UNIVERSITÄT
BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Drivers of hydrological model diversity and model selection factors - The example of Switzerland.

Pascal Horton, Bettina Schaefli, Martina Kauzlaric

University of Bern

EGU, 24.05.2022

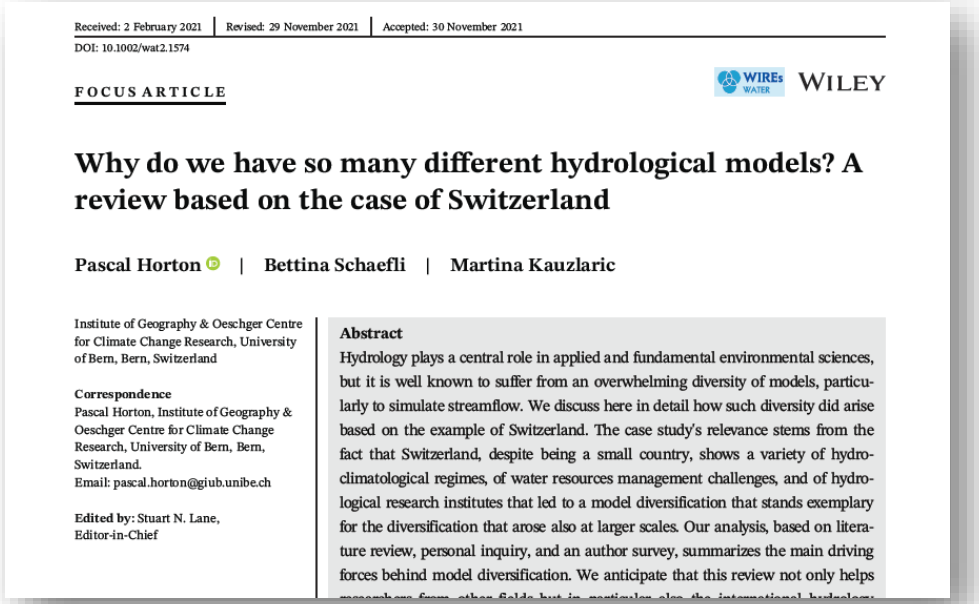
Motivations and methods

Overwhelming diversity of hydrological models

→ Switzerland: a small country with several hydrological models

→ How did such diversity arise in Switzerland?

→ What are the factors considered in model selection?



Received: 2 February 2021 | Revised: 29 November 2021 | Accepted: 30 November 2021

DOI: 10.1002/wat2.1574

FOCUS ARTICLE

WIREs WATER WILEY

Why do we have so many different hydrological models? A review based on the case of Switzerland

Pascal Horton | Bettina Schaefli | Martina Kauzlaric

Institute of Geography & Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Correspondence
Pascal Horton, Institute of Geography & Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland.
Email: pascal.horton@giub.unibe.ch

Edited by: Stuart N. Lane, Editor-in-Chief

Abstract

Hydrology plays a central role in applied and fundamental environmental sciences, but it is well known to suffer from an overwhelming diversity of models, particularly to simulate streamflow. We discuss here in detail how such diversity did arise based on the example of Switzerland. The case study's relevance stems from the fact that Switzerland, despite being a small country, shows a variety of hydro-climatological regimes, of water resources management challenges, and of hydrological research institutes that led to a model diversification that stands exemplary for the diversification that arose also at larger scales. Our analysis, based on literature review, personal inquiry, and an author survey, summarizes the main driving forces behind model diversification. We anticipate that this review not only helps

Only in Switzerland?

- Variety of hydro-climatological conditions
- Variety of hydrological research institutes
- Diversity in hydrological models vs processes or application context

Methods

- An exhaustive (or close to it) literature review of hydrological modelling studies in Switzerland: 157 peer-reviewed articles
- A survey to all first authors of these papers: ~50 participants

Models developed/applied in Switzerland

Model name	Full name
Alpine3D	Alpine3D
CemaNeige-GR6J	CemaNeige - Genie Rural à 6 paramètres Journalier
DECIPHeR	Dynamic fluxEs and ConnectIvity for Predictions of HydRology
GERM	Glacier Evolution Runoff Mode
GSM-SOCONT	Glacier and SnowMelt {SOil CONTribution model}
HBV	Hydrologiska Byråns Vattenbalansavdelning
HBV-light	Hydrologiska Byråns Vattenbalansavdelning - light
HYPE	HYdrological Predictions for the Environment
LISFLOOD	LISFLOOD
LARSIM	Large Area Runoff Simulation Model
mHM	meso-scale hydrological model
PREVAH	Precipitation-Runoff-Evapotranspiration HRU Model
RS	Routing System
SEHR-ECHO	Spatially Explicit Hydro. Response model for ecohydro. applic.
StreamFlow	StreamFlow
SUPERFLEX	SUPERFLEX
SWAT	Soil Water and Assessment Tool
TOPKAPI-ETH	TOPographic Kinematic APproximation and Integration - ETH
VIC	Variable Infiltration Capacity model
WaSiM(-ETH)	Water Flow and Balance Simulation Model (- ETH)
wflow	wflow

Type of use
Developed in Switzerland
Further evolved in Switzerland
Applied in Switzerland

- Use of a «swiss» model: 93%
- Model's adequacy addressed: 25%
- Reuse of a model setup: 20 - 51%
- Model developer (or team leader) as co-author: 72%

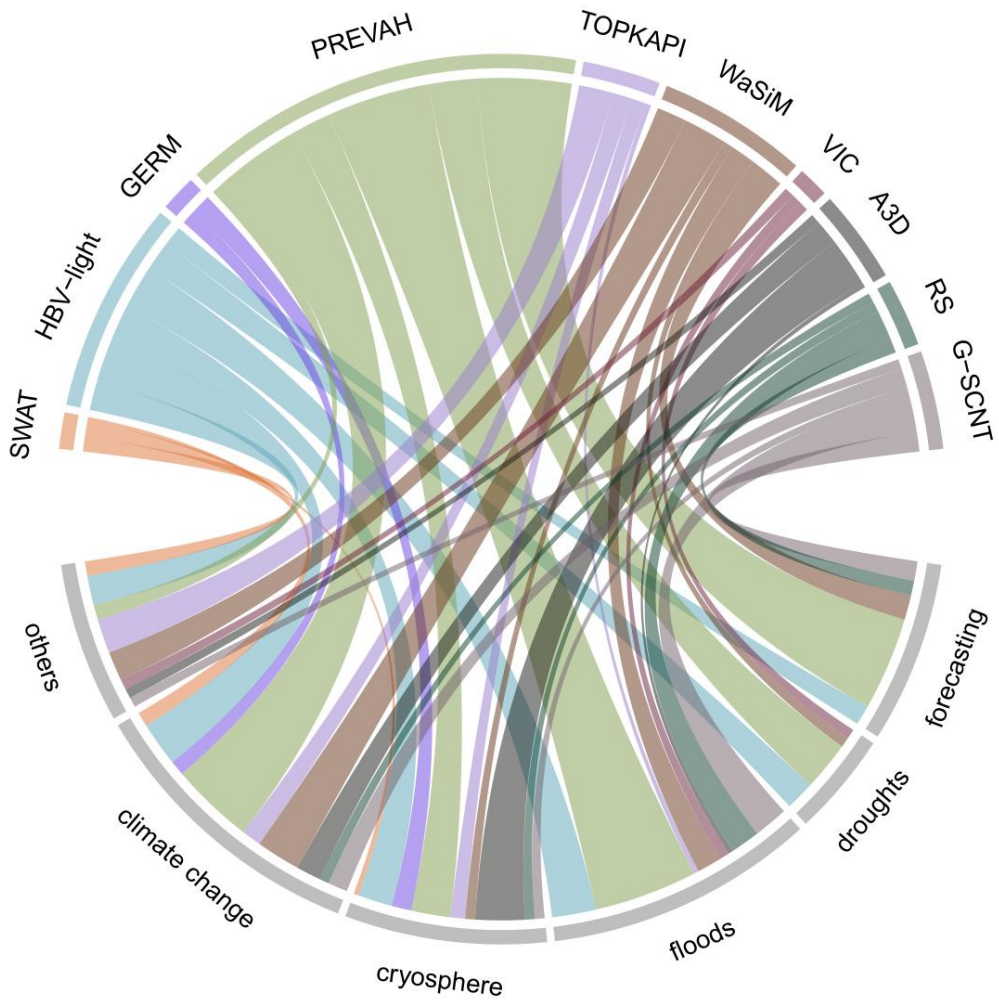
b
UNIVERSITÄT
BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

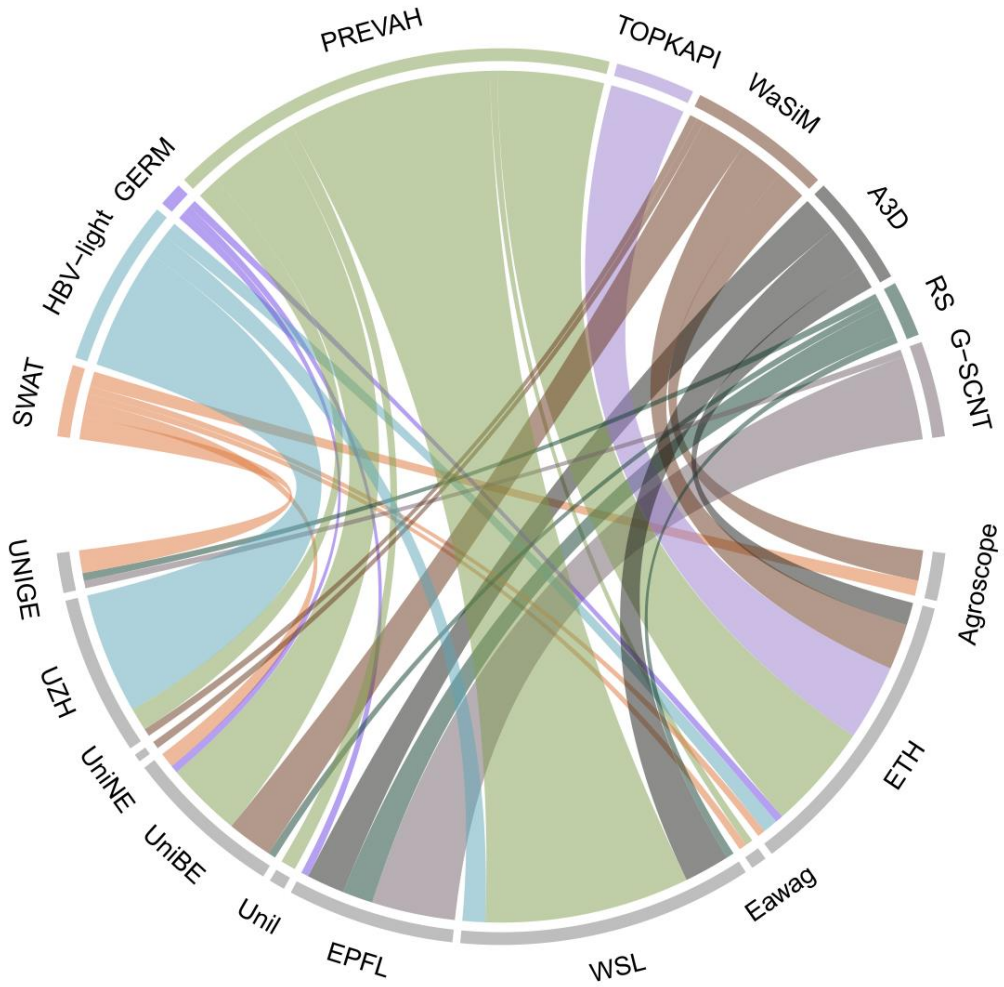
Link between models and contexts/institutes

UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Links model – contexts

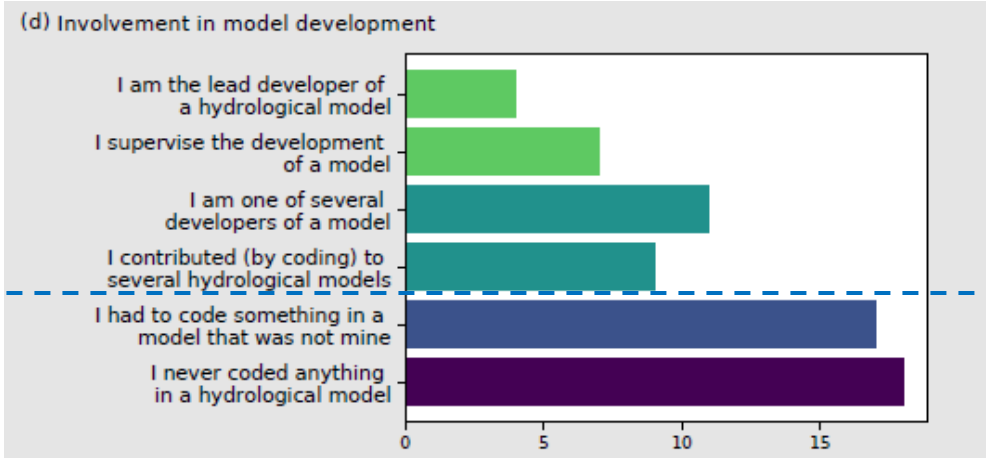


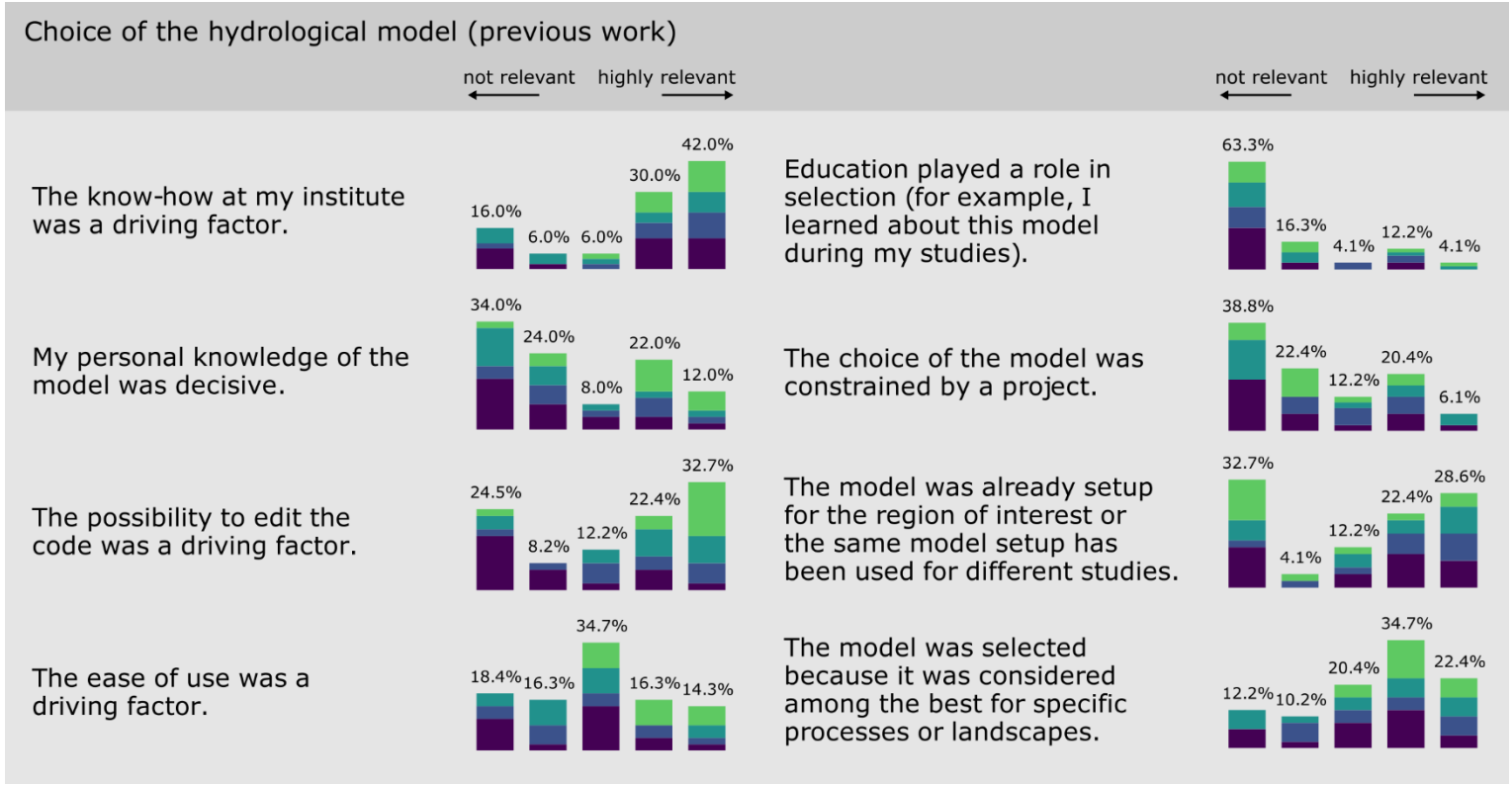
Links model – institutes



Model selection factors: past

- Know-how at the institute is a key factor → expertise/habits (cf Addor and Melsen, 2019)
- Institute expertise higher than personal one
- Possibility to edit the code more important than the ease of use
- Education & project constraints: not relevant
- Potentially relevant: reuse of an existing setup & adequacy

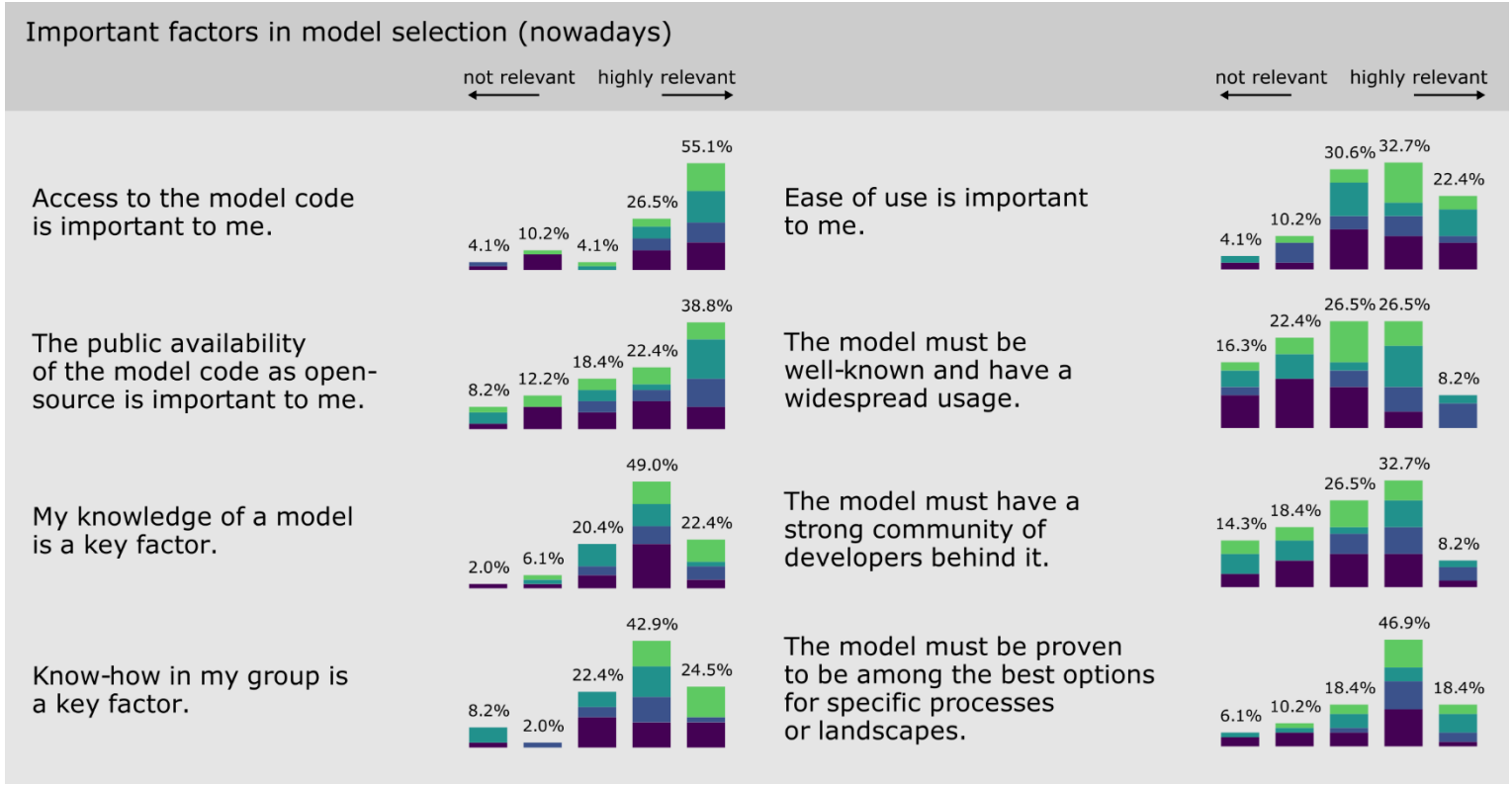




b
UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Model selection factors: future

- Access to model code highly relevant
- Personal knowledge: increased relevance
- Know-how in the group: as relevant
- Adequacy: mostly relevant

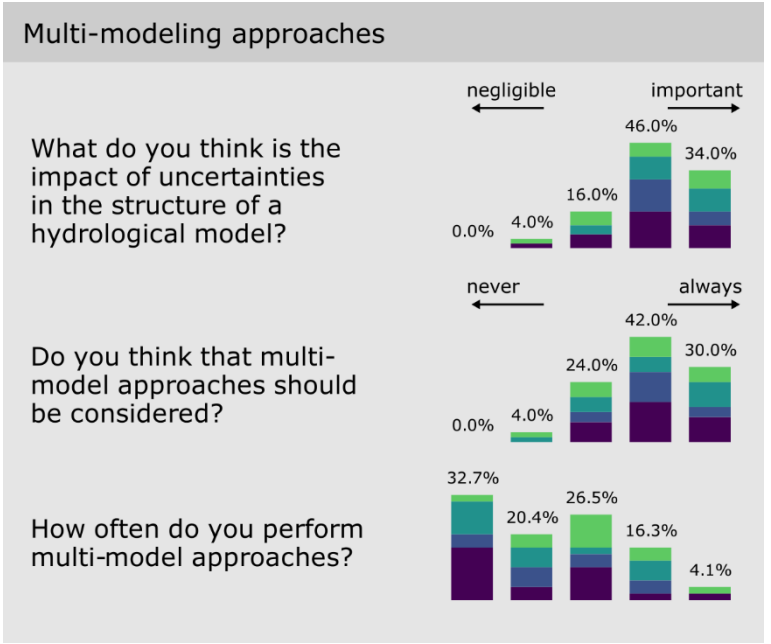


Take home messages

UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH

- Modeling studies should come with a succinct statement about the model choice
- The expertise in a group is a plus when it is not at the expense of adequacy
- Better consider/justify adequacy to the landscape/processes
- Access to code matters for 82% of the authors
- Open-source software promotes shared efforts in model development
- Multi-modelling approaches are considered important, yet not applied:
  Small projects → little money → not enough time for multi-modelling



Horton, P., Schaefli, B., & Kauzlaric, M. (2022). Why do we have so many different hydrological models? A review based on the case of Switzerland. *WIREs Water*, *9*(1), e1574. https://doi.org/10.1002/wat2.1574

Pascal Horton: pascal.horton@giub.unibe.ch