Inflow Hydrology of the Peace-Athabasca Delta

Dear Dr. Gorber and others,

I was interested to learn of, and then view the recent report, Strategic Environmental Assessment of Wood Buffalo National Park (SEA), and I followed the substantial media coverage. The study was ambitious, with the substantial breadth of topics and a range of reference resources, including the rigorous journal papers by Daniel Peters, Terry Prowse, Fred Wrona, and others.

A focus of the Summary, which was emphasized in the media reports is the drying of the Park and particularly the complex Peace-Athabasca Delta (PAD) wetlands. There is an implied major influence from declining river inflows, partly due to human activities. As represented in Bob Weber’s Canadian Press report (July 15, 2018):

‘Gorber found major changes in the park. Behind them all is water - or the lack thereof. Peace River flows have fallen nine per cent since the Bennett Dam was built in British Columbia. Flows from the Athabasca have declined 26 per cent.’

These two values originate from consulting reports but are incomplete. Recent, more complete analyses provide different outcomes.

The 26% decline of the Athabasca River is from our report (Gill and Rood (2009), referred to in Lebel et al. (2009)). However, that analysis had a specific and narrow focus and considered the interval from 1958 to 2007, which represented the limited hydrologic record for the river gauge near Fort McMurray. We recognized the limitations in the summary and text, and indicated that the decline would partly reflect a phase transition of the regionally influential Pacific Decadal Oscillation (PDO).

The 9% decline for the Peace River reflects a similarly limited assessment by the consultant, Golder Associates (2012). That analysis considered only an eight year interval prior to the Bennett Dam (1960-1967) versus a three-decade interval after, again reflecting the limited hydrometric record of a specific hydrometric gauge, in that case Peace Point. This was the same interval as for our Athabasca River study and the flow reduction would again substantially reflect the phase transition of the PDO.

Many Canadians are aware of reversing, climate oscillations and particularly El Niño and the Southern Oscillation (ENSO). The PDO is a longer-term oscillation which is more strongly correlated with river flows in western Canada. Like ENSO, the PDO involves variations in the distribution of warmer surface waters of the Pacific Ocean. A positive or warm phase involves warmer water off the British Columbia coast and is associated with warmer and dryer conditions in western Canada such as during the extensive North American drought of the 1930s.
Relative to the reported statistics, the 1960s involved a wetter, cool phase of the PDO that provided unusually high river flows. A transition followed and this was associated with declining precipitation and river flows in Alberta and across western North America. Thus, the 26% and 9% declines largely reflect the PDO phase transition, and not an influence from Bennet Dam, from water withdrawal for the oil sands projects, or from progressive climate change.

With the influence from the PDO, sufficient analyses must consider longer-term patterns and we and others have undertaken these. River flow measurements in western Canada commenced about a century ago but there were seasonal limitations, data gaps and gauge relocations. Through interpolations and splicing, we have developed century-long records for the Athabasca, Peace and other rivers and these have allowed more confident determinations, which somewhat absorb the varying influence from the PDO. We have presented these analyses in recent journal papers, which are more complete than the prior technical reports.

These analyses indicate that:

1. **Annual flows of the Athabasca River have not displayed a net change over the past century.**

There have been regional differences with slight flow decline from the Rocky Mountain headwaters, consistent with the decline of Alberta’s other Rocky Mountain rivers. Conversely, boreal contributions to the Athabasca have apparently compensated. There have been shorter-term changes associated with the PDO, but no significant long-term trend over the past century.

These analyses for the Athabasca River are provided in Rood et al. (2015, attached), which also includes a literature review. I’d recommend Figure 4 which displays the temporary decline from around 1960 to 2010 and illustrates the lack of long-term trend.

The studies cited in the SEA indicate that the licensed water extraction for the oil sands has been modest, representing around 1% of the Athabasca flows. This slight influence would not be detectable in the river flow record due to the natural interannual variation. There would be proportionally greater withdrawals during the low-flows of winter and this may be revealed as the record is extended. This is prompting considerations for seasonal water storage projects.

2. **Annual flows of the Peace River have gradually increased over the past century.**

While flows of the Athabasca haven’t changed, there has been a significant, but modest increasing trend for the Peace River (Rood et al., 2017, attached). Interestingly, more substantial increases occurred along the larger, and more northerly Liard River which drains parts of the Yukon and northeastern BC. There have thus been differences in the hydrological consequences of climate change along the Rocky Mountain corridor, with decreasing river flows from the southern Canadian region versus increasing flows from the northern region (as in Figure 10 of the new Philipsen et al. (2018) paper, following).
Map of Alberta with major rivers and the location of the Peace-Athabasca Delta. Arrows represent statistical trends in river flows over the past century: $\uparrow$ = increase, $\downarrow$ = decrease, $\approx$ = no change. (Modified from Philipsen et al., 2018).
The Slave River represents the combined flow from the Athabasca and Peace rivers, along with smaller tributaries. Its hydrometric record is more limited and doesn’t display an overall statistical trend (Rood et al., 2017). With the increasing inflows from the Liard, the Mackenzie River flows to the Arctic Ocean have apparently increased.

While the Bennett Dam would have little influence on annual flows, it has provided major attenuation of downstream flood flows. This would be certain to influence flooding in some parts of the PAD and there are a sequence of relevant papers from Peters, Prowse and others, with some cited in the SEA. The regulation would also influence downstream river ice, including break-up and jam events, which would also alter flooding of some wetlands. These influences may invite some alterations to the dam operation and we and others often recommend flow naturalization for a range of ecological benefits.

Drs. Wolfe and Hall have provided some excellent reports that explore the PAD paleohydrology and were referred to in media reports of Aug. 15, 2018. Their studies revealed that the system had been drying for more than a century, and long before Bennett Dam was built. Relative to this drying, while river flows have been relatively unchanged over the past century, the regional warming would increase the water demands and thus contribute to the drying. The warming not only increases evaporation, but the vegetation growth season has probably lengthened and plant transpiration increased, further increasing the net water demand from the system. Thus the hydrology of the PAD involves both water supplies and demands and as the SEA recognizes, there are a range of influences.

I would close with a further emphasis which is somewhat recognized in the SEA. Rivers and floodplains are inherently dynamic and delta zones are often even moreso. Of course there have been hydrological changes over the past century and there will be further changes in the future. These will involve many interactions and some compounding influences from natural and anthropogenic processes. The hydrological changes will have ecological consequences for the PAD and it will be appropriate to further investigate these. It will not be possible to ‘restore’ the conditions of the nineteenth century but there will probably be opportunities for environmental benefits from some human actions, potentially including deliberate adjustments to dam operations.

Respectfully,

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Cc: Katherine Cumming, Parks Canada; Bob Weber, Canadian Press