very high heat capacity, the oceans are storing most of the extra heat trapped by greenhouse gases. Evidence for accelerated evaporation from the oceans includes studies that document a clear increase in salinity of warm ocean water, and an increase in river flow into the oceans. The other important factor, delivering more water from the oceans to the continents, is the greater capacity of warming air to store water vapour. Other hypotheses are related to a poleward shift in the trajectory of major storm tracks and the influence of the rapid loss of arctic sea ice on the circulation of the atmosphere in the northern hemisphere. The warming of the Arctic, at a faster rate than the rest of the world, is causing a lesser difference in temperature and air pressure between low and high latitudes in the Northern Hemisphere. This may be causing the jet stream, the very strong westerly air current 10-15 km above the earth, to slow down and form large meanders. As storm systems follow a slower and more meandering jet stream across North America, rain could fall for extended periods of time at any location producing higher river levels.

The reliability of model projections of future climate depends very much on the climate variable of interest and the resolution of the model relative to processes and variables. Climate scientists use two indicators of certainty in the projection of climate changes. The quality of a climate model experiment is measured in terms of its capacity to simulate historical climate conditions. The level of confidence in a climate change scenario depends on the agreement among climate models. There is high confidence in robust results, those that are similar results irrespective of the model and methods.

The most robust climate projections are of mean annual global temperature averaged over decades, and the related changes, such as trends in Arctic sea ice extent, global mean sea level and ocean heat content. With the substantial warming anticipated in the 21st century, global increases in the frequency and magnitude of maximum daily temperatures and decreases in cold extremes are virtually certain.

The least reliable model output is anything related to precipitation at the regional scale. Therefore, there is low confidence in the modeling of small storms such as tornadoes, thunderstorms and hail; current climate models cannot resolve these small weather systems. Drought on the other hand is a feature of the hydro-climatic that spans larger areas, and also results from high temperatures, and thus there is a medium confidence in the simulation of future droughts in a warmer climate.

It is likely that, over much of the globe, the frequency of heavy rainfalls, and/or the proportion of total precipitation from heavy rain, will increase in the 21st century. This applies in particular to high latitudes, and to winter in the northern mid-latitudes (Alberta). Environment Canada scientists did some of the first and most cited modeling studies of extreme precipitation. They determined that the amount of maximum daily precipitation that historically occurred once every 20 years is likely to occur with a frequency of once in five years to once in 15 years by the end of the 21st century. In some regions, including Alberta, increases in heavy precipitation will occur despite projected decreases in total precipitation. Physical reasoning suggests that projected increases in heavy rainfall, and accelerated snowmelt with higher temperatures, will lead to more severe and frequent local flooding. Confidence in the model simulation of flooding is low, however, because the causes of regional changes are complex. For example, in Alberta future flooding should more often result from heavy rain, whereas historically rapid snowmelt has been a major cause.

Whereas numerical models are able to reliably simulate the changes in the earth’s energy balance and related affects, the response of the circulation of the atmosphere to global warming is highly uncertain and yet the regional aspects of climate change are controlled by atmospheric dynamics, including teleconnections between large scale climate oscillations and regional climate variability (in the case of Alberta, between El Niño South Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) and inter-annual and decadal climate variability). There is low confidence in projections of changes in large-scale patterns of natural climate variability. Model projections of changes in ENSO variability and the frequency of El Niño events are inconsistent, and thus there is low confidence in projections of changes in this important mode of internal climate variability.

The significant disparity in the ability of existing climate models to simulate mean states versus extremes, the climate of large versus small areas of the globe, and temperature versus precipitation is a problem of the inherent complexity of the climate system and how scientists have chosen to model (simplify) climate change primarily as a perturbation to the earth's heat and radiation balance. The dominant conceptual framework, the anthropogenic (CO_2) forcing of linear trends in temperature and other variables that define mean climate, is problematic for scientists and journalists; especially when weather departs from a monotonic warming trend. A shift in climate variability, and the severity of extreme weather events, is as likely an outcome of human modification of the atmosphere as a thermodynamically forced linear trend. The defining feature of global warming may be changes in the magnitude of climate variability rather then a monotonic upward trend in temperature implied by the terminology global warming.

The most challenging impacts of climate change are not trends in temperature by rather shifts in the distribution of water supplies between seasons, years and watersheds, and changes in the frequency and severity of extreme weather events (e.g., flooding and drought). Thus, for many regions, the most relevant climate changes are the least understood. For the foreseeable future, regional climate regimes will be dominated by natural variability, especially where it is characteristically high, as in western Canada for example.

Further reading:

Intergovernmental Panel on Climate Change (2012) "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" Available at http://ipcc-wg2.gov/SREX/ This is a very important document and the 19-page Summary for Policymakers (if not 594 page full report) should be required reading for anyone with an interest or opinion on climate change.

SECTION II: FEEDBACK FROM ALBERTANS

- The biggest point is the leadership! Someone (including the government) has to be out there taking on these challenges.

- There are lots of places in Calgary where you can stand on a bluff and look at the river valley. The valley is a path cut by the river over millennia and now slowly filling with houses, hard surfaces, waste water treatment plants, rip rap and high rise buildings. It's pretty easy to see the places where the water will go during a flood event and equally easy to see how it will travel there.

  How about re-establishing some natural buffer zones? Yes, costly, but more costly than flood repairs? That's a long term project. In the short term, some king somewhere should outlaw building within 500 meters to a kilometer of a river bank and start a fund to buy existing properties.

- Discussion has occurred regarding the development of wetlands and natural water sources (and I add protection) to control flooding. While this is a good idea, it can make problems worse than before if not managed correctly. If the wetlands are allowed to build up in height ahead of time, staging can occur where there is a momentum of water towards the outlet then bursting over and making the peak flow higher than would have been. This can greatly intensify flooding. Someone would need to be responsible for promptly controlling the level of the wetlands and would need to be notified ahead of time. I have witnessed this first hand during my work in this field. They can be valuable for flood control.

- The lack of water licencing policy that is in tune with modern demands. The current policy is out of date by many decades and does not have the flexibility to deal with the inevitable shortage (drought).

  One feature the next policy requires is the concept of needs based on priority of uses with domestic use ranking high. It needs to include the available groundwater resource of which there is a great deficit of factual knowledge. It needs to include some flexibility for quantities (and qualities) available over time as the natural flows fluctuate over the seasons.

- In terms of reducing the negative impacts of floods the key issue as I see it is awareness. Information helps with this but zoning, development regulations and insurance regulations are going to be the key tools for implementing this. We need to move out [of] the flood plains and there should be no disaster assistance for those who rebuild in a flood plain. Development has a double negative impact. First, it increases the probability and intensity of downstream floods but reducing the effectiveness of the flood plain in dispersing the energy of water. Second, the developments in the flood plain take the lion's share of resources for flood preparedness and response before, during and after the flood event but have the lowest per unit yield.

- When I talk to non-water people about the recent flooding, they frequently bring up the Winnipeg diversion ditch and ask why we don't do something similar here. When I describe the problem of wetland drainage in the watershed to the south, vs. up-slope rainfall in the foothills, these non-water people understand that Winnipeg's frequent flooding problems are largely man-made while ours is due to extreme meteorological conditions -- oversimplified, I know, but those are the basics.

  I believe that we have a huge responsibility to all the residents of the Bow River Basin to manage our headwater areas so that our natural wetlands and riparian zones continue to act as a buffer for heavy rainfall. Can you imagine the flooding that would have occurred if our wetland areas and riparian zones had already been turned into ditched or paved areas of near-instantaneous runoff during a time of extreme rainfall?

- While the five flood prevention issues mentioned will help they are really meant to facilitate evacuation and reaction, with the exception of number 3 which suggests paying attention to infrastructure. Infrastructure is the overlook[ed] key component to flood mitigation. We have a network of 12 dams upstream of the population centers on the Bow river. Those dams are old and have been filling in with sediment for over a century in some cases. The dams and reservoirs dampen flood events if managed properly. The reservoirs have lost huge storage capacity volume over the decades and their ability to dampen floods has been grossly diminished. The reality is neither government nor industry has any idea how much upstream storage capacity has been lost because this issue is ignored until there is a crisis event. This occurs because it is out of sight and out of mind to the larger population. Even senior bureaucrats pay little attention to the matter, and the reality is that Alberta as a whole has little expertise in this critical area.

  Gradual accumulation of sediments is a slow process that tends to be ignored. Most of the sediment accumulates underwater below the median reservoir supply level where it is not visible which has the effect of removing it from popular, political, social, and engineering consciousness. In our part of the world the rates are relatively slow and the bulk of the sediment moves in pulses around spring flood events. However events such as the one we recently experienced move a colossal volume of material of all sizes ranging from Nano-sized flocculated clays to rocks the size of automobiles. As a result, the net effect of decades and centuries of accumulation goes unnoticed by the untrained eye that does not have a comparative time perspective. Industry, afraid of the potential expense, has made conscious effort to down play and divert attention away from this issue on few occasions when it has surfaced. In general government has taken a complacent assumption that somebody else, members of a future generation, will find a miracle solution when todays inventory of reservoirs become seriously affected by sediment. The reality is we have already reached the point of serious consequences. If you are serious about addressing flooding in the Bow River Sub basin the government of Alberta must address reservoir sedimentation head on and implement an active reservoir sedimentation management plan that amortizes the cost over decades and centuries and splits the cost up amongst the primary benefactors of the reservoirs. Entities in industry make huge profits off the reservoirs on the Bow and put absolutely nothing back to maintain the sustainability of the reservoirs and preserve upstream water storage capacity.

I recommend the following: the Government of Alberta in open and transparent consultation with all relevant ministries and stakeholders [should] undertake to study and quantify the current state of the water storage reservoirs in the Bow River sub basin, upstream of the major population centers. The study should have the following objectives:

- Quantify the original (New Construction) water storage capacity of all 12 sub basin reservoirs individually, by compiling all historical survey and bathymetric data from Government and industry sources.
- Design and execute a comprehensive program for acquisition of modern and up to date survey and bathymetric data.
- Accurately compute and quantify the current upstream water storage capacity and accurately compute and quantify the volume of water storage capacity that has been lost due to reservoir sedimentation over the past century. Rate of original storage volume lost per year should be calculated per reservoir and reservoir half-life calculated.
- Accurately compute and quantify the volume of sediment that has accumulated in each reservoir over the last decades and century.
- Classify sediments accumulated in each reservoir as top-set, mid-set, and bottom-set beds as well as by size, type and hydraulic sorting of material that the sediment in each reservoir is composed of.
- Undertake a sediment transport study that quantifies the deliverability of each main individual upstream reservoir tributary.
- Design a study to look at all options for active reservoir sediment management and preservation of upstream water storage capacity.

Brian Meller
Hydrologist
Lethbridge AB

In response to your flooding forum, I submit that part of the issue isn't so much that there hasn't been floodplain mapping, as this has existed since the 1980's. The issues to me are that (1) the validity of the mapping varies as the database increases, and (2) floodplain zoning hasn't respected the variability in these limits, nor has it built in a sufficient safety margin to respect the fact that flooding can exceed our scientific expectations, as has just occurred. This raises an interesting question as to whose fault is it that so much development has taken place within the flood-prone areas, and who is therefore responsible to pay for it?

Kevin Van Tighem
Retired, Fourth-Generation Albertan, Professional Ecologist

Recommended additions to the draft report arising from the June 27, 2013 Alberta Water Summit, addressing the question *"What can we do to mitigate these flood situations in the future?"*

Although generally I think it's a strong report, in my view the emphasis on restoring and optimally managing the headwaters needs to be strengthened. This year, our problem was flooding; in future years we will face summer drought too. Restoring the sponginess of the headwaters landscapes is essential for dealing with both problems. We need to optimize the ability of our headwaters to capture and retain snowmelt and spring rains, rather than to release it in increasingly early and intense spring runoff events.

The 2013 flood was exacerbated by linear disturbances and road compaction in the headwaters. After the flooding I went back into the Waiparous, Wind Creek and other valleys to see what I could learn about the way water came out of those landscapes. I saw three causes of major gullying indicating concentrated runoff:

- alpine drainage gullies that blew out (unavoidable with that volume of rain and such thin vegetation cover);
- roads, off-road vehicle tracks and trails running up or across slopes (avoidable with fewer, better designed roads and aggressive reclamation of unneeded ones); and
- steep-gradient streams that got overloaded (could be partially mitigated with less funneling of runoff to the stream by above-noted trails and roads and by more friction on the floodplain by way of beaver dams.

Where logging had been completed and haul roads reclaimed and covered with slash, I found little sign of gullying but there is no question that the intense rainfall mostly ran off these sites and into nearby creeks for lack of tree canopy and understory vegetation to trap and retain moisture.

Margaret Creek (local name for an unnamed tributary of the Waiparous) has a robust beaver population. Its banks were intact with no evidence of erosion and flood debris on the willows and bog birch showed that the runoff from this valley was spread out and slowed due to the dams that reduced hydrological head and spread the water into floodplain willow thickets and sedge meadows.
Given these observations and other insights I've gotten from two years of research for a book I'm currently working on, ***I recommend that flood mitigation planning incorporate the following specific landscape management measures:***

1. **Revise land use policies for the area west of Highway 22 to make headwaters landscape health the dominant over-riding management priority**. All land use and regulatory decisions should be framed around the linked imperatives of: **maximizing water production** (through snow accumulation and runoff retention), **maximizing water quality** (through riparian

protection and wetland health), and **spreading out the annual hydrograph as optimally as possible** (by retaining snow cover as late into the spring as possible, protecting shallow groundwater from early release to the surface, and encouraging small impoundments in side drainages and smaller streams). Headwaters landscape health results from all three of these factors, not one or two of them; in other words, policy approach that integrates all three management imperatives is essential.

2. **Shift from clear-cut logging to canopy-retention logging designed to reduce canopy snow loss while spreading out the snow melt over a longer period, while retaining sufficient forest canopy and ground-cover to intercept and retain rainfall**. Research out of the U of A has shown that tree canopies and trunks retain a high proportion of the water that falls in normal rain events.

3. **Manage for maximum population densities of beavers** to maximize their free ecosystem services; either eliminate or significantly curtail by way of quotas, the trapping of beavers in the headwaters of the Oldman, Bow and Red Deer Rivers.

4. **Limit off-road vehicles and industry vehicles to a limited number of trails and roads specifically designed to minimize gullying and sedimentation** (i.e. laid across the grain of the landscape and fitted with effective, well-maintained, flow deflectors) **and to avoid water source areas** such as fen meadows, wetlands, etc. The current degree of landscape abuse from unplanned off-road recreation should never have been allowed to become so well-established. It clearly contributed to the intensity of this year's flooding by concentrating overland flow from that very intense rainfall and enabling it to flush rapidly into nearby streams.

5. There are numerous locations where well-designed small check-dams in coulees and shallow basins could lead to the development of riparian vegetation and retard runoff during heavy rainfalls. Planned well, they could also help with livestock distribution issues resulting both in less streambank damage by cattle and fewer areas of concentrated grazing on uplands – both of which are factors that contribute to the severity of flooding effects on streams and, consequently, on downstream communities and infrastructure. Riparian vegetation sequesters carbon and sustains several species of at-risk species. For all these reasons, **investment of public funding in a program to encourage private landowners to install small catchments in headwater areas** may be another appropriate policy option for reducing the risk of future intense floods and summer droughts.

Thanks for the opportunity to contribute to the development of a comprehensive policy response to this year's flooding that will reduce the risk of future flood damages.

Kevin Van Tighem
Retired, fourth-generation Albertan, professional ecologist

Bill Wahl

<u>An open letter to the Citizens of Alberta</u>
<u>Flood Recovery and/or Flood Prevention</u>

My name is Bill Wahl and I am frustrated!!

Like others in Medicine Hat and Southern Alberta we live in proximity of the South Saskatchewan River (have for 40 years) and have been affected by flooding, all-be-it not this year due to the installation of a high tech backflow preventer after the 1995 flood. We are thankful to family and friends who helped us move out of our home and for better preparedness of disaster services.

The main reason for my frustration is that I always thought that the dams on the tributaries of the South Saskatchewan River were there in part to help us out during times of impending floods. The Alberta Government meetings after the '95 flood reported that flooding was caused by a severe precipitation event that occurred in very close proximity to the Oldman River Dam. That and a combination of technical issues caused by washed out flow sensors, telephone communications and the short time from onset of precipitation to significant increases in inflow did not give dam operators sufficient time to spill water ahead of high water entering the dam. Although dam safety was never an issue, water was released from the dam at a rate no greater then inflow. So what happened this year? According to records obtained from Alberta Environment and Sustainable Resource Development, the 2013 peak was ~5590 cm3/s and the 1995 peak was ~4200 cm3/s. The gauging station reports of the 2013 peak was more than 1m higher than 1995. The cross section of the river valley at other locations will affect this value to some extent. Levels in Medicine Hat never reached those predicted with an increase of 50 cm3/s increase in flow rate over 1995 reported. Persons who experienced the 1995 levels commented on water levels about 20 cm higher; all this being enough to cause significantly damage in Medicine Hat. How is it that the dam[s] that impact our flow rate could not have done more to mitigate flood issues this year given the knowledge gained from the '95 flood, and new technologies for weather forecasting? We have experienced more floods in the past 20 years than the first 20 years of living by the river.

Using the internet, phone, and communicating with acquaintances I have learned a few things. My first conversation was with an engineer who works with a team of others who oversee Dam Maintenance and Integrity. During our conversation he kept referring to the 'owners and operators' when discussing dams and reservoirs. After farther prompting I learned that **the majority of large Alberta dams and reservoirs are privately owned and operated. Most of water contained in these facilities is used for irrigation which has an economic benefit to both owner and user; or, for the production of hydroelectricity which is sold back to the grid for consumer use. It is to the owners and operators benefit to keep water levels in their facilities as high as is safe to do so. Most of the dams and reservoirs upstream from the South Saskatchewan River were at or around 98% of capacity prior the June flood. It appears that only the Ghost Lake and Reservoir near Cochrane was overly high, and it looks like they had already moderated two significant inflow events. The purpose of a reservoir or dam is specified in its licence; owner/operators function within guidelines provided by the**

Alberta Government. They have considerable autonomy and the Alberta Government cannot mandate that they lower their water reserves in an attempt to mitigate flooding. Their main priorities are to maintain a quantity of water to best meet their intended purpose without adversely effecting dam integrity.

My next contact was an acquaintance now retired after being involved with the Alberta Water Commission. He confirmed what I had learned from the Dam Safety Engineer and added some additional information. Two of the major dams in the Saskatchewan River System, the Oldman and the Dickson on the Red Deer, are operated for different priority purposes.

The Oldman is a strategic impoundment created to meet the needs of the downstream irrigation districts, which have their own infrastructure to manage day to day water call needs. The Oldman is typically lowered over the course of the summer as licenced demand exceeds natural river flow. The Oldman reservoir is filled the following year with the spring freshet and early summer precipitation. Each irrigation district will have their internal reservoirs at preferred levels by the end of the irrigation season (end of Oct). This also allows the Oldman some flexibility going into summer depending upon moisture reserves, precipitation, and degree of expected snow melt in the cordillera. As we have seen, if the Oldman reservoir gets too full, they will release water according to established guidelines and also to ensure the structural integrity of the dam itself. Operators are very cognizant of the impact of flood flows downstream; regularly managing small peak flows to keep the river below bank full, and operating during large events to attenuate the peak to the extent possible.

The Dickson Dam upstream of the City of Red Deer has a slightly different mandate. The priority for the reservoir is to provide stable downstream flows between 40-50cm3/s. This supplements natural flow and contributes to the Instream Flow Needs and Water Conservation Objectives that have been established to ensure aquatic health and assimilation of contaminants from downstream urban centres such as the Cities of Red Deer and Drumheller. Another purpose of the Dickson is to ensure a minimal flow regime throughout the winter, essentially for the same purpose as mentioned above. One of the secondary functions of the Dickson is to help manage downstream flood attenuation, particularly for Red Deer. It is interesting to note that Red Deer and Drumheller did not sustain the same flood damage that was experienced farther south in part because of less precipitation. Part of the operational complexity for the Dickson involves providing recreational levels of water in the reservoir that has, over time, become known as Glennifer Lake. It is a well beaten path in Alberta where reservoirs built for domestic or agricultural use have become recreational destinations surrounded by expensive developments. **Dam and reservoir usage and guidelines vary and the province has little appetite for adjusting the existing operational policies for the dams. However, there could be room to gain some efficiencies of use that would benefit downstream users, especially in times of water shortages or to assist in downstream flood attenuation.**

A telephone call to the Department of Municipal Affairs resulted with me being contacted by a representative of the Alberta Environment and Sustainable Resource Development. This was extremely helpful, confirming that operating guidelines for Waterton, St Mary and Oldman require the reservoirs to be drawn down over the course of the summer to a maximum level for the winter, balancing the probability of filling the next year and the probability of needing to manage a large snow pack and run off in the spring. as high as is safe. Issues of not having enough water would be very concerning on many fronts. Even with advanced weather forecasting it is difficult to totally predict what might occur in the various catch basins of the South Saskatchewan River System. The farther away from the mountains the water travels, the more difficult it is to predict flow rate and rise. This was experienced in Medicine Hat as the crest forecast of the 2013 was delayed numerous times. The Oldman Dam did store incoming water in the flood pool and the surcharge zone. Outflow from the reservoir was increased very soon after inflows became significant and continued to increase in sync with inflows until the peak flow occurred. Operations did not lower levels in anticipation of increased water flow into systems to the north. It was also interesting to find out there are no dam/reservoirs upstream from the Glenmore Dam in Calgary but there are more numerous dams upstream from Calgary on the Bow. **Dam and reservoir owners and operators do not work collectively to proactively mitigate flooding by lowering levels in anticipation of high stream rates and levels downstream. It was suggested we need a review of the purpose and operation of dams in Alberta. The GOAl would be to determine whether water management can better meet daily requirements of water use and consumption as well as mitigate potential environmental catastrophes that storms and climate change might cause. This would be to everyone's advantage.**

Do I feel a little bit better? Perhaps a little**, I think pressure needs to be put on the Alberta Government to make flood attenuation a huge priority.** Consider the disruption that would have resulted to transportation of goods and commodities if bridges in Medicine Hat would have gone out. The destruction of public and private property in southern Alberta was massive as a result of this flooding. We need to ask the question: what did the managers of the Diefenbaker Dam in Saskatchewan do to regulate the increased inflow so that flooding did not happen as it did in 1995? All Albertans are contributing financially to the flood recovery efforts as provincial and municipal administration redirect funding from other initiatives into the recovery process. When multiple insurance claims are paid out, some companies increase all premiums in an attempt to top up reserves. There are municipal administrations like Edmonton who have created a series of dry ponds that are sports playing fields until they are required to become reservoirs to store excess water that storm sewers can't handle. I am sure that there are coulees and valleys on crown land near some of our large dams that might be put into service in a similar way. Over the years Albertans have contributed more than $4,000,000,000.00 of taxes and revenue into the formation and development of our dams and reservoirs; perhaps it's time to formulate a new model of how this network is managed.

Sincerely,

Bill

SECTION III: ADDITIONAL RESOURCES

Past Floods

For a look at past flood events in Alberta, two articles were provided. The first is from the *Calgary Daily Herald's* Monday, July 3, 1929 front page paper, which reported on the severe flooding in southern Alberta. Similar damages occurred in both the 1929 and 2013 floods (e.g., wreckage of Bowness Park and the Zoo). For the full front page, see http://www.ourfutureourpast.ca/newspapr/np_page2.asp?code=NBBP0848.JPG

The second article, called the "Bow River Enigma" was published in the *High Country News* in July 2013. The article gives an overview of the past flood events on the Bow River, and can be accessed on page 6 of the document: http://www.highcountrynews.ca/pdfs/current.pdf

Flood Prevention Measures in Canada

Informal notes from Jim Bruce on flood prevention measures in Canada:

PARTIAL HISTORY OF FLOOD PREVENTIVE MEASURES IN CANADA

1954 - Oct. 14-16: **Hurricane "HAZEL"** rainfalls cause extensive loss of life and damages in southern Ontario centred on the Humber River.

1955 – 1960: **Flood Plain Mapping** based on the Hazel rainfall centred over watersheds in the region to delineate flooded areas, or areas that would have been flooded, were carried out by the Conservation Authorities Branch, Dept. of Planning and Development in collaboration with River Valley Conservation Authorities. CA's, municipalities and provinces moved to prevent or inhibit development in flood-designated areas – mostly through their designation as parkland and with the Meteorological Service a flood warning system.

1975 - **Federal cabinet,** increasingly concerned about many large payouts under their disaster assistance program, adopted the **Flood Damage Reduction Program (FDR).** It was administered by Inland Waters Directorate of Environment Canada as a cost-shared program with the provinces, under the **Canada Water Act of 1970.**

The program was to:

1. Map flood plains in all threatened areas,
2. Agree to "designate" the flood plain and use federal, provincial and municipal powers and spending authorities to inhibit further development, (e.g. limit CMHC mortgage insurance)

3. Where extensive developments already existed, provide for floodways, dykes and similar preventive measures. **(e.g. Fraser River dykes)**
4. The federal government agreed to not pay disaster assistance for developments built in flood plains after they were mapped and designated. (However some Ministers could not resist handing out cheques in affected areas after floods.)
5. In some provinces sub-agreements on cost-shared flood forecasting services were negotiated (e.g. New Brunswick, Manitoba).**By 1992: The number of designated [flood plain] areas per province was as follows:***

- **Alberta:** 4 (St. Albert, Cochrane, Medicine Hat, Fort McLeod) Note: Alberta came late to the agreement but conducted further mapping unilaterally.
- **British Columbia:** 62***
- **Manitoba:** 16***
- **New Brunswick:** 8
- **Newfoundland:** 16
- **Nova Scotia:** 5
- **Ontario:** 64***
- **Quebec:** 24
- **Saskatchewan:** 16***
- **Northwest Territories:** 9
- **No agreement with Yukon**

1990 – 2000: Federal government phased out the FDR program with all agreements concluded by 2000.

2005: Severe flooding ("100 year flood") Southern Alberta – Report recommending preventive actions similar to FDR program, but broader, led by Alberta MLA and later Agriculture Minister G. Groeneveld, completed in 2006 – widely released only in 2012.

2013: Severe flooding southern Alberta with flows in Calgary slightly less than those proposed for flood-plain mapping in a 1979 report of Montreal Engineering to the Provincial Ministry of Transport.

*Flooding: Environment Canada 1993: 171pp

****** Note 1: It should be noted that while many of these flood plain maps are still in use, changes in land use upstream and changes in climate (e.g. more frequent intense rains) require that they be up-dated periodically. This is not systematically done in Canada.*

ALBERTA watersMART Water Management Solutions

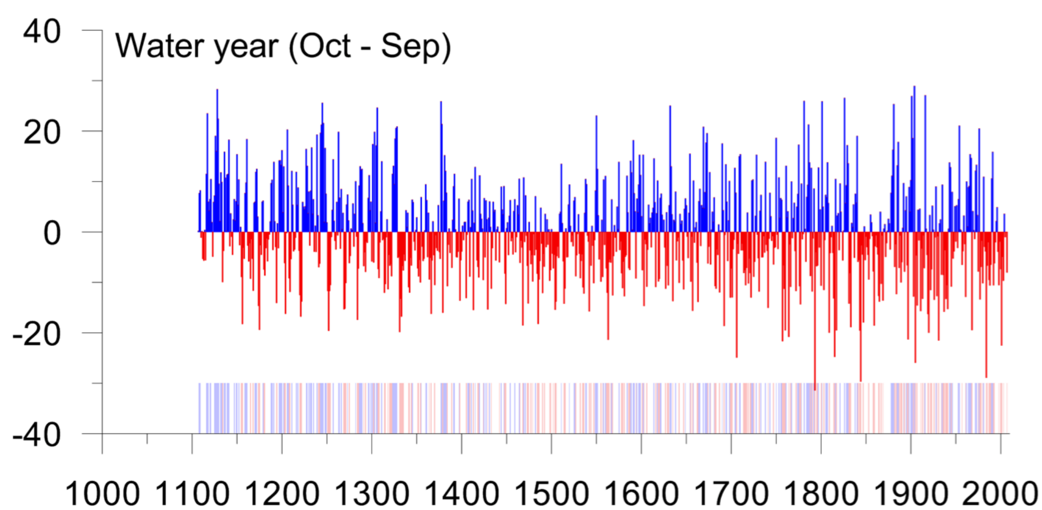
Note 2: The federal disaster assistance program remains on a "dollar-per-capita" formula, with federal contribution amounting to 50% of the costs for the second and third dollar costs per person, in the province affected, and rising to 90% for very damaging disasters (e.g. floods) causing more than $5 per capita losses.

J.P.Bruce, July 10th, 2013

Departures from Mean Annual Flow – Bow River at Calgary

Chart from Dave Sauchyn, Ph.D. and P.Geo from the Prairie Adaptation Research Collaborative (PARC).

Departures from Mean Annual Flow (m3/s) Bow River at Calgary, 1107-2007



"Last fall we completed a project for the City of Calgary in support of their drought mitigation plan. We produced a tree-ring reconstruction of the Bow River for the period 1107-2007. That record is attached [see above]. Note that it's a record of mean annual flow and not flooding. Water causes trees to grow but floods do not necessarily. It's possible to have a flood in a dry year although they tend to occur in wet years. Thus the tree rings show that 2005 and 1995 were wetter than average years but there were other years that were much wetter - they may or may not have been flood years. The message from the long tree-ring record is that the climate is more variable than we think - because our perception of the river is based on our personal experience and instrumental gauge records. The tree rings show that the basin can be much wetter and also much drier then we've experienced."

ALBERTA watersMART Water Management Solutions

Additional Resources

Rood, Stewart B. et al. 1999. "Influence of Flow Regulation on Channel Dynamics and Riparian Cottonwoods Along the Bow River, Alberta." ***Rivers*** **Volume 7, Number 1, pages 33-48.**

This article was provided by Stewart Rood, Professor and Board of Governors Research Chair in Environmental Science at the University of Lethbridge. This paper focuses on flood-flow attenuation of the Bow River and finds that historic river flows indicate that the dozen dams and reservoirs upstream of Calgary attenuate at least minor and moderate floods.

The Nature Conservancy. 2013. "Hurricane Sandy Disaster Recovery Principles." The Nature Conservancy. Accessed online at:
http://www.housedems.ct.gov/shore/pubs/TNC_post_Sandy_policy_principles_final.pdf

This document was provided by Lisa Wojnarowski Downes, North America Coordinator for the Alliance for Water Stewardship and the Nature Conservancy. She thought the recovery principles outlined in this document would be relevant to flood planning in Alberta.