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Impact of climate change on pit lakes water balance and water quality

Alexandre Fuentes and Thomas Pabst

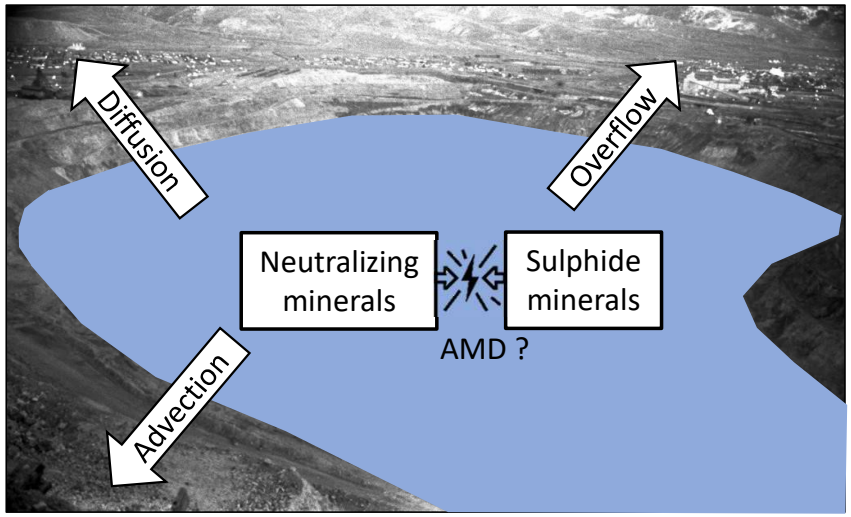
Polytechnique Montréal

Groundwater, key to the Sustainable Development Goals

Paris – May 18 to 20, 2022

Environmental issue of pit lakes

Berkeley pit (1956)



Berkeley pit lake (2015)

Gammons 2015

Direct oxydation of pyrite

$$2FeS_2 + 7O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4SO_4^{2-} + 4H^+$$

Aubertin 2002

> 300 bird deaths / year

Treatment plant in 2018 for 19 M$

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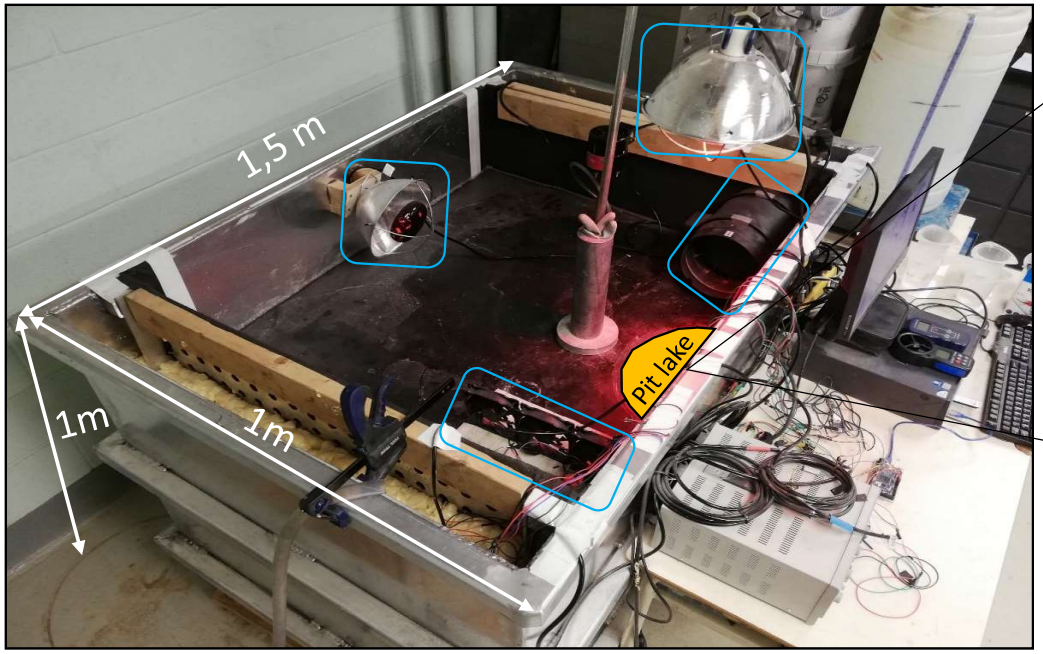
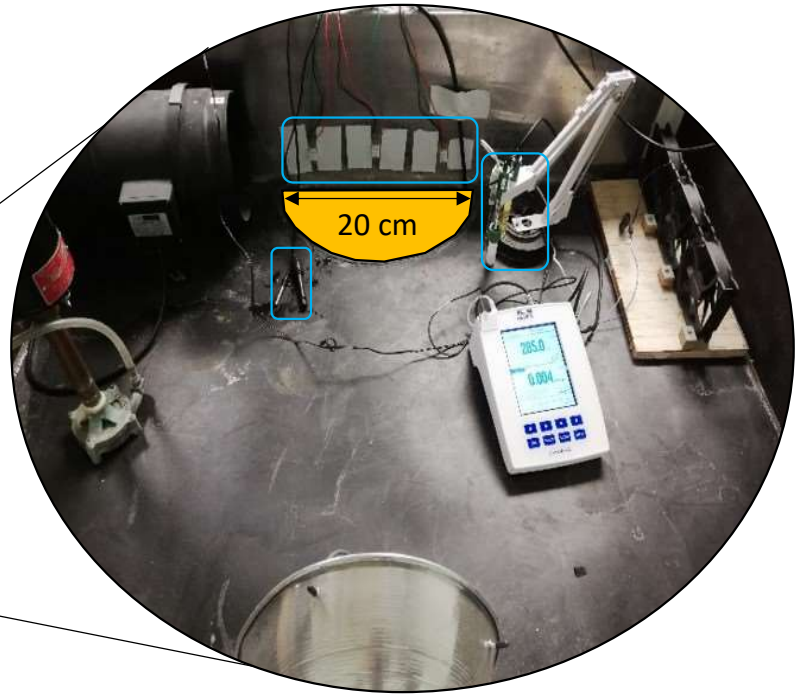
Laboratory model





Numerical modeling

$$\Delta S = R + RO_{in} + GW_{in} - E - RO_{out} - GW_{out}$$

Laboratory tests

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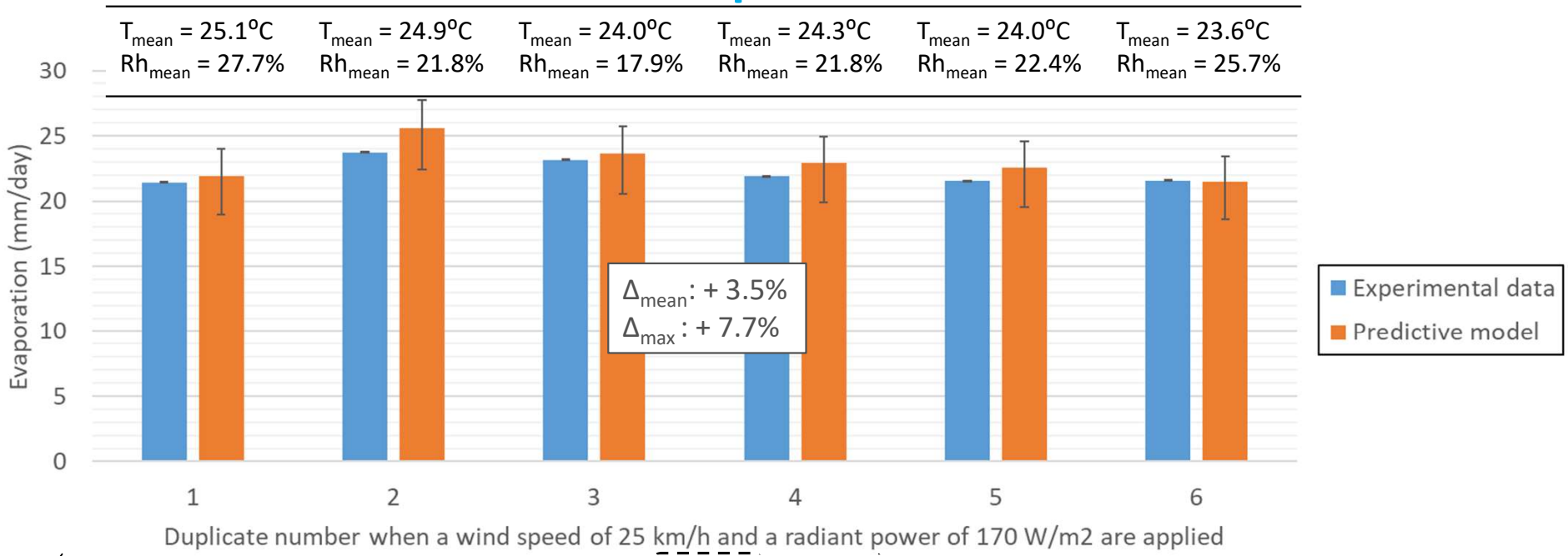
Calibration of the evaporation law



$$E = \left(\frac{0.87\Delta \cdot (Rns - Rnl) + \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad}{\Delta + \gamma} \right).$$

McJannet 2019

: Effect of pit walls

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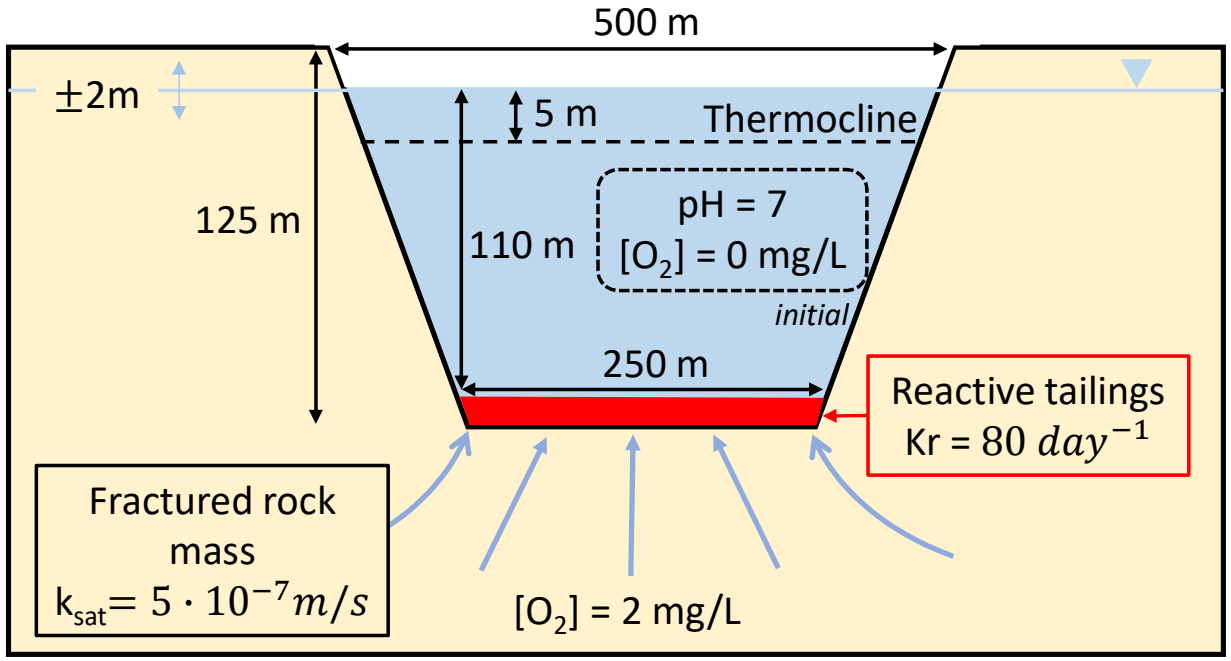
Reference case

- Evaporation
- Overflow (pit lake morphology)
- Groundwater flow (dilution tests and Seep 3D)
- Rainfall (climate model)
- Runoff (rational method)

Goldsim

Diffusion
Advection
~~Limnology~~



Watershed

Area : 0.5 km^2

Runoff coefficient : 0.3

Climate model (CanRCM4)

Experiment name : NAM-22_CCCma-CanESM2

Localisation : 48.1°Lat, -77.8 °Long (Abitibi)

Scinocca 2016

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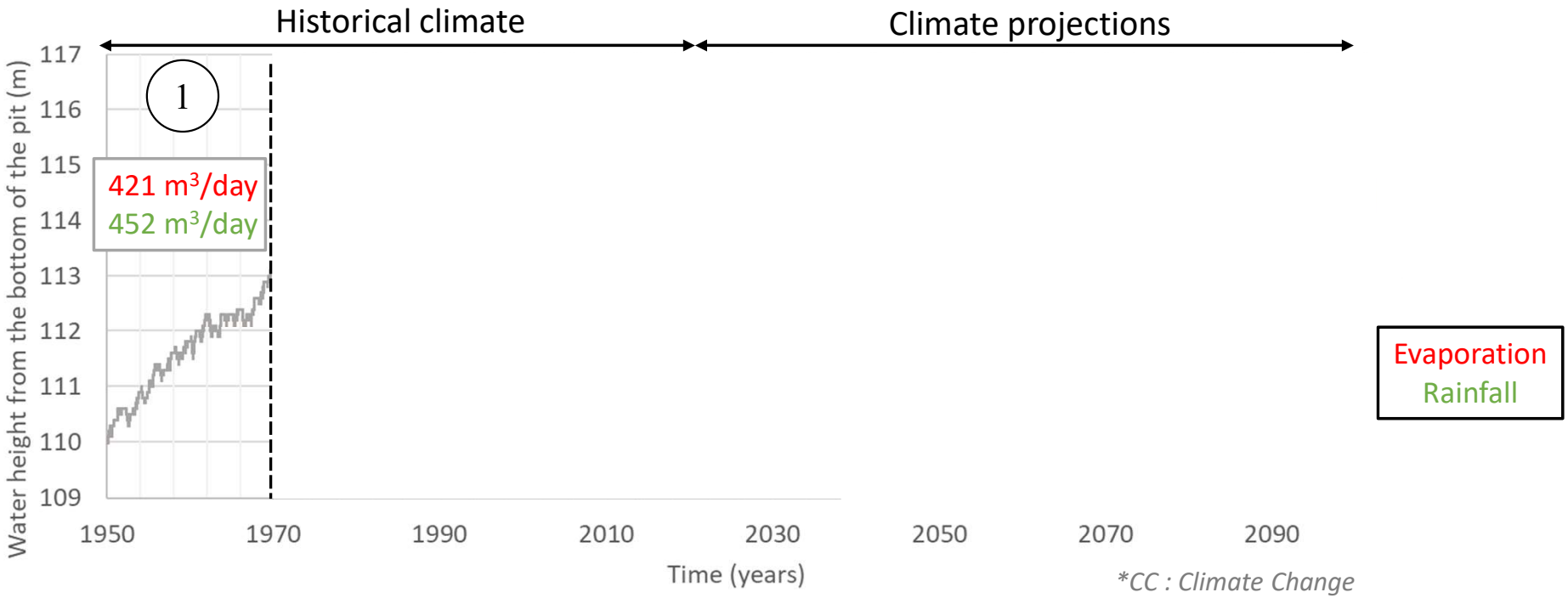
Water level evolution



*CC : Climate Change

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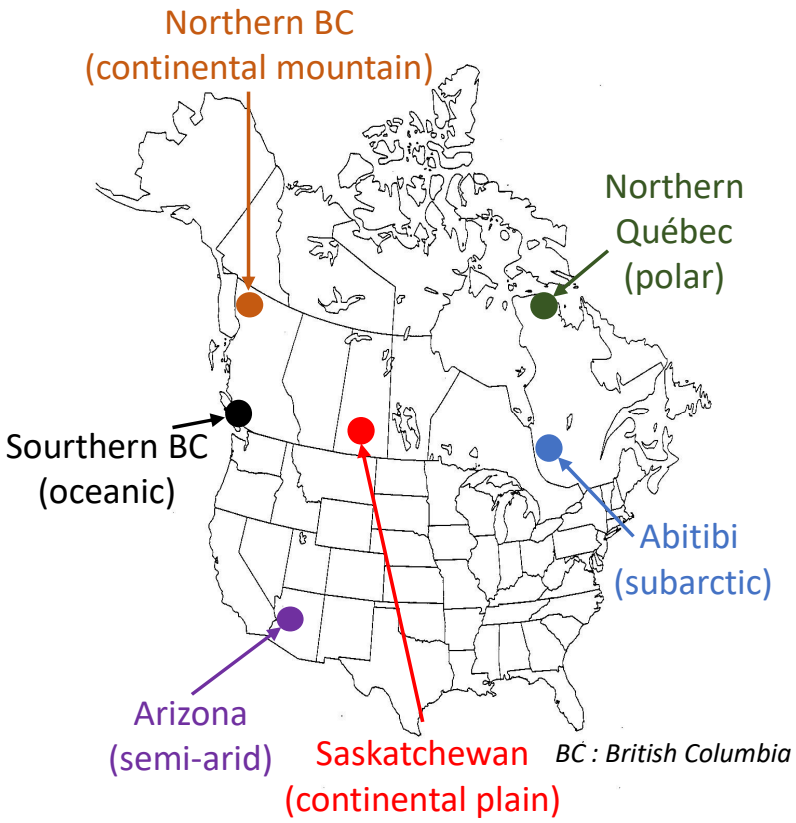
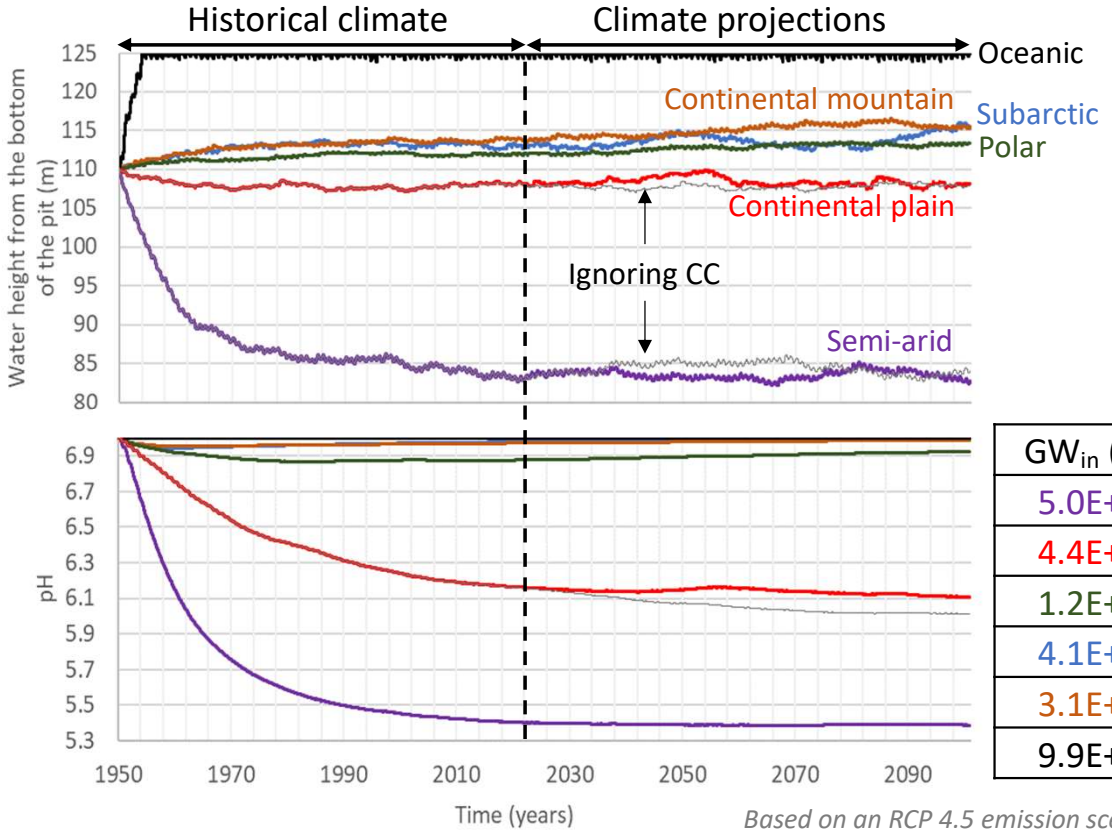
Different types of climates





GW_{in} (m^3)
5.0E+07
4.4E+06
1.2E+05
4.1E+04
3.1E+04
9.9E+02

Based on an RCP 4.5 emission scenario

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Conclusion and ongoing work

Climate change is expected to have :

- a significant impact on pit lakes water balance ;
- a low impact on water quality in pit lakes in most cases.

Changes in pit lake behaviours and their intensity are expected to vary depending on site location (→ requires a site specific study).

- Conduct a field-scale study to verify the upscaling method.
- Characterize the impact of climate change on pit lake limnology (and it effect on water quality).


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