Eawag
Institut Fédéral Suisse des Sciences
et Technologies de l'Eau

eawag
aquatic research

Strategies/Challenges/Approaches on extreme weather events

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(based on input from Lauren Cook, Christine Weber, Mario Schirmer, Joao Leitao, Eberhard Morgenroth)

Eawag: a clear focus, a broad profile

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Swiss Federal Institute of Aquatic Science and Technology

Eawag: a clear focus, a broad profile

Water as core and link

Eawag: broad research themes

Aquatic and Fish Ecology

Social Sciences

Process Engineering

Environmental Microbiology

Environmental Chemistry and Toxicology

Water Resources Management

Sanitation and Water for Development

Systems analysis and Modelling

Eawag: a clear focus, a broad profile

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Water as the link

Extreme weather events affect all water-related processes

Helicopters supply water to alpine meadows

https://www.swissinfo.ch/ger/alle-news-in-kuerze/helikopter-versorgen-duerstende-alpkuehe-mit-wasser/44299432

Helicopters aren’t the solution

https://www.swissinfo.ch/ger/alle-news-in-kuerze/helikopter-versorgen-duerstende-alpkuehe-mit-wasser/44299432

Contents

Examples of Eawag research

- Urban systems and natural systems
- Water management linking between extremes (flood and drought)
- Protection of humans and conservation of ecosystems
- Innovations (technologies, scientific methods, systems' design, co-creation with stakeholders)

Climate change and extreme weather events

Climate change:

"The occurrence of extreme events unprecedented in the observed record will rise with increasing global warming, even at 1.5°C of global warming."
IPCC
(https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-11/)

https://www.cdt.ch/ticino/lugano/allagamenti-e-frane-nel-luganese-JE4464913?_sid=g4zlulBR

Historical contingencies:

Existing infrastructure reflect mostly past climate conditions:

After Cook, 2023

Coping strategies

Warning systems: nowcasting

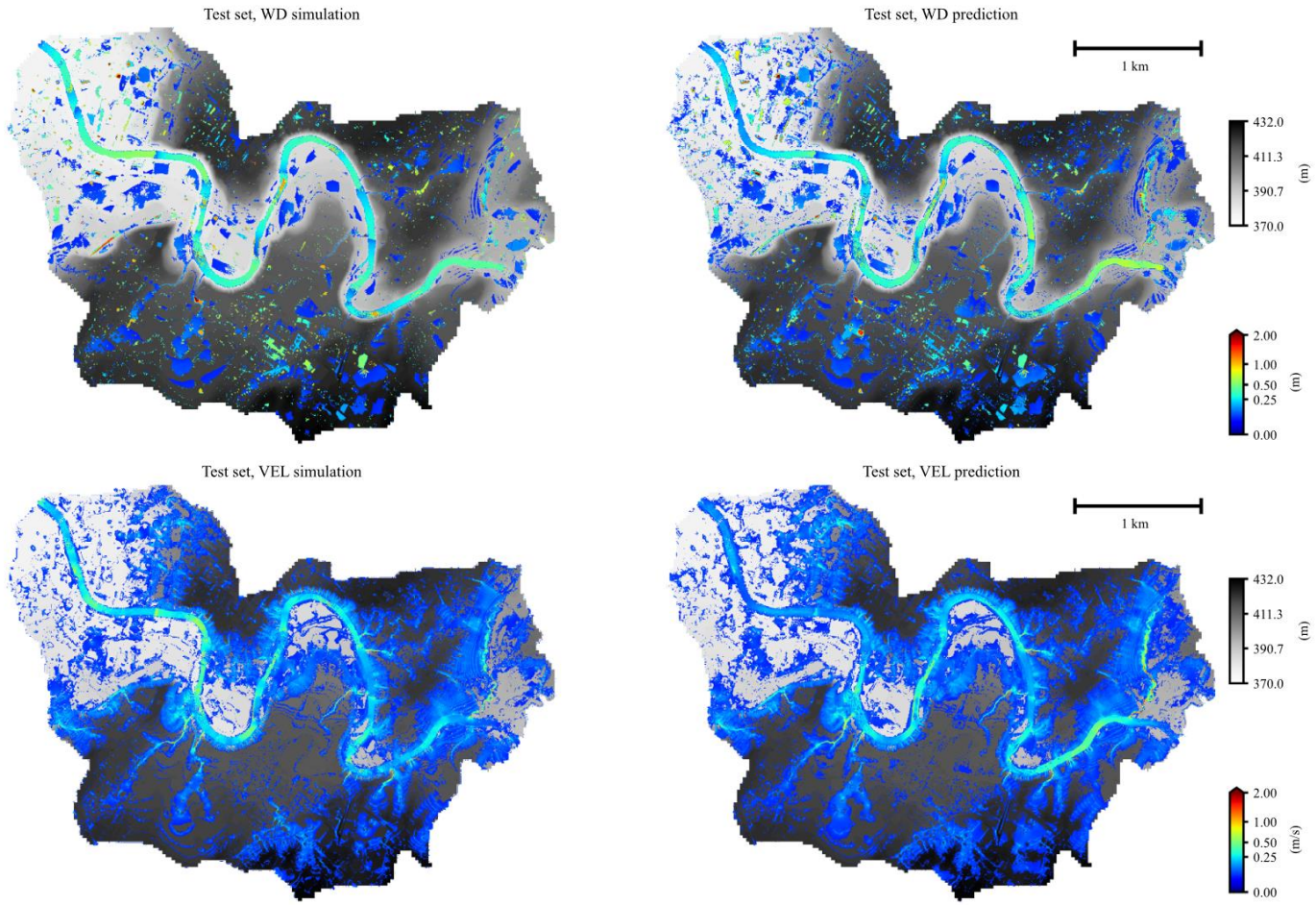

Fig. A1. Sample 1 from the test dataset. Top: simulated and predicted water depth. Bottom: simulated and predicted flow velocity.

Guo, Z. et al., 2022

Innovation needed:

- High spatial resolution terrain representations
- Fast processing of 2-D models
- Spatially distributed data for calibrating models (proxy data incl. pictures etc.)

Re-shaping the urban system: Sponge city

Retention of rain water

Heat reduction

Improving biodiversity

Energy saving (reduce cooling needs)

Retention of pollutant

Improved human health status

Blue-green infrastructure BGI

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Retention structures

Green roofs

Experimental studies of BGI types:

- Effects on water retention and heat development
- Combination of experiments and modelling
- Water cycle: linking drought and flood periods

Greenery

(1) Short Vegetation
(2) Trees
(3) Urban Parks
(4) Littoral / Riparian Vegetation
(5) Vertical Greenery
(6) Green Roofs
(7) Vegetated Swales / Bioretention Systems

Water Bodies / Features

(8) Ponds / Lakes / Sedimentation Basins
(9) Rivers
(10) Constructed Wetlands
(11) Fountains / Water Sprinklers

Hard Surfaces

(12) Pervious Pavements
(13) Reflective Surfaces

Practices

(14) Irrigation
(15) Surface Watering
(16) Planning of Ventilation Corridors

Arrows:

Water Flow

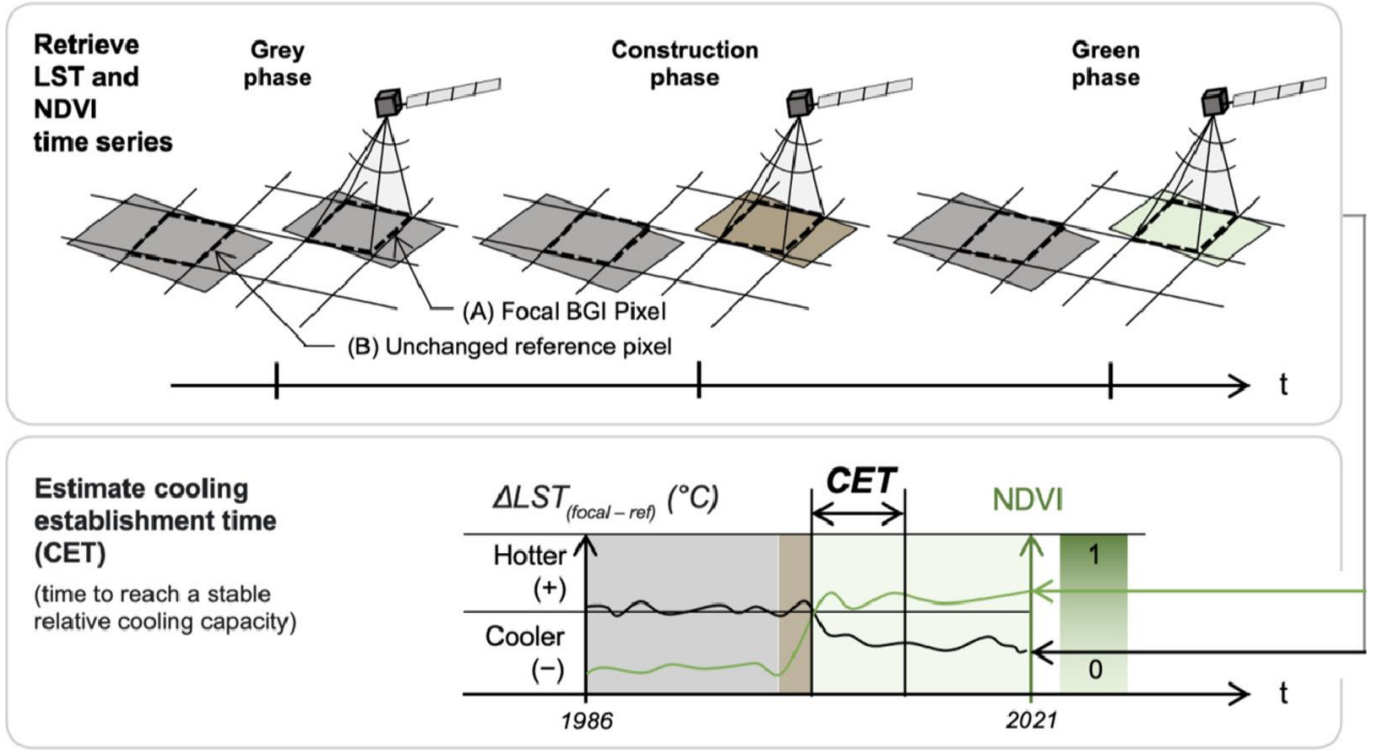
Wind Flow

Alternative Water Sources

(A) Rainwater Harvesting
(B) Stormwater Harvesting
(C) Sewer Mining
(D) Greywater Capture and Reuse

Probst, N. et al., 2022

Quantifying BGI effects across space and time



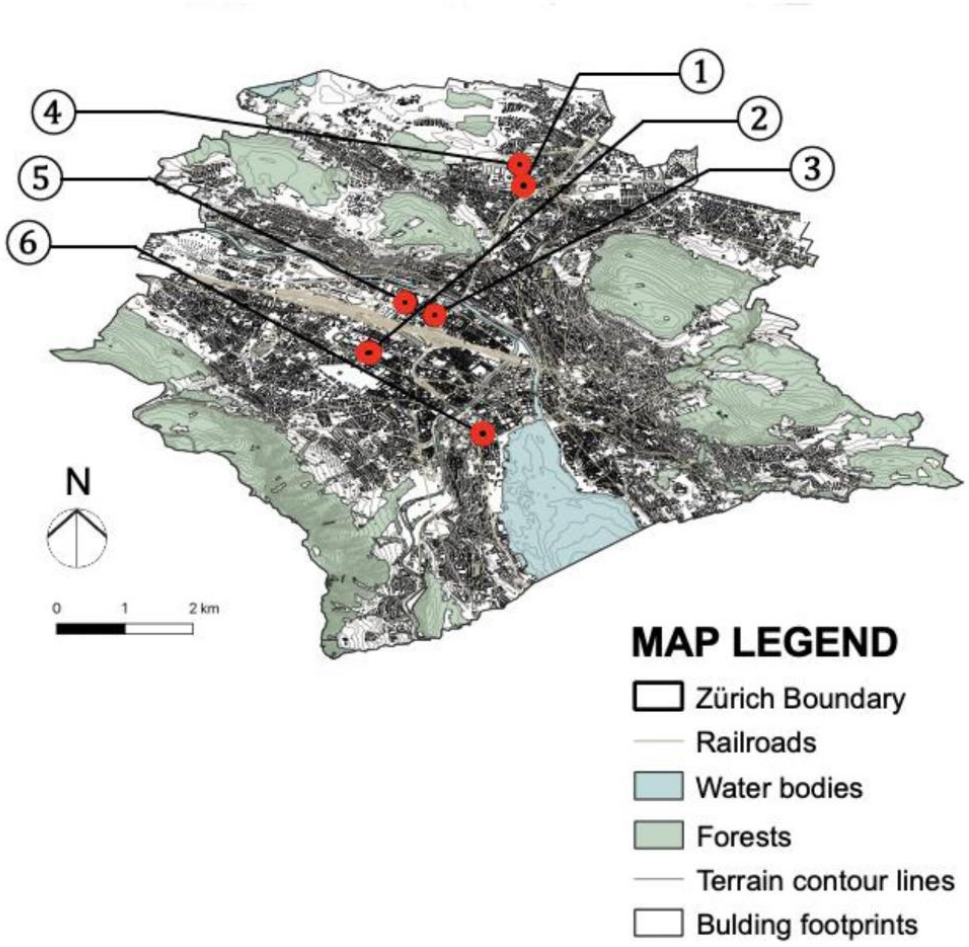
Surface temperature

- *before,*
- *during and*
- *after*

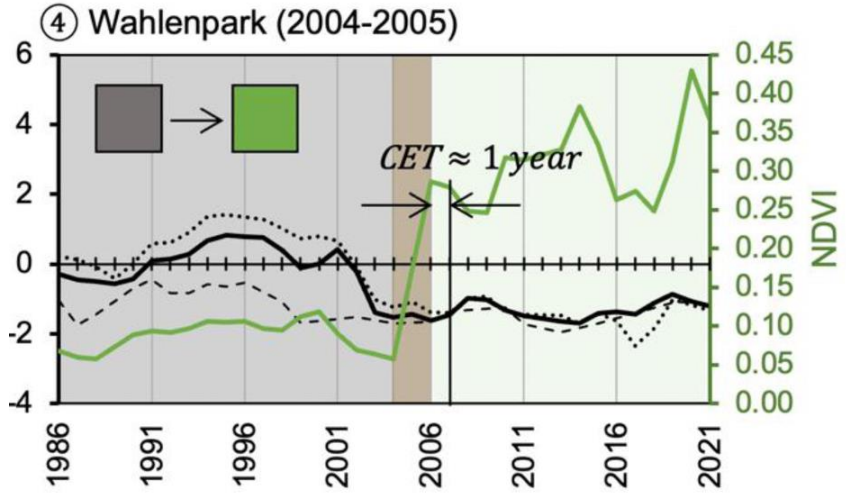
the construction of blue-green infrastructures

Gobatti, L. et al., 2023

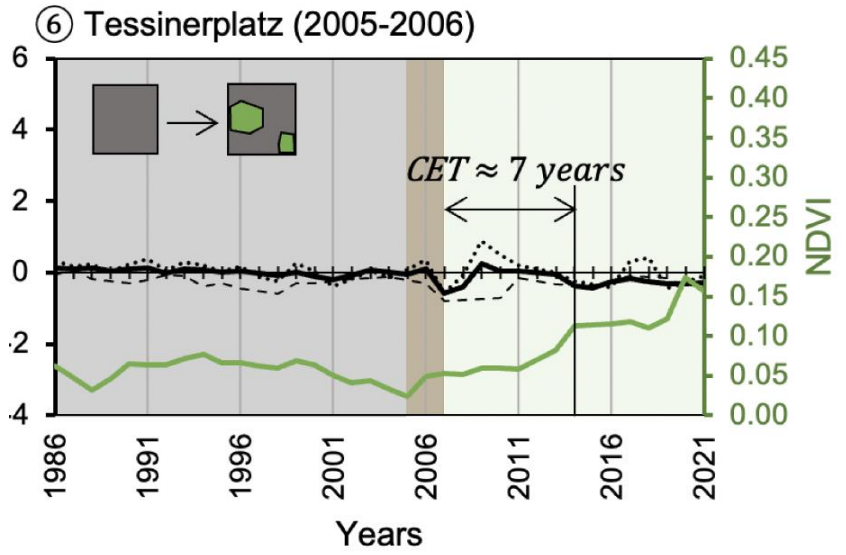
Adapting to heat waves



Short vegetation



Trees



Gobatti, L. et al., 2023

Water scarcity: Re-use!

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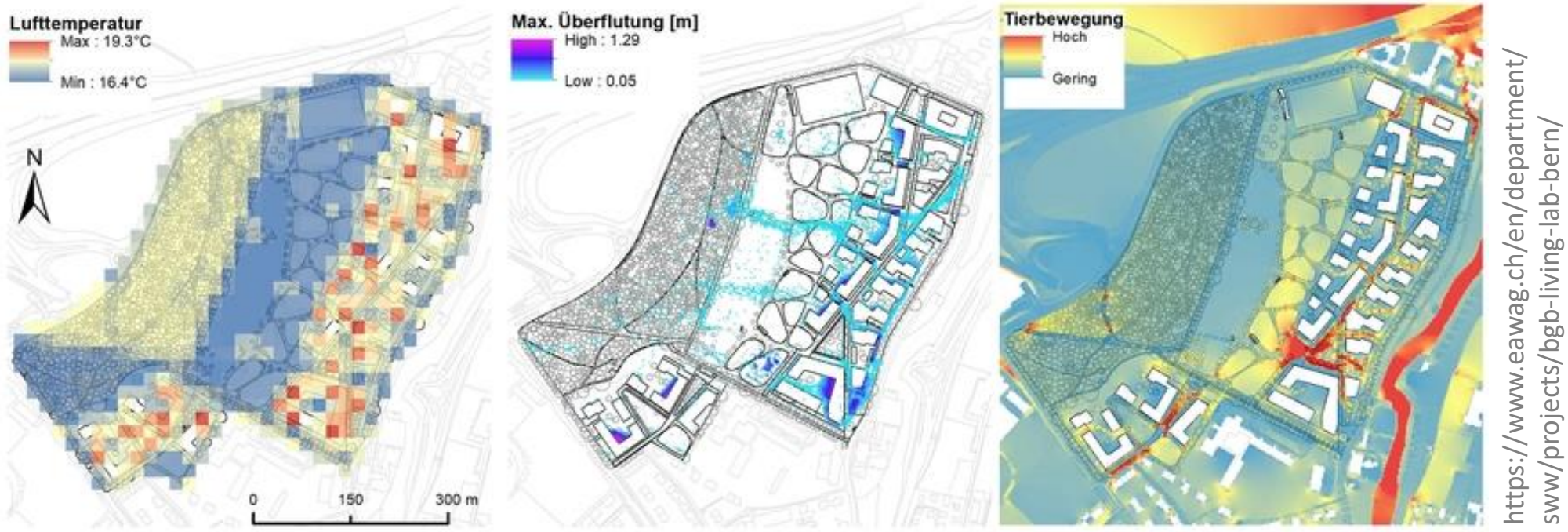
Informal settle-ments	Bangalore	San Francisco	Dübendorf	Train toilets
				

From Morgenrot, 2023

Scaling up: Urban living labs

Real-world experiments



https://www.eawag.ch/en/department/sww/projects/bgb-living-lab-bern/

Bern Viererfeld/ Mittelfeld: urbanization on a 20 ha greenfield site

- to be developed to house 3'000 people.
- opportunity to capture the 'pre-development' state before and during construction
- baseline hydrological, microclimate and other environmental conditions
- **Goal: longitudinal observation of an urban transformation**.

Floods and aquatic ecology

Human perspective: damage!

Engelberger Aa (Grafenort) 2005

Reuss (Perlen) 2005

Floods and aquatic ecology

Ecological perspective: Creation and maintenance of essential habitats/habitat structures!

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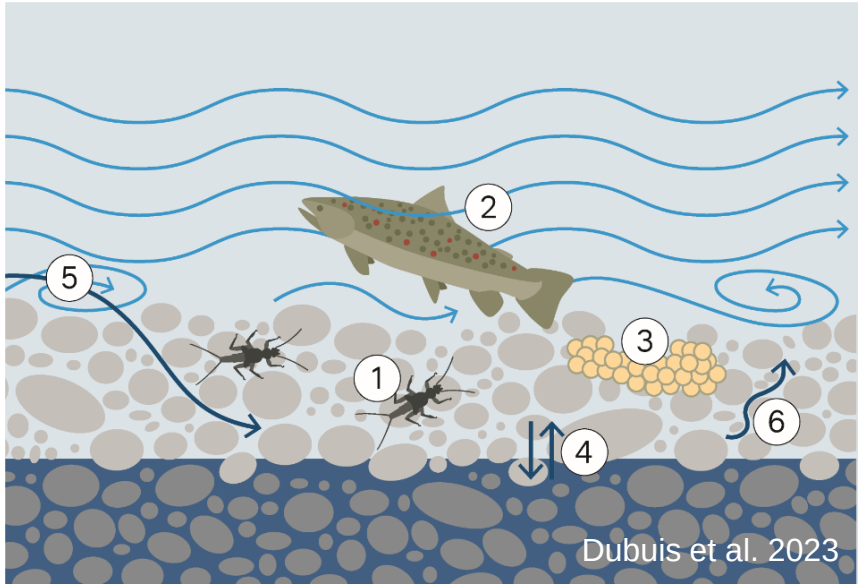

Removing fine sediments from river bottom

Creation of new (terrestrial) habitats

Floods and aquatic ecology

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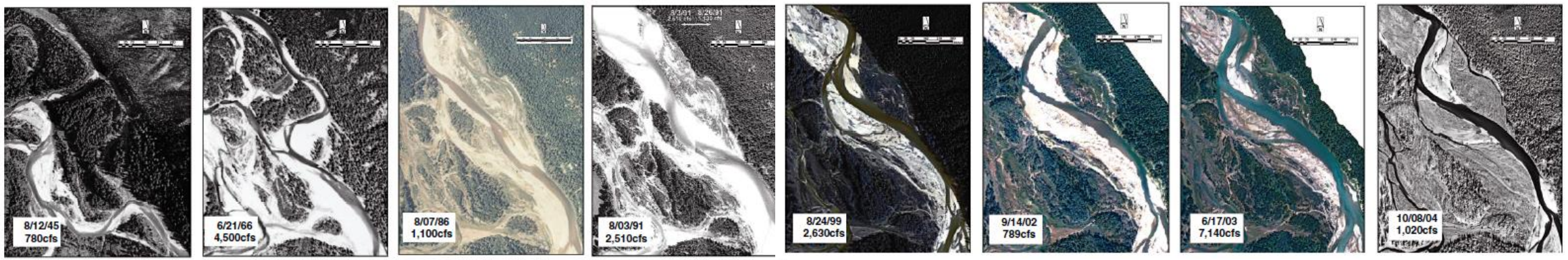
Ecological perspective: Creation and maintenance of essential habitats/habitat structures!

Example Flathead River (Oregon, USA) 1945 to 2003



Lorang & Hauer 2006

→ Major challenge: how to reconcile protection for humans with necessary natural dynamics of ecosystems?

Transdisciplinary research program «River engineering and ecology»

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal office for the environment

River engineers & Ecologists

EPFL ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

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Program characteristics:

- long-term collaboration
- Inter- and transdisciplinary
- Output for science, practice and policy

Rhone-Thur Project (2002-2006)

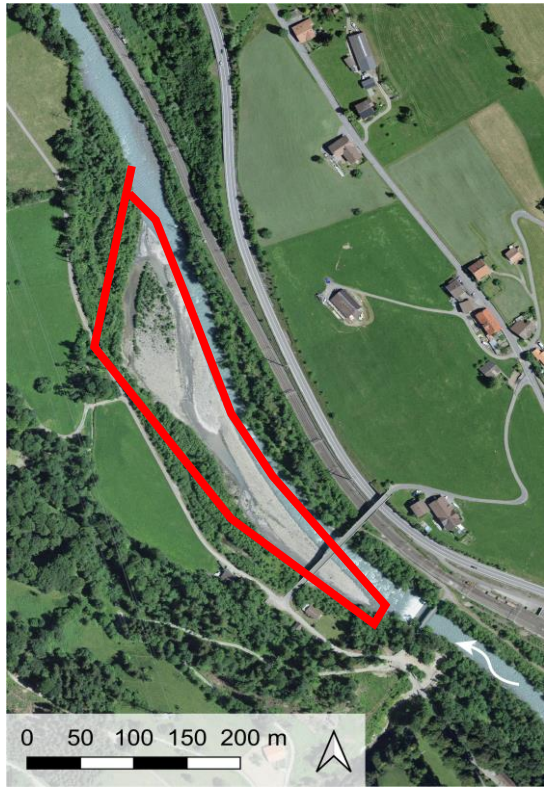
Integrated river management (2007 – 2011)

Sediment and habitat dynamics (2013 – 2017)

Riverscape (2018 – 2021)

Resilient Rivers (2022 – 2026)

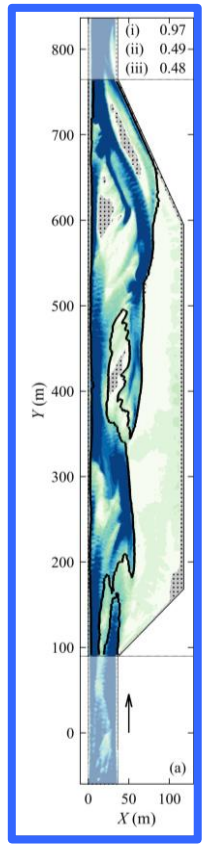
Transdisciplinary research program «River engineering and ecology»



How to best invest land for ecological processes?

Physical model (lab)

Numerical model (2D, Basement)



Different discharges, different bedload supplies

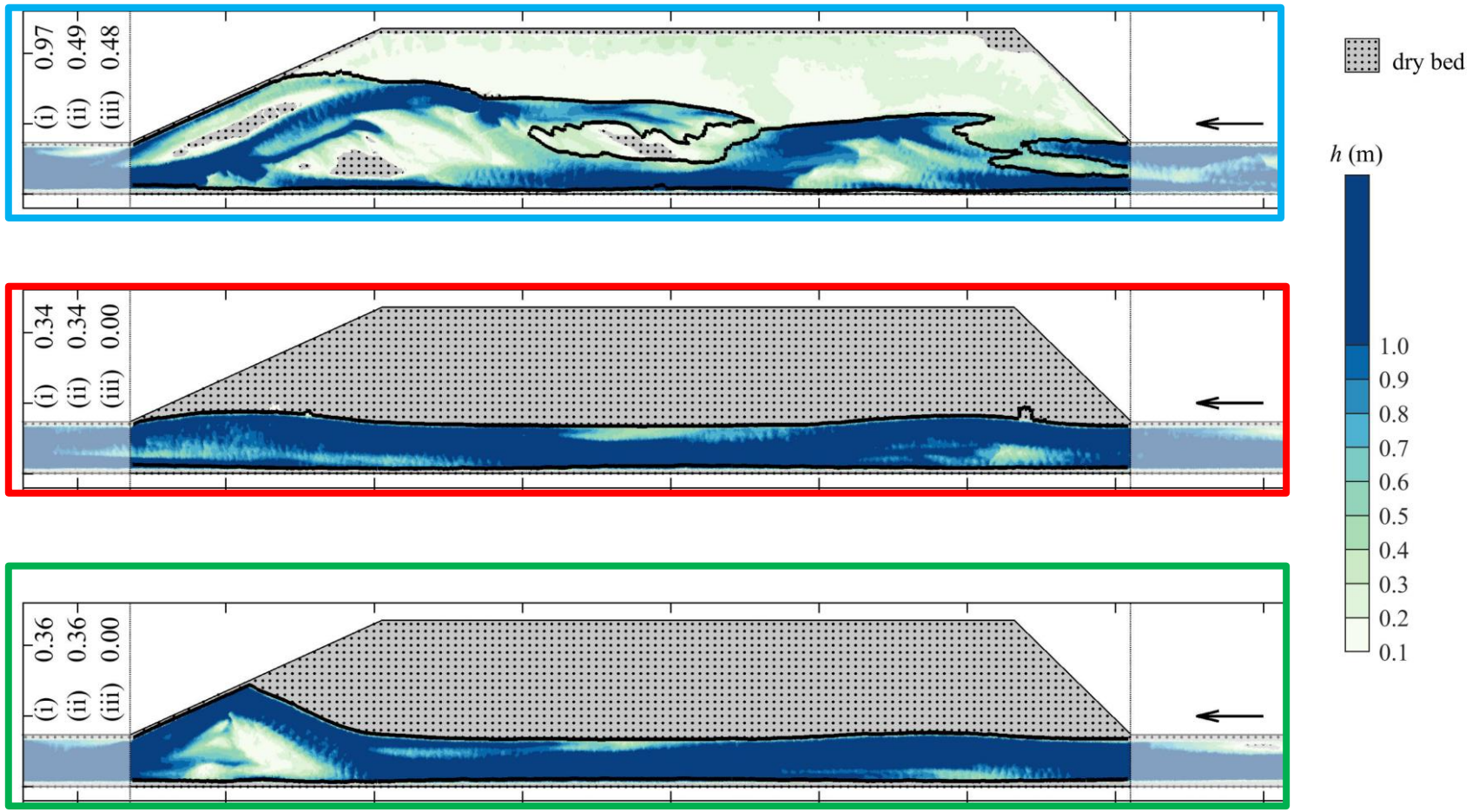
Rachelly et al. 2023

Transdisciplinary research program «River engineering and ecology»

Floods an ecologicals status:

It’s more than just water!

Water management requires also the sediment perspective



Rachelly et al. 2023

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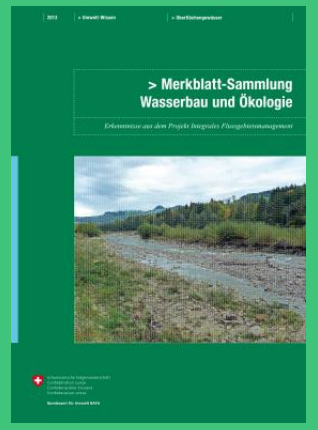
Different outreach products:

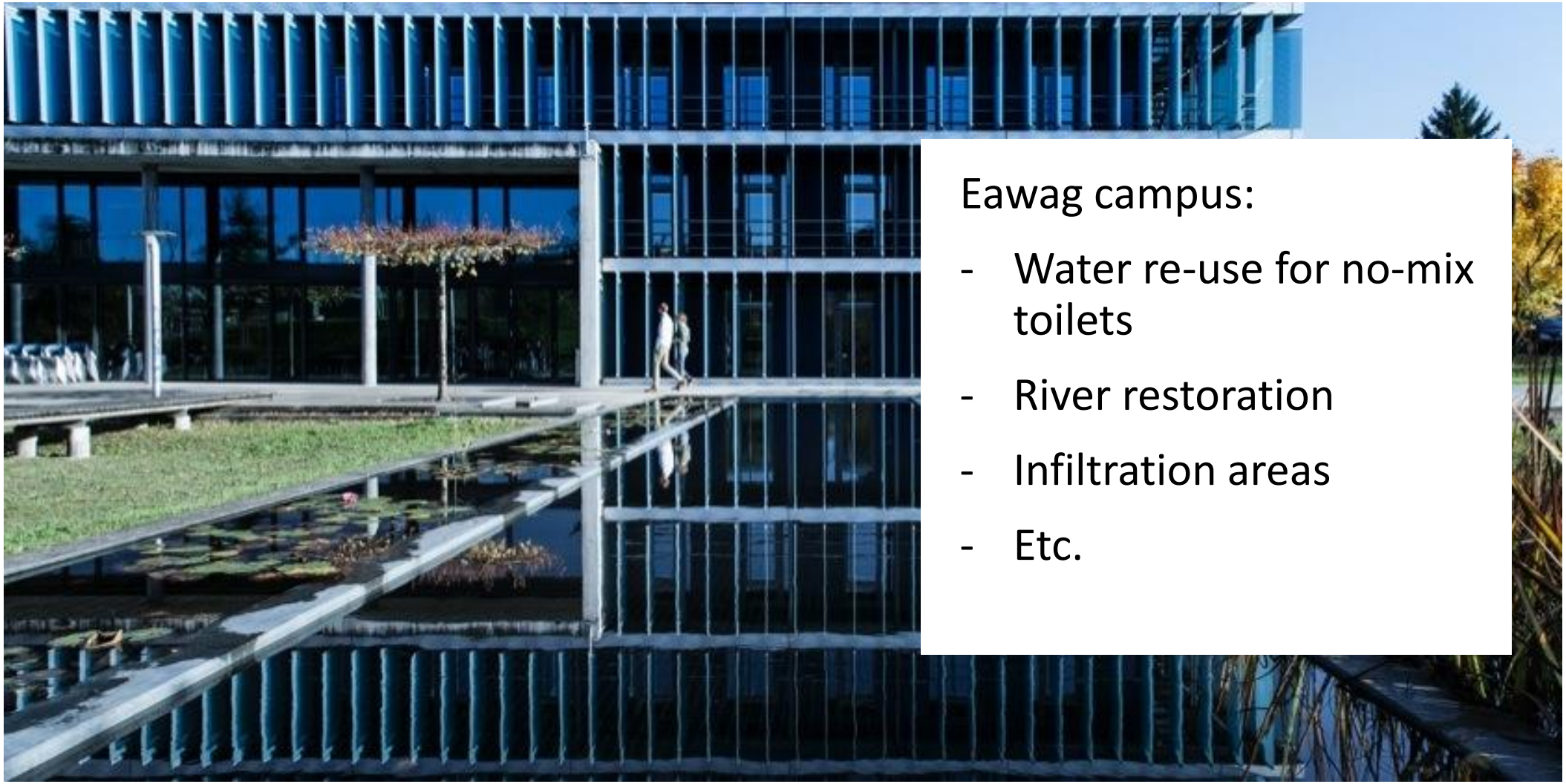
Factsheets



Movies and interactive map

Workshops and courses for practice

Eawag: from research to implementation

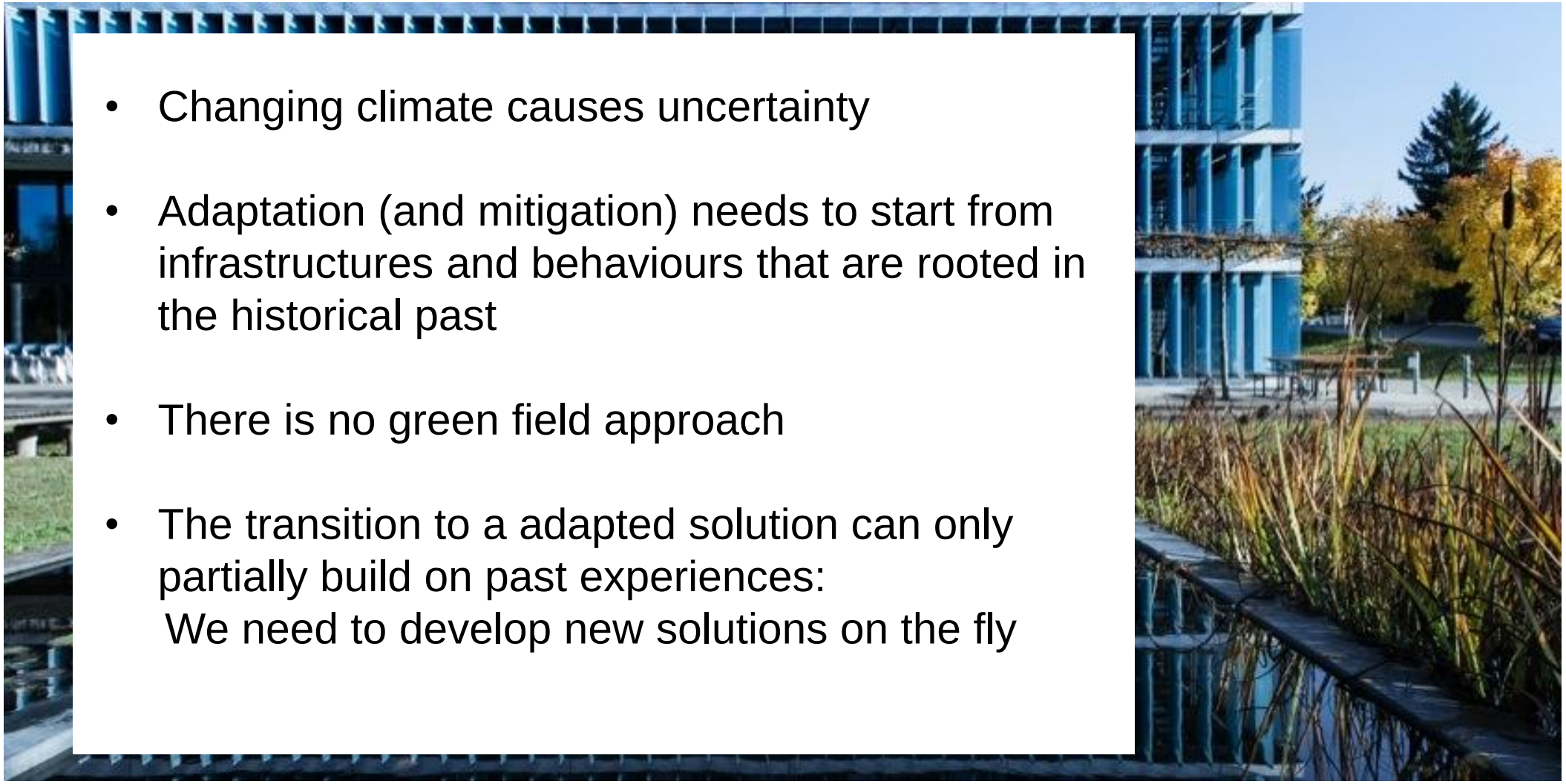


Eawag campus:

- Water re-use for no-mix toilets
- River restoration
- Infiltration areas
- Etc.

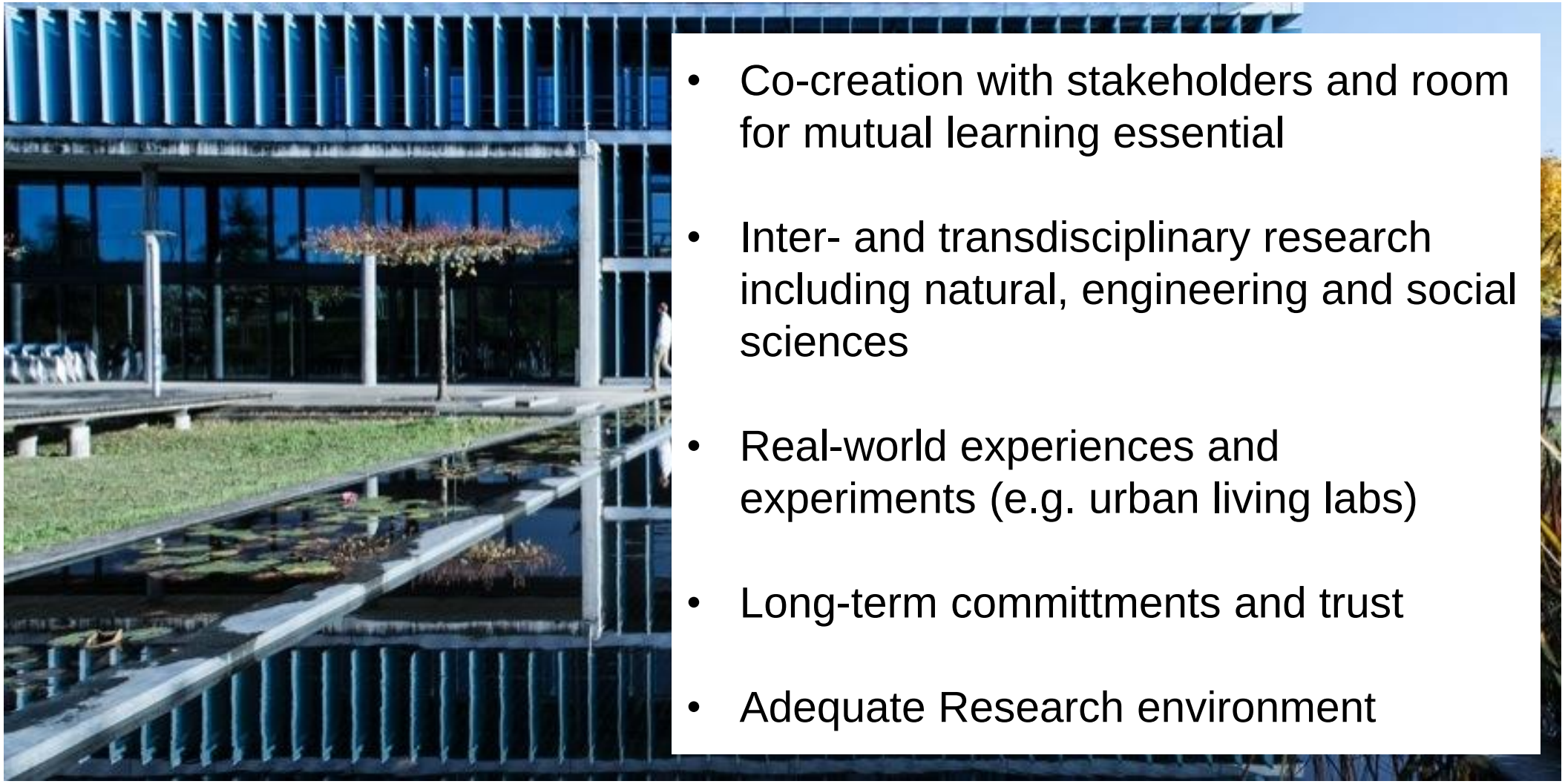
Foto: Eawag

Challenges



- Changing climate causes uncertainty
- Adaptation (and mitigation) needs to start from infrastructures and behaviours that are rooted in the historical past
- There is no green field approach
- The transition to a adapted solution can only partially build on past experiences:
  We need to develop new solutions on the fly

Approaches



- Co-creation with stakeholders and room for mutual learning essential
- Inter- and transdisciplinary research including natural, engineering and social sciences
- Real-world experiences and experiments (e.g. urban living labs)
- Long-term committments and trust
- Adequate Research environment

Eawag: from research to implementation

Foto: Eawag