Faculty of Graduate Studies: Graduate College & Transdisciplinary Programs

April 30, 2025

UNIVERSITY OF CALGARY
FACULTY OF GRADUATE STUDIES

I would like to acknowledge and pay tribute to the traditional territories of the peoples of Treaty 7 located in the heart of Southern Alberta, which include the Blackfoot Confederacy (comprised of the Siksika, the Piikani, and the Kainai First Nations), the Tsuut'ina First Nation, and the Stoney Nakoda (including Chiniki, Bearspaw, and Goodstoney First Nations). The City of Calgary is also home to the Métis Nation of Alberta (Districts 5 and 6).

Dr. Tara Beattie

Dean and Vice Provost
Faculty of Graduate Studies
University of Calgary

Dr. Clifton Cunningham

Head, Graduate College
University of Calgary

Graduate College

- Home for transdisciplinary graduate students

- Community of graduate students (“scholars”) and faculty members (“senior scholars”) and community members

Dr. Jenny Godley

Associate Dean
Transdisciplinary Scholarship
University of Calgary

Available Transdisciplinary Graduate Programs

Course-based Masters'- Certificate programs

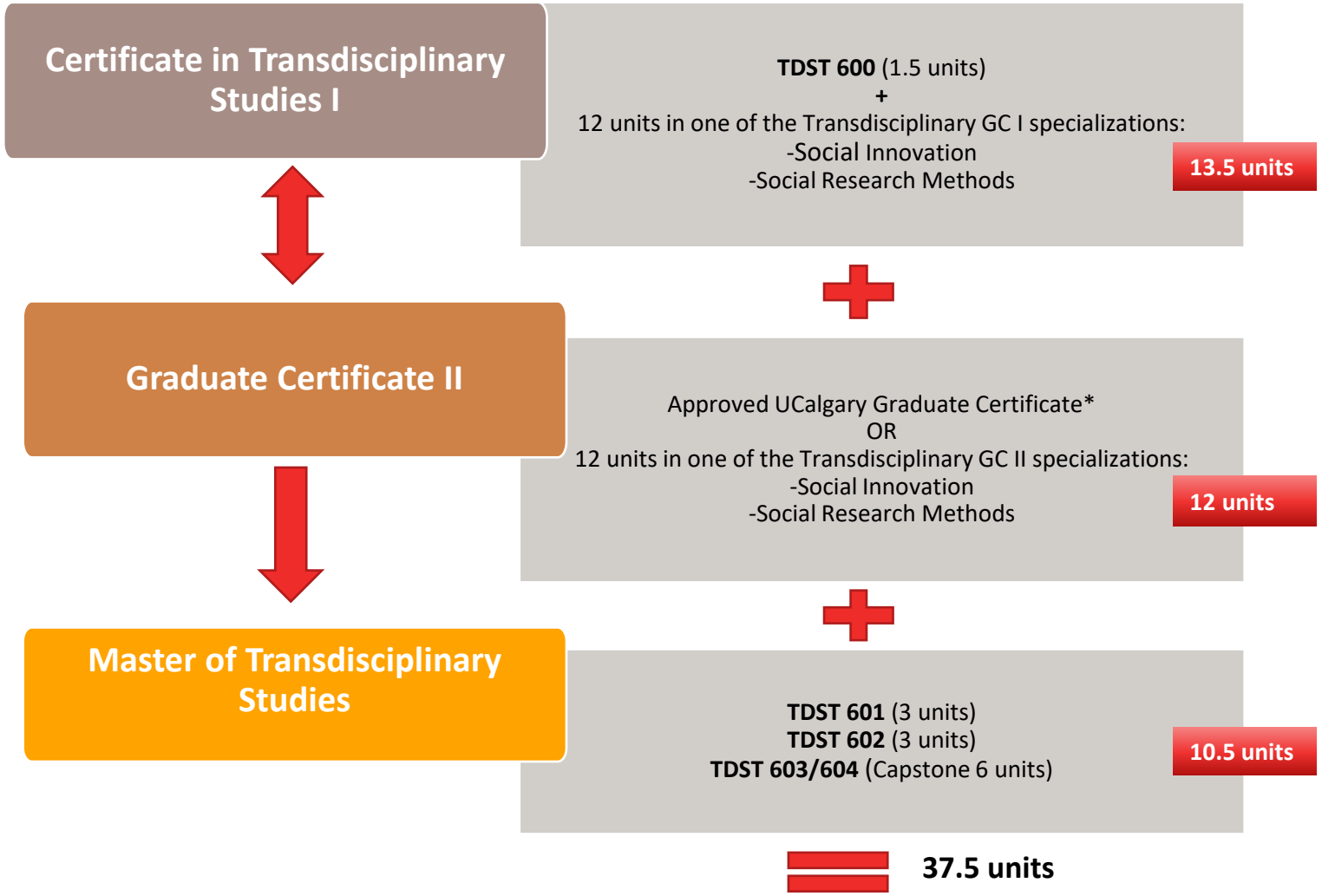
Social Research Methods

- Dept of Sociology (4 courses)

Social Innovation

- Nursing and CSM - Dept of Community Health Sciences (4 courses)

Course-based Program Overview - Laddering



***Approved UCalgary Graduate Certificates**

- Fundamental Data Science and Analytics
- Educational Research
- Advanced Engineering I
- Data Privacy
- Network Security
- Software Security
- Natural Resources, Energy and Environmental Law
- Business Intelligence and Data Analytics
- Management Analytics
- Precision Health Medicine
- Advanced Nursing Practice I

Thesis-based Master's (Master of Transdisciplinary Research – MTR)

1. **Required TD courses**
    - TD 600 (Introduction to Transdisciplinary Scholarship)
    - TD 601 (Knowledge and Community Engagement)
2. **Additional course units (3 courses)**
3. **Proposal and Thesis**
4. **Specializations**
    - Individualized; Water resilience; Policy Studies
5. **2-year program**

Thesis-based PhD

1. **Required TD courses**
    - TD 600 (Introduction to Transdisciplinary Scholarship)
    - TD 601 (Knowledge and Community Engagement)
2. **Additional course units (2 courses)**
3. **Portfolio, Proposal, FoS exam, Thesis**
4. **Specializations**
    - Individualized; Water resilience
5. **4-year program**

Amir Shahbazi
Schulich School of Engineering

Amir Shahbazi
Schulich School of Engineering

Dynamic Digital Twin Framework for Enhanced Construction Site Safety

Supervisors:
- Dr. Farnaz Sadeghpour
- Dr. Sayeh Bayat

April 30th, 2025

Construction Site Safety

Construction Industry Accident Statistics

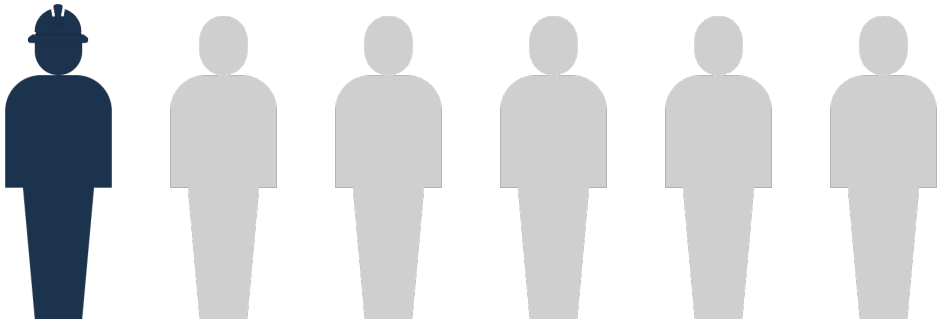
High Fatality Rate

About 10 fatalities per

100,000 workers

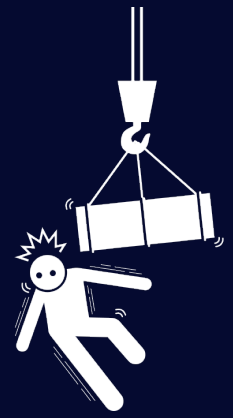
annually (worldwide)

(more than double other industries)

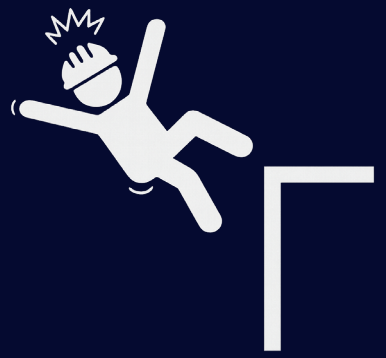


1 in every 6 fatal workplace accidents worldwide happens in construction

Leading Causes of Accidents on Construction Sites



STRUCK BY OBJECTS



FALLS FROM HEIGHTS

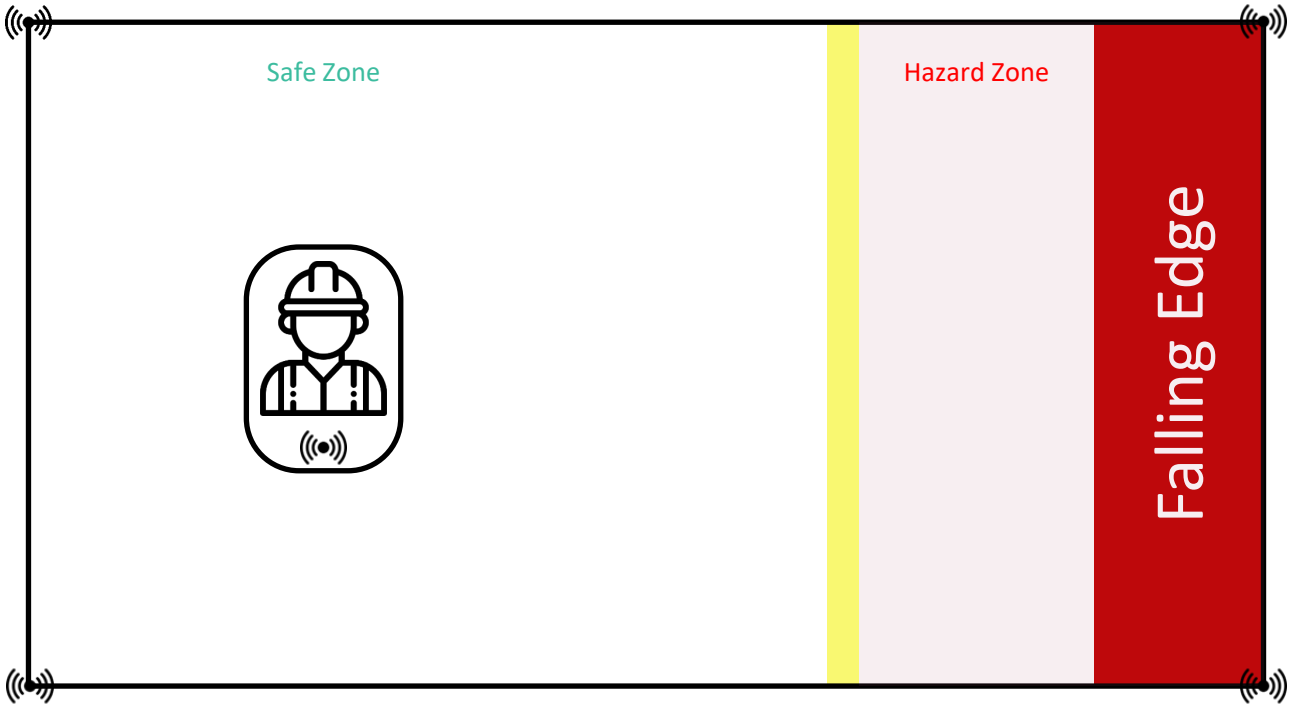
WHY EFFECTIVE MONITORING MATTERS

- Timely monitoring of worker behavior can prevent accidents
- Traditional supervision methods are limited by site complexity and scale

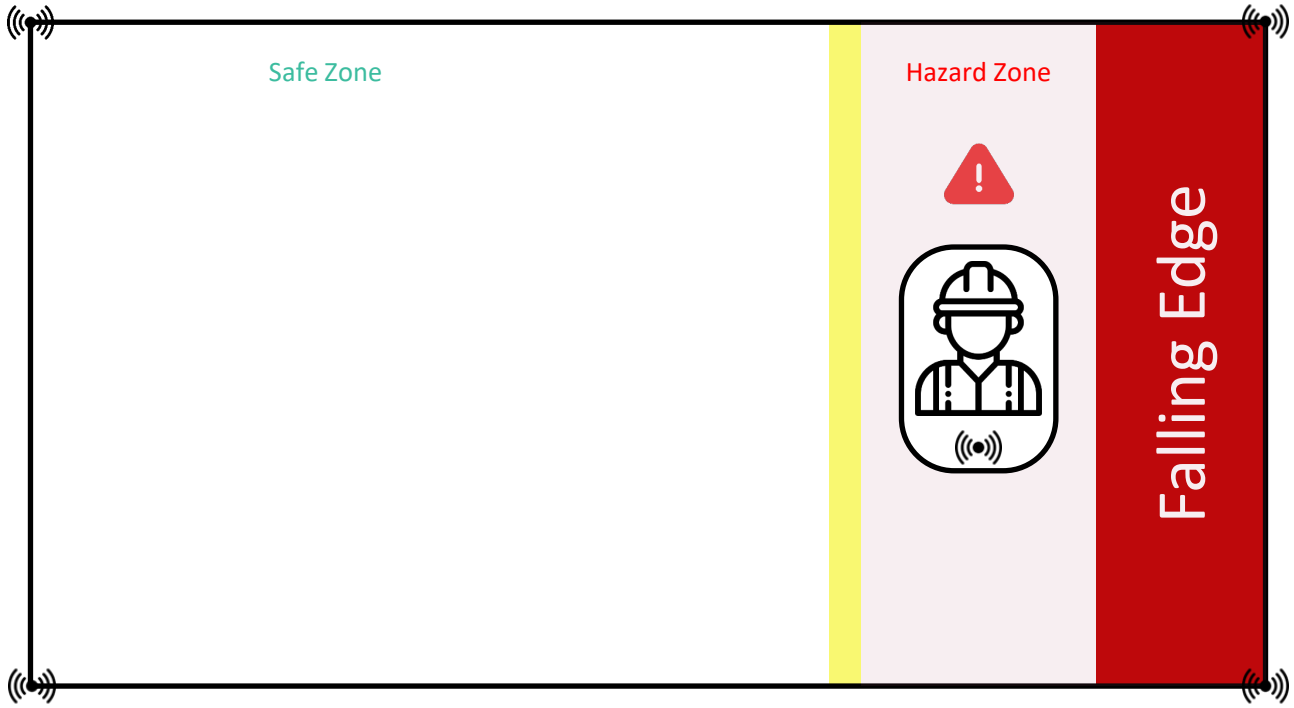
ROLE OF AUTOMATION IN SAFETY

- Automated systems provide real-time alerts
- Smart monitoring reduces accident risks significantly

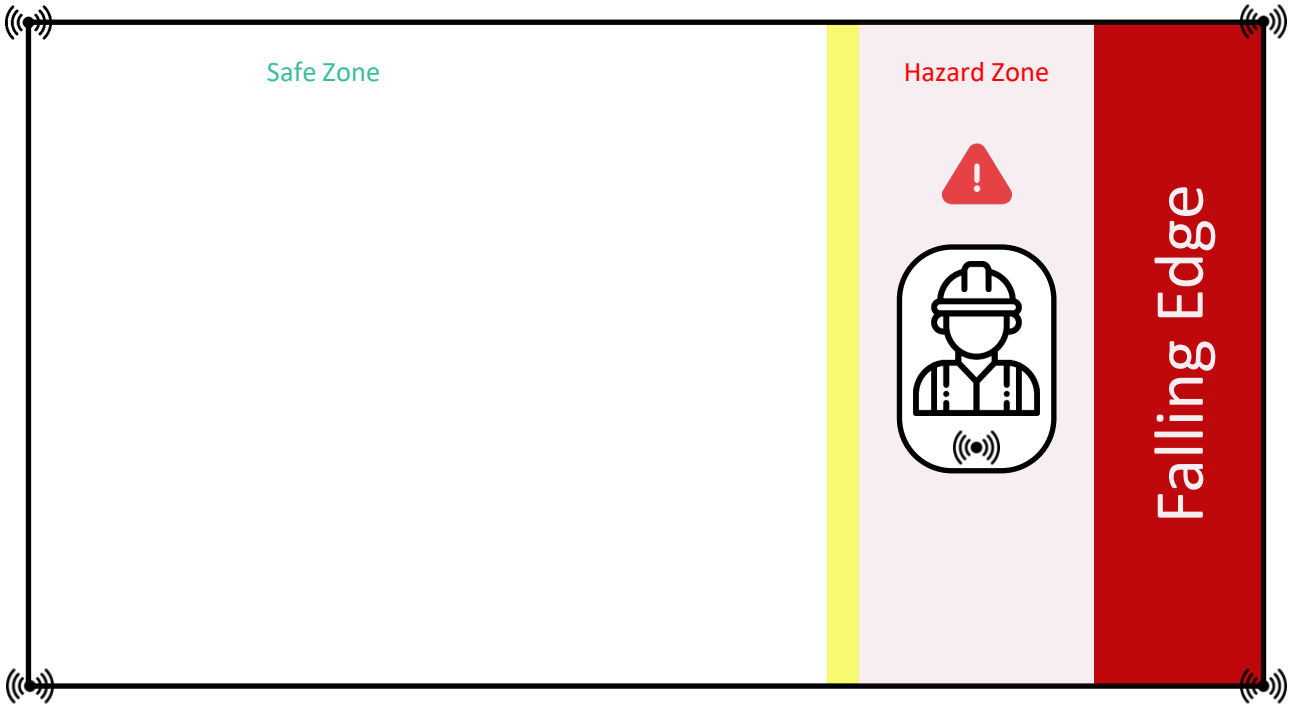
Proximity Warning Systems in Construction Safety



Proximity Warning Systems in Construction Safety



Proximity Warning Systems in Construction Safety



CHALLENGES

- Technical Issues
- Human perception
- Economic constraints
- Privacy concerns

Solving Safety Challenges Through Transdisciplinary Collaboration

Working with experts across key disciplines

Civil Engineering
Dr. Farnaz Sadeghpour

Geomatics Engineering
Dr. Sayeh Bayat
Dr. Kyle O'keef

Psychology
Dr. Jeffrey Caird

Kinesiology
Dr. Carolyn Emery

My Research Objectives

Developing dynamic Digital Twin framework for automated safety monitoring on construction sites

Dynamic Digital Twin

Minimizing Time Latency

Dynamic Digital Twin

Core Capabilities

- Represents sites, workers, and equipment in real-time
- Goes beyond geometry with embedded semantic data
- Enables two-way interaction between physical and digital environments

My Research Objectives

Developing fynamic Digital Twin framework for automated safety monitoring on construction sites

Dynamic Digital Twin

Minimizing Time Latency

Minimizing Time Latency

- **Edge Computing for Speed**

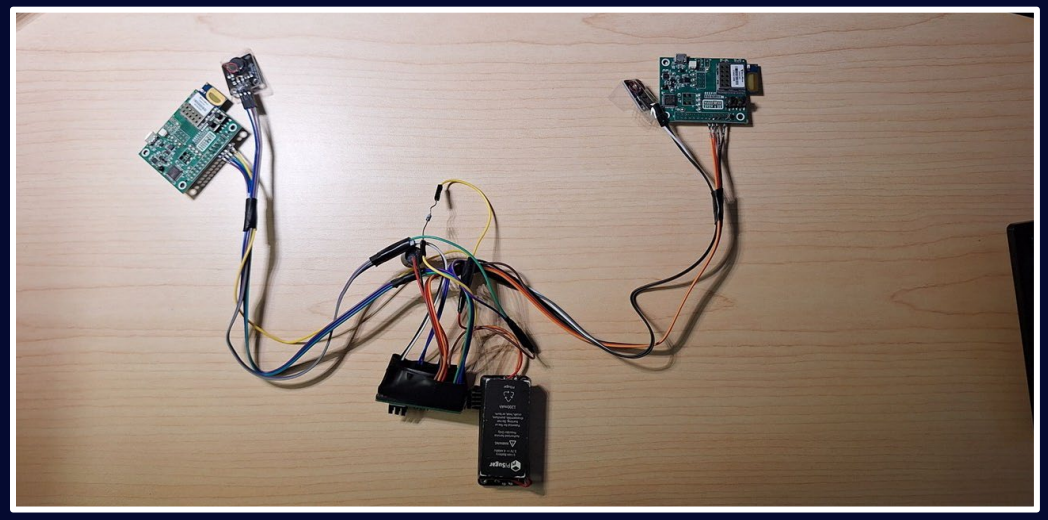
  Real-time processing at the edge to reduce delay in safety monitoring

- **Predictive Modeling**

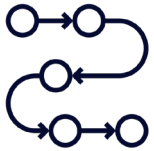
  Using AI to forecast worker movements and identify potential hazards

- **Smart Wearables**

  Connecting physical workers to the digital twin with real-time alerts



Conclusion



Next Steps

- Testing in real construction sites
- Building intelligent twins using RL
- Developing personalized worker alerts

Broader Applications

- Manufacturing – Safer human–machine interaction
- Mining / Oil & Gas – Real-time hazard detection
- Healthcare – Movement tracking & rehab support
- Smart Buildings – Adaptive, occupant-aware systems

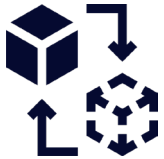
Conclusion

Significance

Safer construction saves lives and improves productivity

Transdisciplinary Insight

Collaboration across disciplines drives smarter solutions



Our Contribution

Real-time digital twin and monitoring enhance worker safety

Thank you!

Do you have any questions?

Ignacio Aguirre

Schulich School of Engineering

REDUCING UNCERTAINTY IN HYDROLOGICAL MODELS

PhD Student: Ignacio Aguirre Belmar
Supervisor: Dr. Martyn Clark
Schulich School of Engineering

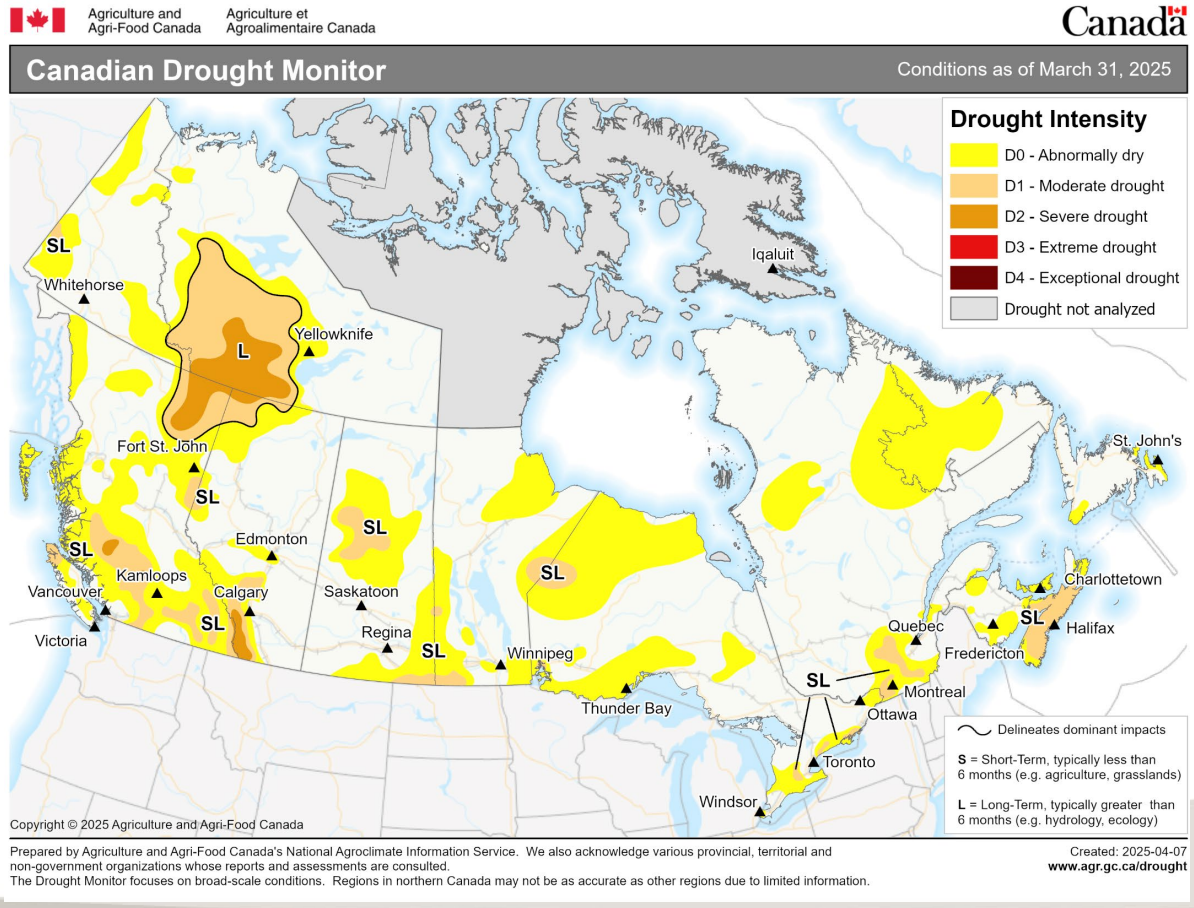
Transdisciplinary (TD) Week!

April 30, 2025

Motivation

- To make decisions regarding:
  - Urban and rural water availability
  - Flooding warnings
  - Food security
  - Drought response plans
  - Climate change adaptation

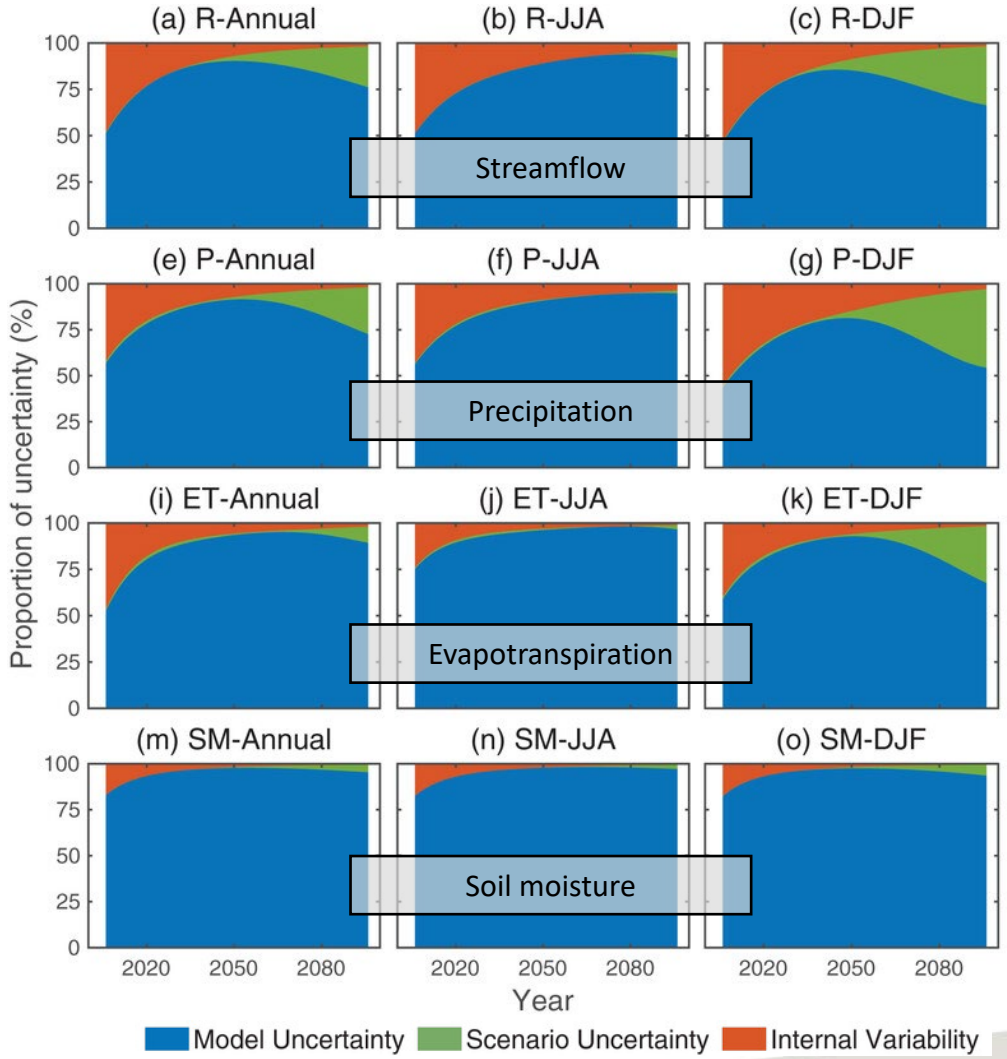
We must have accurate and realistic water cycle simulations, especially streamflow and evapotranspiration.



Sources: City of Calgary & *Agriculture and Agri-Food Canada*

The problem

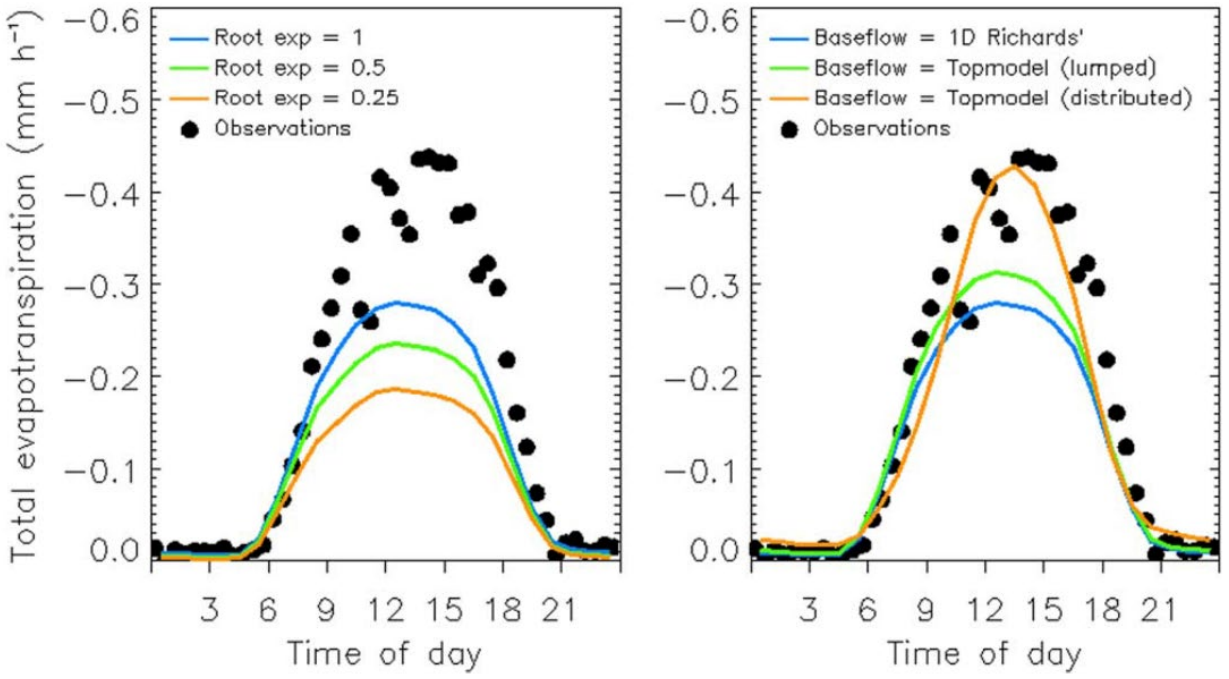
- However, despite the importance and magnitude of these fluxes, the simulations of these fluxes are subject to substantial uncertainties.
- These uncertainties can be traced to:
  - **The equations used to represent the processes**
  - **The parameters in the equations**
  - The input data



Source: Wu et al. (2024)

My thesis

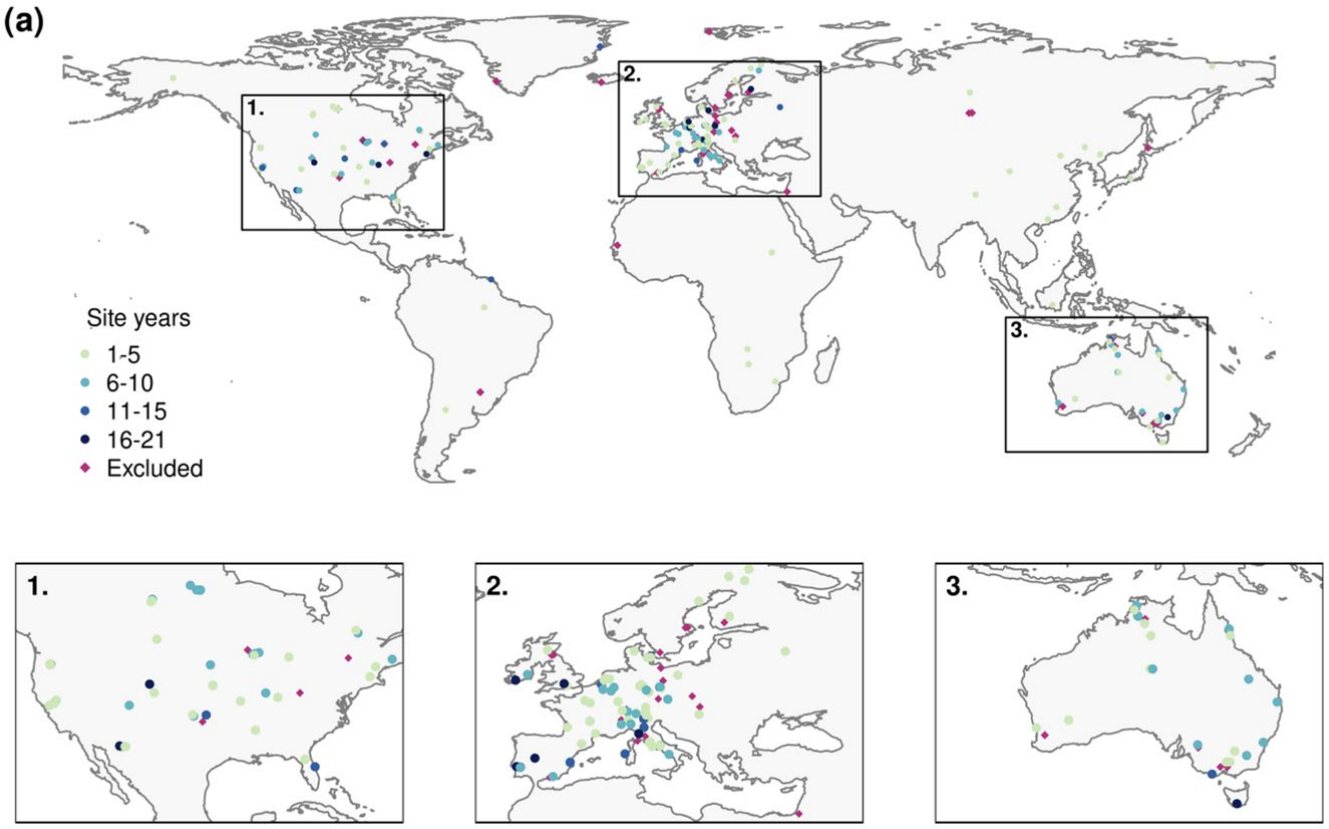
- My research focuses on understanding and quantifying these uncertainties to reduce the simulation errors and generate more accurate and realistic estimations.
- This requires testing multiple equations and values to represent hydrological processes, keeping the other elements fixed to isolate the effects of each decision.



Source: Clark et al., (2015)

Spatial heterogeneity

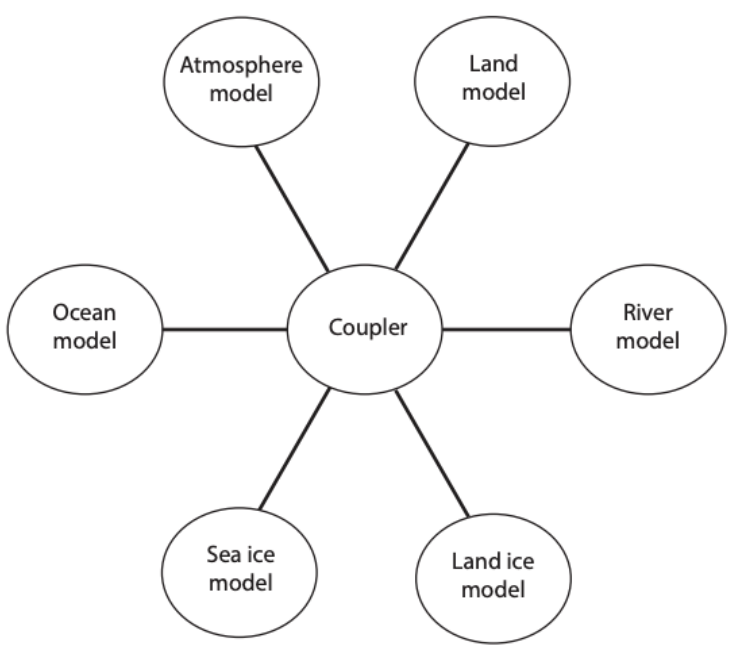
- To avoid relying only on a few sites, the key is to evaluate different modeling hypotheses at many places, ensuring:
  - Different climate
  - Different vegetation type
  - Different kinds of soil
  - Different dominant processes
  - Different human interventions

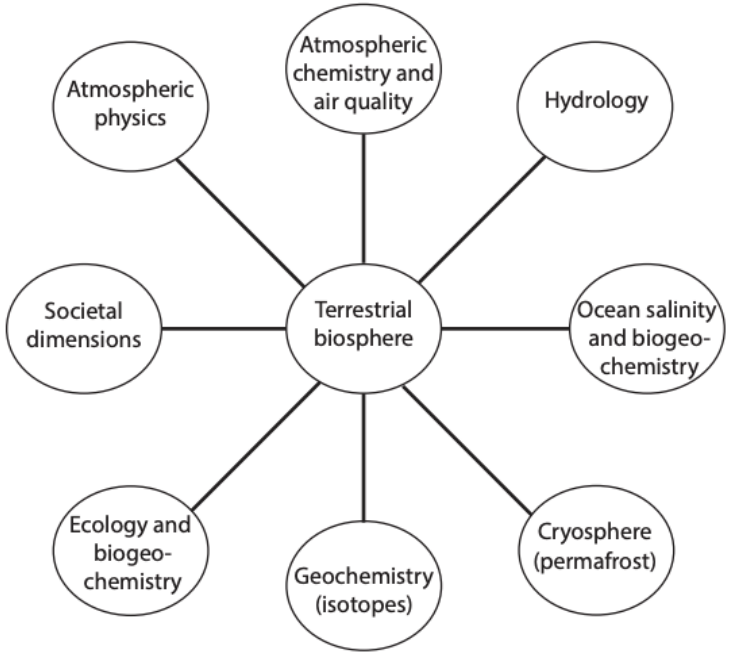


Source: Ukkola et al. (2022)

The transdisciplinary challenge

- Tracing the origin of these uncertainties is a transdisciplinary challenge, as it requires connecting with:
  - Computer scientists
  - Botanists
  - Meteorologists
  - Social scientists
  - Geographers
  - Hydraulic engineers

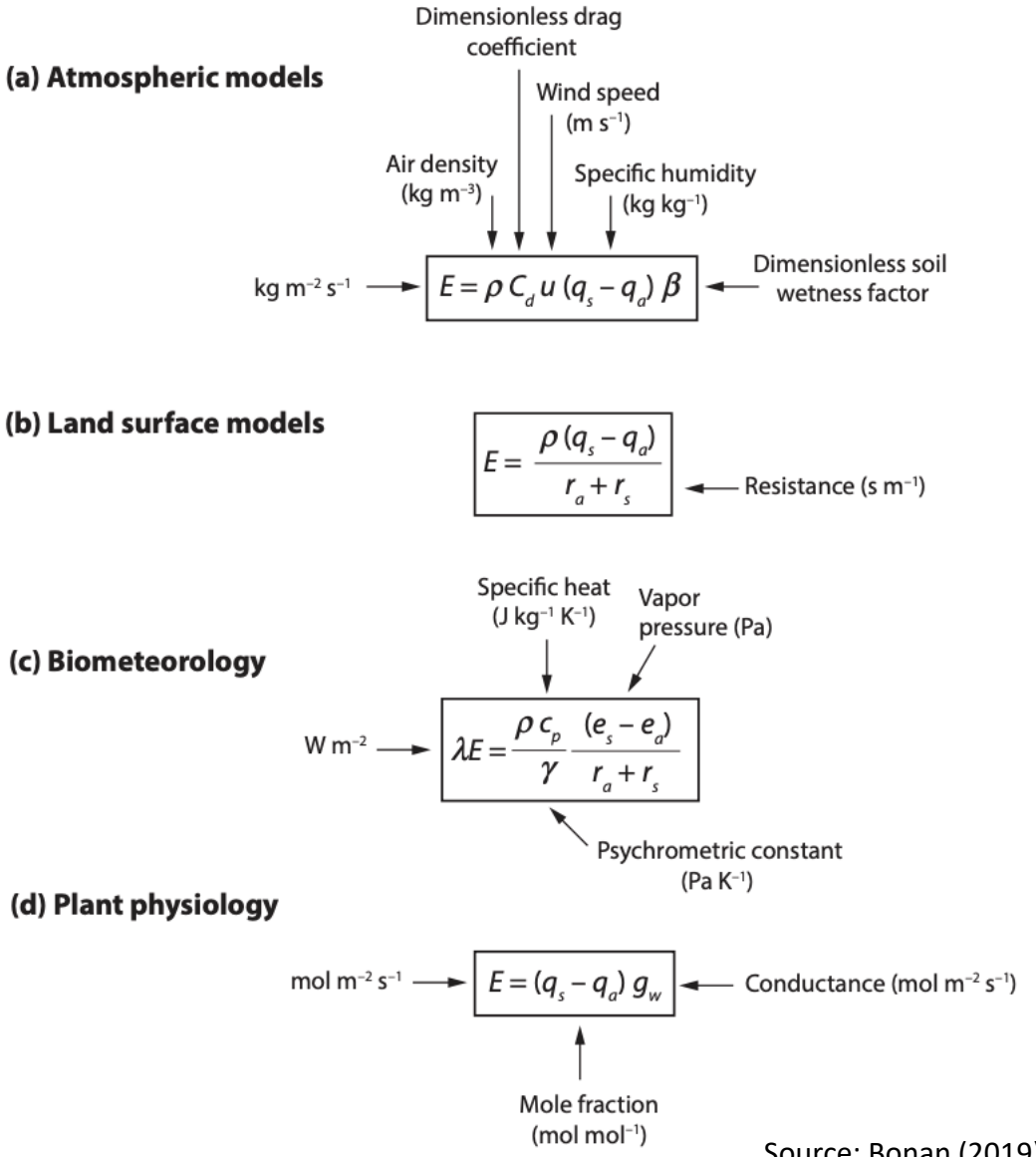




Source: Bonan (2019)

A common problem with a transdisciplinary solution

- Traditionally, each discipline represents the processes from its perspective, hindering the identification of connections with other fluxes (e.g., the carbon cycle). For instance, these four equations represent the same evapotranspiration process.
- Viewing the challenge from a transdisciplinary perspective makes common elements and connections clearer. This understanding allows for the effective use of all four equations to explain the uncertainties.



Source: Bonan (2019)

It is a wicked interdisciplinary problem!

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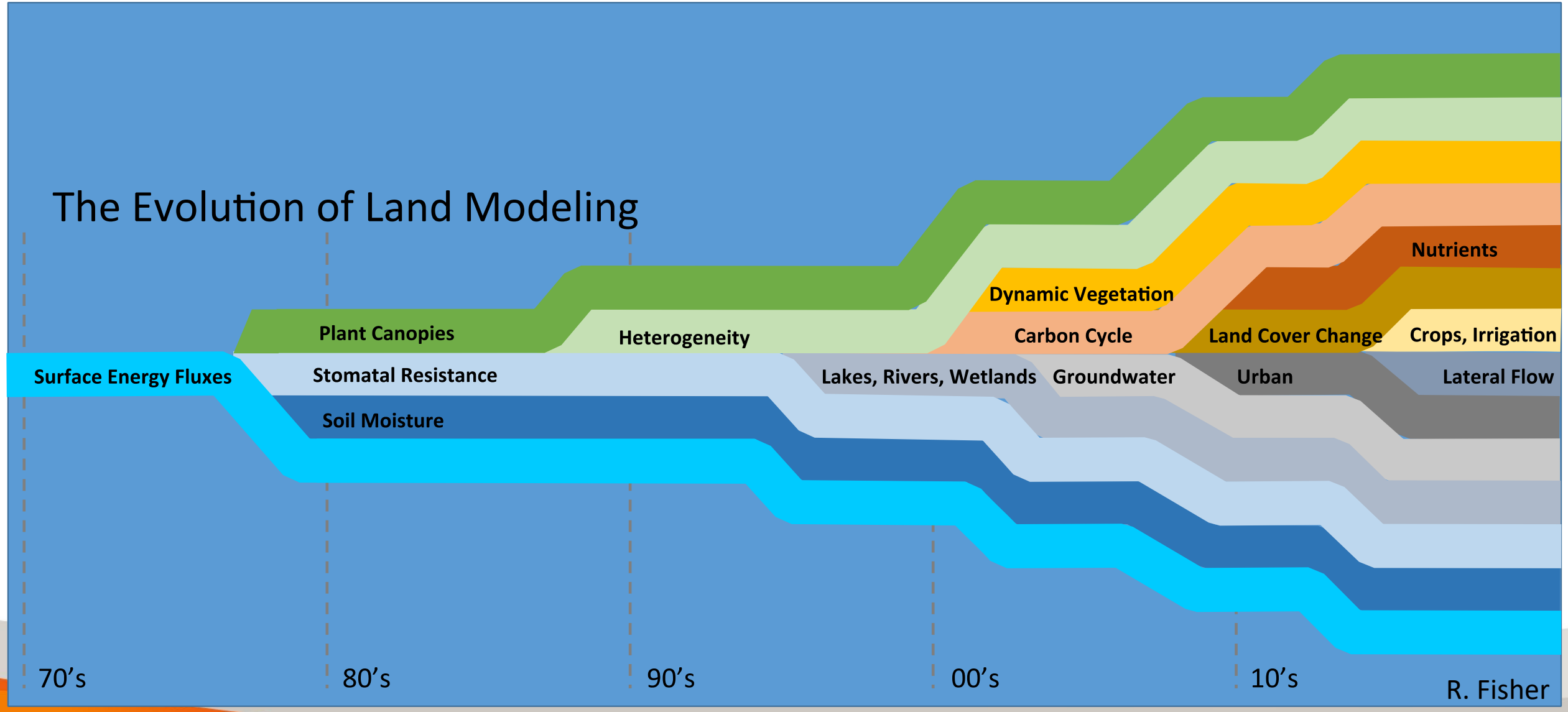
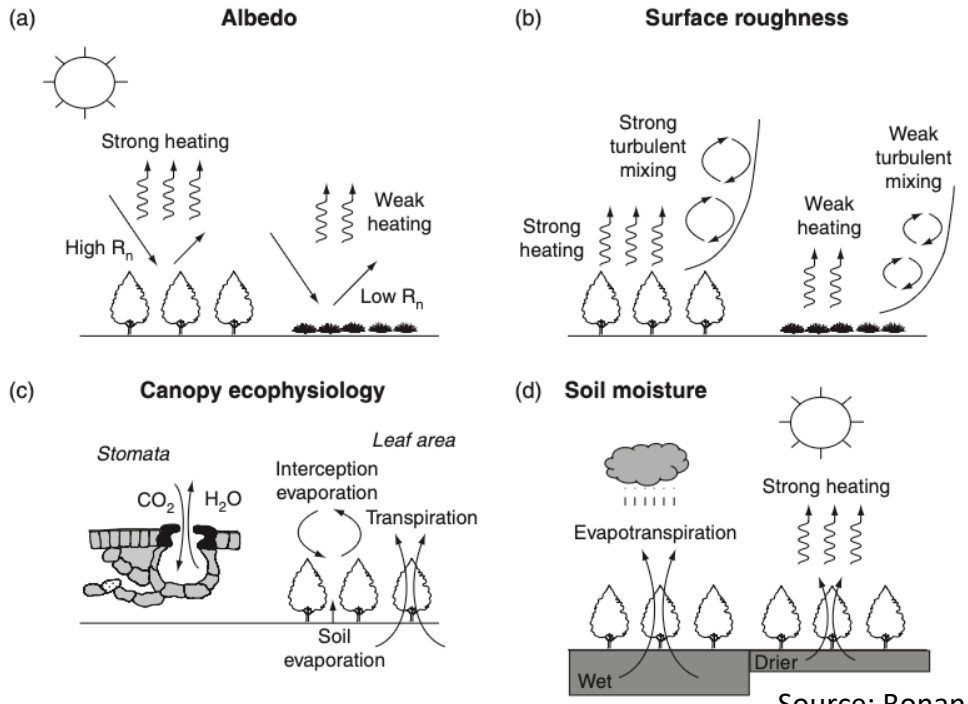
Land as a lower boundary to the atmosphere

Land as an integral component of the Earth System

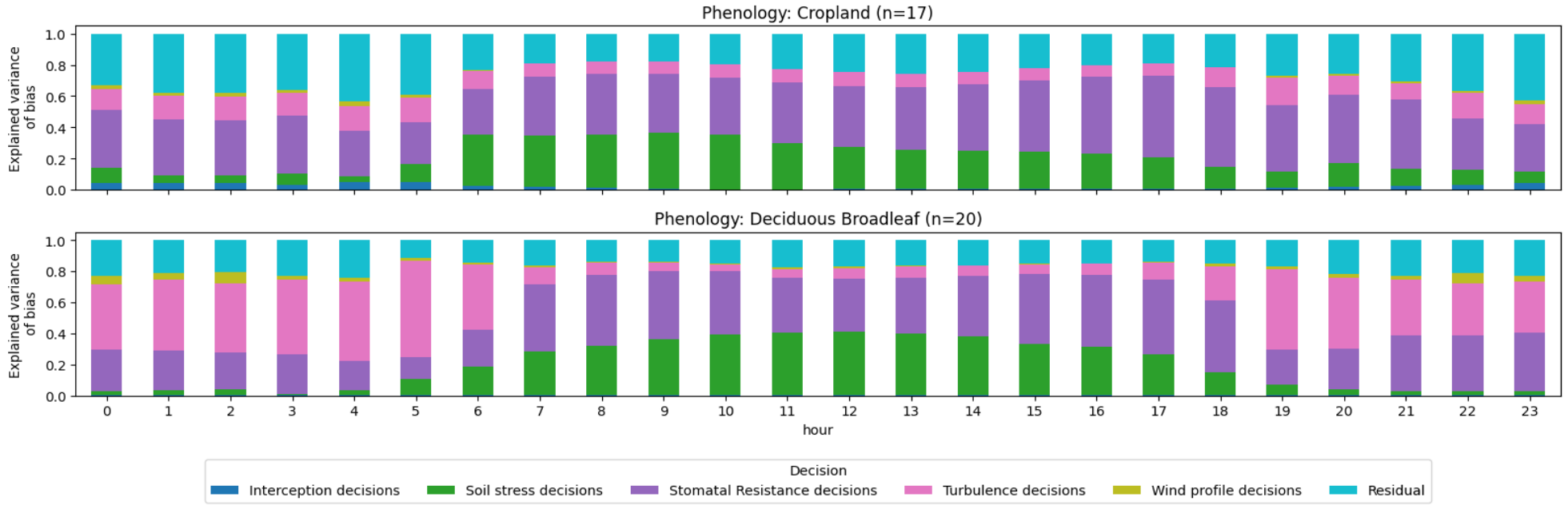


Role of equations

- I ran 108 combinations of five different equations over 154 flux towers to observe that different hydrological processes explain the biases in different vegetation types

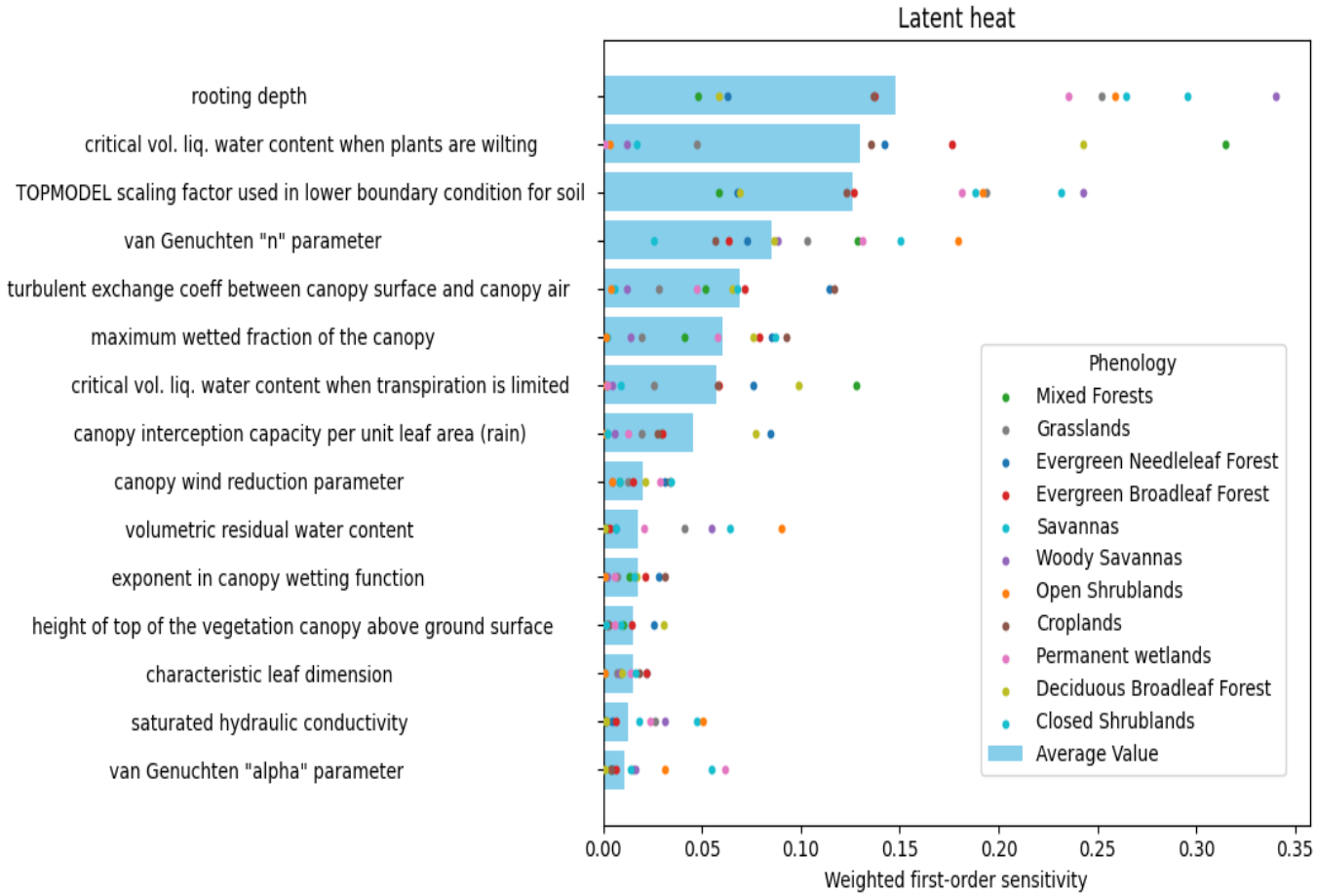


Source: Bonan (2016)



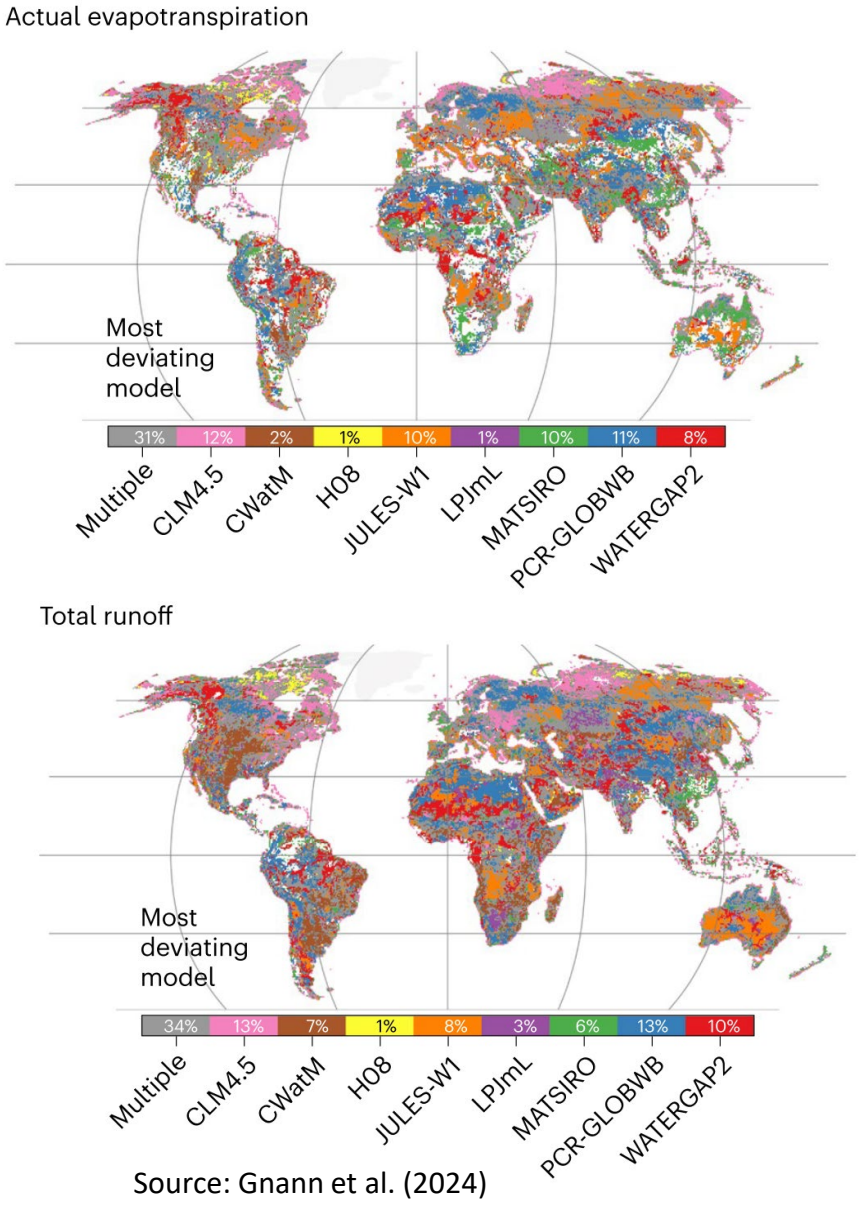
Role of parameters

- Evaluating the combination of parameters and parametrizations is key to understanding uncertainties.
- Challenges:
  - Parameters that compensate for structural deficiencies
  - Different combinations of parameters that look optimal based on looking at one metric
  - Models that are overparameterized
  - Models with hard-coded parameters



Analysis

- Understanding the role of equations and parameters is crucial for explaining models' current performance and suggesting ways to improve accuracy and realism.
- Previous experiments combined all elements, hindering tracing which elements are behind the uncertainty. Identifying the decisions most contributing to uncertainty is key to improving the models.
- Different decisions (parameters and equations) contribute differently in various places, and it is key to include many sites to capture this.



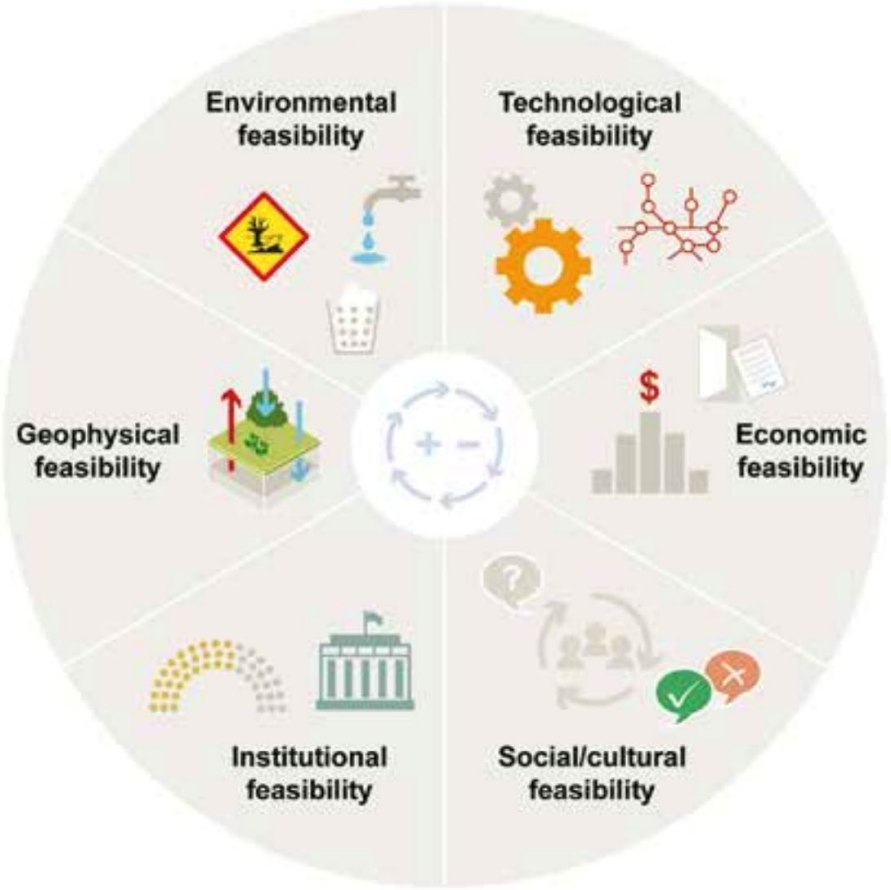
Source: Gnann et al. (2024)

Take home message

FAQ4.1: **The different feasibility dimensions towards limiting warming to 1.5°C**

Assessing the feasibility of different adaptation and mitigation options/actions requires consideration across six dimensions.

- The best way to fully represent the coupled human and natural system in models is to work under a transdisciplinary framework.
- Multiple hydrological processes (e.g., evapotranspiration, streamflow, and snow) and human interventions (e.g., agriculture, dams, and reservoirs) impact basins, which require integrating multiple experts.
- The societal component is key, as multiple communities use the output of models for forecasting, farming, and climate change adaptation. **They provide data to make key decisions for the entire population.**



Source: IPCC (2022)

Thank you

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