Lake level trends in central Alberta

Cristina Buendia, PhD North Saskatchewan Watershed Alliance ALMS workshop- September 2017

Beaverhill lake....



Lac Ste Anne...

Google Earth Engine

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Beaverhill lake....



Lac Ste Anne...



Lakes are important sources of



Socio-economic uses:

- Municipal water supply
- Irrigation/Industrial processes
- Recreation
- Strong spiritual and cultural value **Ecological functions**

As the population grows, demand for freshwater will increase

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Critical in the semi-arid climate of the prairie region of Canada

- Undergoes significant variation in wet and dry conditions (i.e. PDO, ENSO)
 - Instrumental records
 - Proxy data (paleolimnological studies, tree ring analyses- Sauchyn et al.-)
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Fluctuations in Prairie lakes

Prairie lakes have varied markedly over decades:

- Following climate variability:
 - Changes in precipitation and evaporation
- Influenced by changes in land use and water management

STUDIES EVALUATING LAKE LEVEL DECLINES

Van der Kaamp et al. (2008)

Changes in closed-basin lakes of the Prairies

16 closed-basin lakes in the Prairies

- Most of the lakes show a longterm water level decline from ~ 1920 to the present.
- Patterns hold from SC-EC Alberta to through C and SE Saskatchewan

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Trends between 1985 - 2016 (~ 30 y of lake level data)

- Maximize the number of studied lakes
- Avoid potential effects introduced by the wet 1970s
- Keep the period consistend amongst lake records

PROVIDE A REGIONAL OVERVIEW OF LAKE LEVEL TRENDS, SUBJECT TO THE SAME CLIMATIC CONDITIONS, DURING THE TIME WHEN MUCH OF THE DEVELOPMENT OCCURRED

Focus on the **BROAD SPATIAL SCALE**, NOT ON INDIVIDUAL LAKE BALANCES!

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METHODS

- 1. Loss of lake surface area in the NSRB using satellite images
- 2. Statistical trend analyses on median annual lake levels
- 3. Annual Lake Level Index (ALI; Islam and Seneka, 2015)

(1) Mapping Surface Water across the NOD Study of Global Surface Water and its longterm changes by The European Commission's Joint Research Center (JRC)¹

- Global data sets documenting changes in water surface between 1984 and 2015
- Produced from inventories, national descriptions, statistical extrapolation of regional data and satellite imagery.
- High resolution: 30x30m

¹Pekel et al., 2016, High-resolution mapping of global surface water and its long-term changes. Nature 540, 418-422 (2016). (doi:10.1038/nature20584)

(1Maps document different facets of water surface

- - *Frequency* with which water was present on the surface from 1984 to 2015
- Occurrence Change Intensity ------
 - Information on where surface water occurrence increased, decreased or remained the same between two epochs: 1984-1999 and 2000-2015.
 - *Direction and intensity of change* are documented
- Seasonality ------
 - Information concerning the *intra-annual behaviour* of water surfaces.
- Recurrence ------
 - Information on the *inter-annual behaviour* of water surfaces (variability in the
 - presence of water)
- Transitions-
 - Information on the *change in seasonality* between the first and last year
 - Unchanging permanent water surfaces
 - New water permanent surfaces
 - Lost permanent water surfaces
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dynamics:

- Conversion of seasonal into permanent

Change in seasonality

Transitions...





Water transitions map- Lakes (Beaverhill)





Water transitions map- Lakes

(Isle lake and lac Ste. Anne)



Transitions

Change in seasonality



Transitions



Transitions



Transitions



% of the total lake area within the NSRB

THE DATABASE

94 lakes selected to evaluate temporal trends

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Lakes from the <u>South Saskatchewan</u> are highly regulated



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TREND ANALYSIS

Mann Kendall trend test applied to median annual lake levels Non-parametric test to detect monotonic trends in environmental data

Trends classified in 5 categories:

Decreasing Increasing Likely decreasing Likely increasing No trend Negative trend at the 95% CL Positive trend at the 95% CL Negative trend at the 90% CL Positive trend at the 90% CL No statistical trend

RESULTS

Overall decrease in lake levels across the province:





Increasing Likely Increasing No trend Likely Decreasing Decreasing











(3) ALI – Alberta Lake Level Index

- Index developed by Islam and Seneka (2015)* AEP –
- Compares water levels recorded throughout the year to historical patterns
- Resulting index for each year is ranked according to 5 categories:

MAN- Much Above Normal	Level greater than the 90th perc .
AN- Above Normal	70 th perc. < Lake level < 90 th perc.
N- Normal	75 th perc. < Lake Level < 25 th perc.
BN- Below Normal	25 th perc. < Lake Level < 10 th perc.
MBN- Much Below Normal	Lake Level < 10 th perc

*Islam and Seneka, 2015. Development of the Alberta Lake Level Index: A simple approach. Conference: Canadian Society for Civil Engineering Annual General Conference, At Regina, SK. DOI: 10.13140/RG.2.1.1824.5287



PERCENTAGE OF LAKES FOR EACH CATEGORY (1985-2016)

- Not all lakes are included in every year (data constraints)
- 86 lakes / year on average
- Min: 48 lakes in 2010



More questions...

- What are the main drivers of the decline?

- Is there any characteristic that makes a lake more vulnerable to climate/human effects?

More data...



Some observations...

SHAPE OF ALBERTA LAKES (Islam and Seneka, 2016)*

Evaluated volume to depth relationships of Alberta lakes and assigned an "idealized shape"



Islam and Seneka, 2016 (AEP)- *Development of generic shapes of Alberta lakes to support water policy development

Take home message...

- Different methods yield similar results
 - Regional lake level decline across the province
- Lake levels are naturally dynamic
 - Climate is an important signal in lake fluctuations, but do other drivers related to human activities and landscape change exist?

Understanding the dynamics of the lakes in the landscape is essential for developing an adaptive approach in lake management



THANKS!



Comments Questions Ideas

