ETH zürich

Study programme
Environmental Engineering

Information Event for Master in Environmental Engineering

24 February 2025

Prof. Jing Wang (Director of Studies)

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Todays Agenda

Begrüssung mit Einführung zum Masterstudium und Überblick über die Masterstruktur	Studiendirektor Prof. Jing Wang
Vorstellung aktueller Projekte der Vertiefungsrichtungen	
Umwelttechnologien	Yile Tao
Ressourcenmanagement	Jing Huo
Siedlungswasserwirtschaft	Matthias Stähle
Wasserwirtschaft	Luiz Martins da Silva
Fluss- und Wasserbau	Yuhao Yan
Module RemSens / SOIL	Shiyi Li / Julian Schoch
Fach- und Computerlabor	Daniel Braun
Fragerunde	

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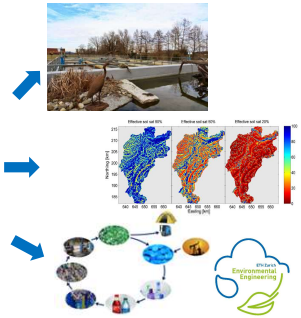
What is environmental engineering?

Environmental engineering is a professional discipline that builds on broad scientific topics, e.g. chemistry, biology, ecology, hydraulics, hydrology, physics, statistics, mathematics, to **create engineering solutions** that **protect and improve the quality of our environment**.

You will train to become an environmental engineer by applying scientific and engineering principles to

- develop new (treatment) **technologies, sensing and monitoring methods**
- **develop and apply numerical models**, make predictions, analyse scenarios, options
- **formulate "best" solutions** to environmental problems for society



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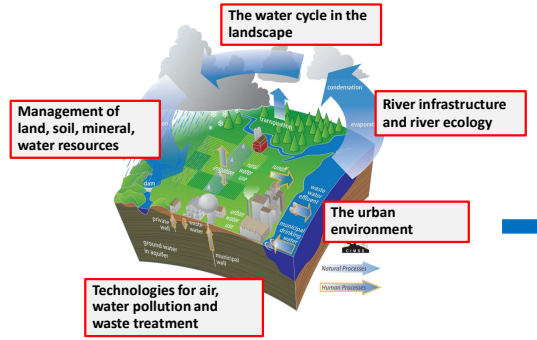
What is environmental engineering?



MAJORS IN

1. ***Urban Water Management***
2. ***Environmental Technologies***
3. ***Resources Management***
4. ***Hydrology and Water Res.***
5. ***River and Hydraulic Eng.***

http://cimss.ssec.wisc.edu/climatechange/GreatLakesModernWaterCycleCIMSS.jpg

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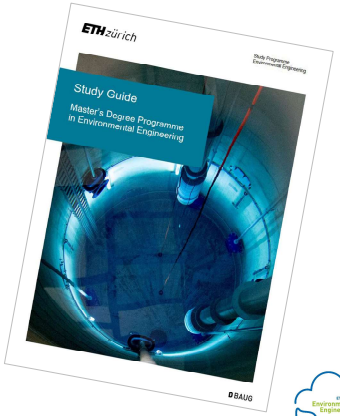
Please read carefully…

Download here:

https://www.baug.ethz.ch/en/studies/environmental-engineering/documents.html



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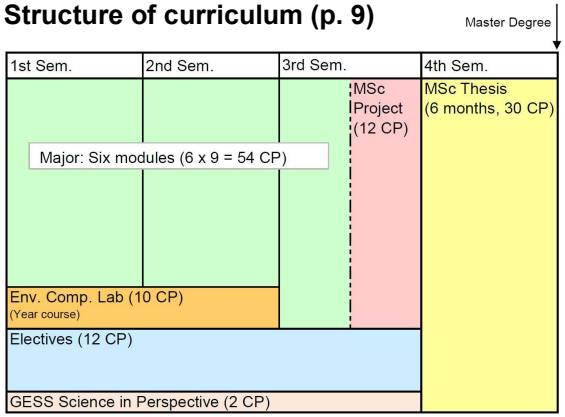
Structure of curriculum (p. 9)



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Five Majors →

Modules (compulsory) ↓

	(1) Urban Water Mngt.	(2) Environm. Technologies	(3) Resources Management	(4) Hydrol. and Water Resources	(5) River and Hydraulic Engineering
Water Infrastr. Plan. & Stormw. Mangt.	●				
Syst. analysis in Urban Water Mangt.	●	●			
Proc. Engr. in Urban Water Managt.	●	●			
Air Quality Control		●			
Waste Management		●	●		
Ecological Systems Design	●		●		
Groundwater			●	●	
Water Resources Management			●	●	●
Flow and Transport				●	●
Landscape				●	
River Systems					●
Hydraulic engr.					●
Remote sensing and Earth Observation					
Soil					

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Key Elements of the Program

- **MAJOR** = obligatory modules (4x9 KP) + voluntary modules (2x9 KP)
- **Free Electable Courses** (Wahlfächer, 12 KP)

- **Experimental and Computer Lab** (1 yr course, begin only in FALL, 10 KP)
- **Project Work** – focus on practical problem-solving (Sem 3, 12 KP)
- **Master Thesis Work** – focus on independent research (Sem 4, 30 KP)
- PA and MA have to be conducted in obligatory or voluntary modules

- Courses in Sem 1 and 3 are replaceable
- Courses in Sem 2 are not
- Semester abroad is possible (especially for MA)
- Graduation ceremony in February/March

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Recommendation for ETH BSc Environmental Sciences students transferring to us

- Unconditional Transfer (Auflagenfreie Zulassung)
- Register in MyStudies, no separate application necessary, no extra credit/course requirements (keine Auflagenfächer)
- BUT, remember that some courses in the MS majors have recommended/required BSc courses (you have to recover this background yourself).
  - Hydraulik
  - Hydrologie
  - Siedlungswasserwirtschaft GZ
  - Wasserbau
  - Luftreinhaltung

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Semester Abroad ?

- Average grade in Bachelor at least 4.5
- If average grade in Bachelor is below 4.5, at least 20 KPs of the first MSc semester have to be completed with grade 4.5 or higher

Bachelor / courses	ETH Bachelor Environmental Engineering	ETH Bachelor Environmental Science
Compulsory modules	Not allowed	Not allowed
Env. Comp. Lab	Not allowed	Not allowed
Optional modules	Allowed	Not allowed
Electives	Allowed	Allowed
Master Project	Allowed is one of the thesis: Master Project OR Master Thesis	Not allowed
Master Thesis		Allowed

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How do you generate your own Master ?

1. Think about what **interests you**, where your skills lie, what would be your dream job
2. Choose your major and look at the obligatory **courses and schedule** you will have
3. Supplement this with 2 voluntary modules and elective courses and **iterate several options**
4. If you are not sure, go **talk to your professor**

5. Iterate between 2 and 4 until you are satisfied with what you will be learning and your time schedule. **Be flexible**, you can make some adjustments as you go along in the MS.

You are welcome to attend master thesis presentations

https://baug.ethz.ch/studium/umwelting/master/master-thesis.html

Master's Thesis Presentation

Every Master's thesis, regardless of whether it was written in Switzerland or abroad, is concluded with a presentation and a poster. The Master's presentations are open to the public. The dates of the presentations can be found in the calendar below.

2025

Date & Time	Title	Stundent	Module
18. March 2025 09:00-10:00 WSL	Assesment of extreme droughts in Swiss catchments using boosted climate ensembles	Robyn Imboden	Water Resources Management
18. March 2025 10:00-11:00 WSL	Seasonal Streamflow Forecasting in Swiss Snow-Fed Basins: Evaluating a North American Data-Driven Workflow	Laurin Nüesch	Water Resources Management
1. April 2025 14:00-15:00	Hydrologic modelling of twolcelandic catchments	Antonius Heger	Water Resources

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You skillsets after the Master in Env. Eng.:

You will have the following skills

- Broad theoretical knowledge
- Capability for interdisciplinary work
- Critical and quantitative thinking
- Advanced computer/data analysis skills
- Ability to work in an international setting
- Communication and report-writing skills
- Commitment and social responsibility

Typical jobs of our graduates

- private engineering companies and consulting offices
- environmental divisions of local, regional, national administrations
- water and wastewater treatment plants
- companies developing environmental technologies
- NGOs dealing with the environment
- research at universities and in the private sector

Valentin Müller
magma AG, Schaffhausen

My job

The magma AG is a small company for geology, planning and environment. As an environmental engineer I work at the branch office in Schaffhausen dealing with many different projects. My duties include, among others, environmental impact studies, computation of traffic noise, the investigation of polluted areas, or the consultation for excavations on contaminated sites. Very often these works require the use of Geographic Information Systems (GIS), which I either use simply for visualization purposes, but frequently also for the processing of spatial information or for doing spatial calculations.

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Contact persons

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E-Mail: schirrmacher@stab.baug.ethz.ch

www.umwelting.ethz.ch

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Chairs at IfU, VAW & Lab

IfU = Institute of Environmental Engineering

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Questions

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Environmental Technologies

eDNA in the Air

Yile Tao

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SARS-CoV-2 monitoring

USZ Universitäts Spital Zürich

Mobile air sampler prototype

Track virus concentrations in the air:

- Allow a more informed pandemic response
- Protect safe places for vulnerable people

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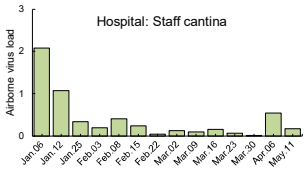
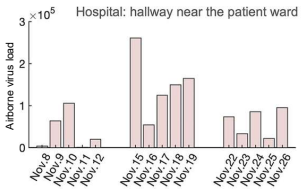
SARS-CoV-2 monitoring





- Track Virus prevalence
- Identify on-site issues

Daily data available via QR code

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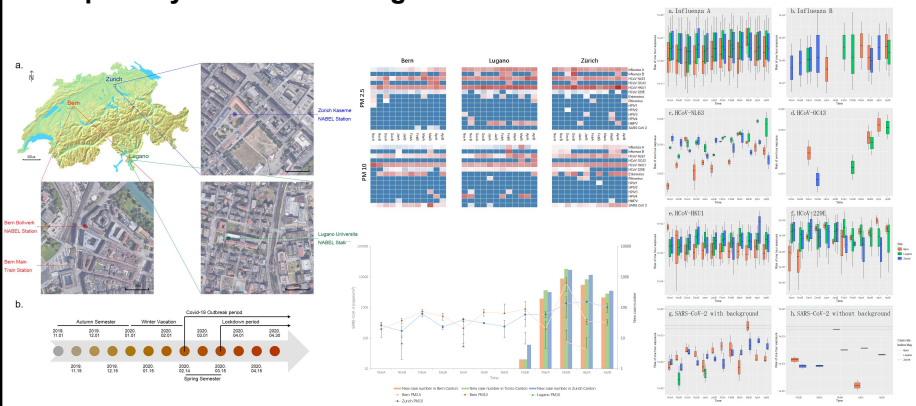
Respiratory Virus monitoring



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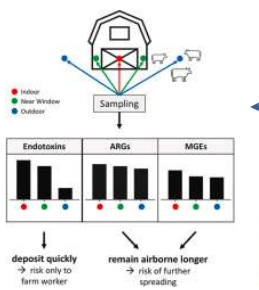
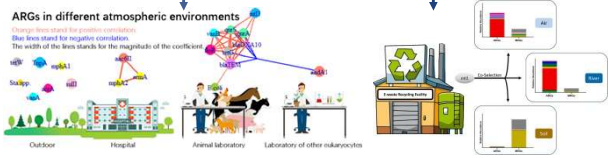
Antibiotic Resistance Gene monitoring



Where antibiotics are used
- Hospital
- Farm
- Bio lab

Where antibiotics are discharged
- Waste water treatment plant
- Recycling facility & Landfill



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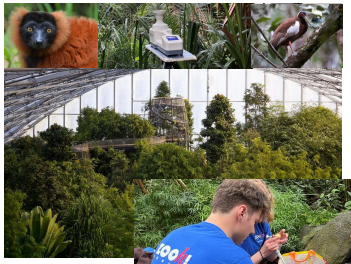
eDNA release from animals



zooh! ZÜRICH

Track DNA from endangered species:
- Simple, non-invasive sampling
- Access to remote areas
- Detect small/nocturnal species

Thank you for your attention!

Air Quality & Particle Technology

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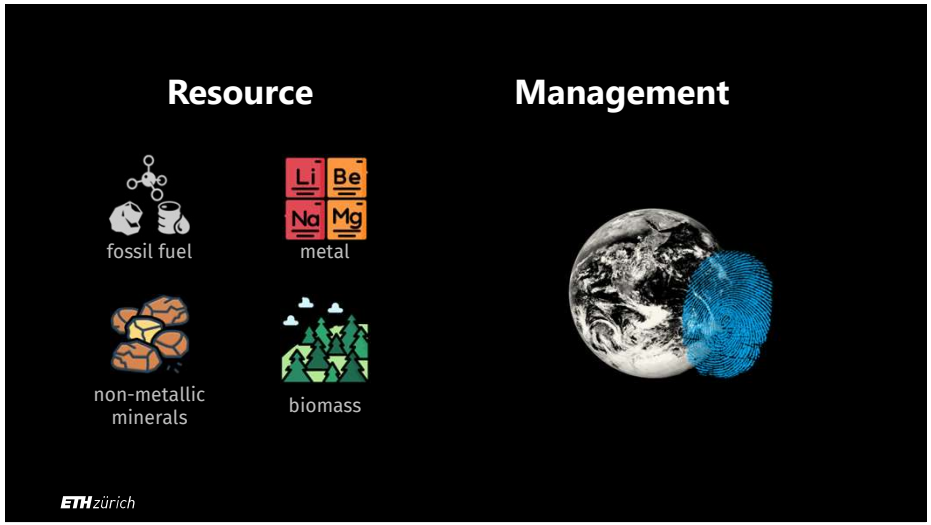
ESD ecological systems design www.esd.ifu.ethz.ch

Resource Management

Jing Huo
Ecological Systems Design


Resource
Management
fossil fuel
metal
non-metallic minerals
biomass
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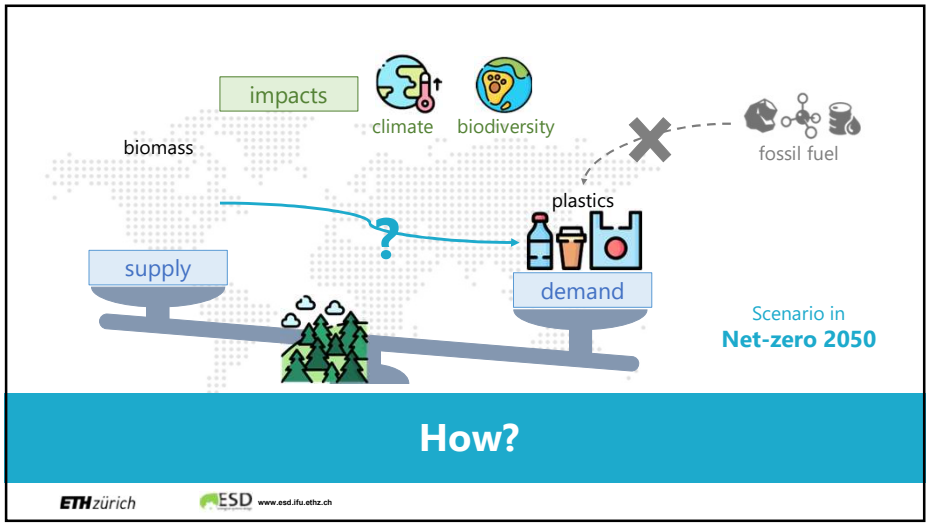
impacts
climate
biodiversity
biomass
fossil fuel
plastics
supply
demand
Scenario in
Net-zero 2050
How?
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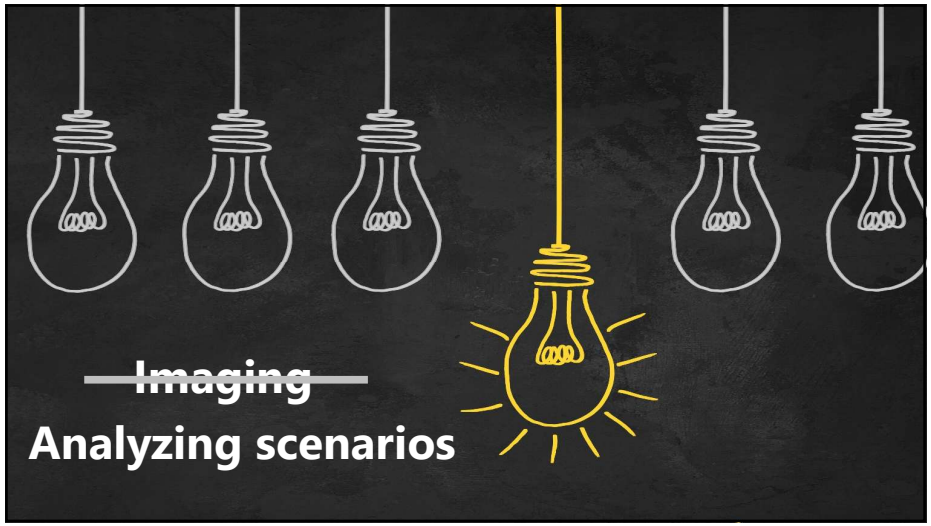
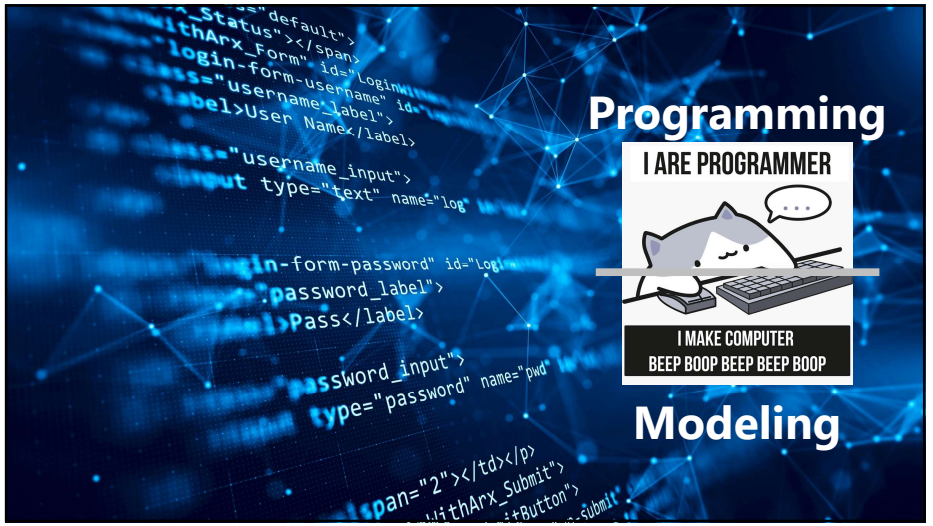
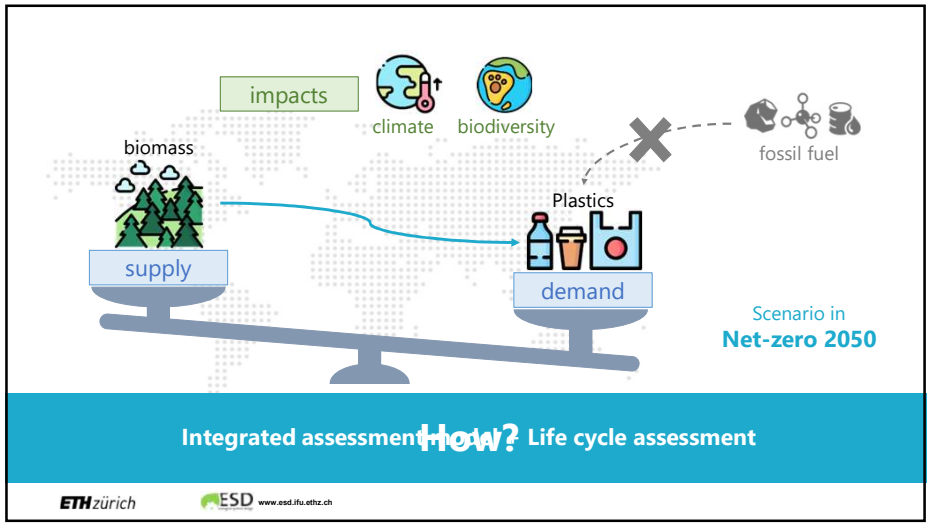
ESD www.esd.ifu.ethz.ch


~~Imaging~~
Analyzing scenarios


Programming
I ARE PROGRAMMER
I MAKE COMPUTER BEEP BOOP BEEP BEEP BOOP
Modeling


impacts
climate
biodiversity
fossil fuel
biomass
Plastics
supply
demand
Scenario in
Net-zero 2050
Integrated assessment models
How?
Life cycle assessment
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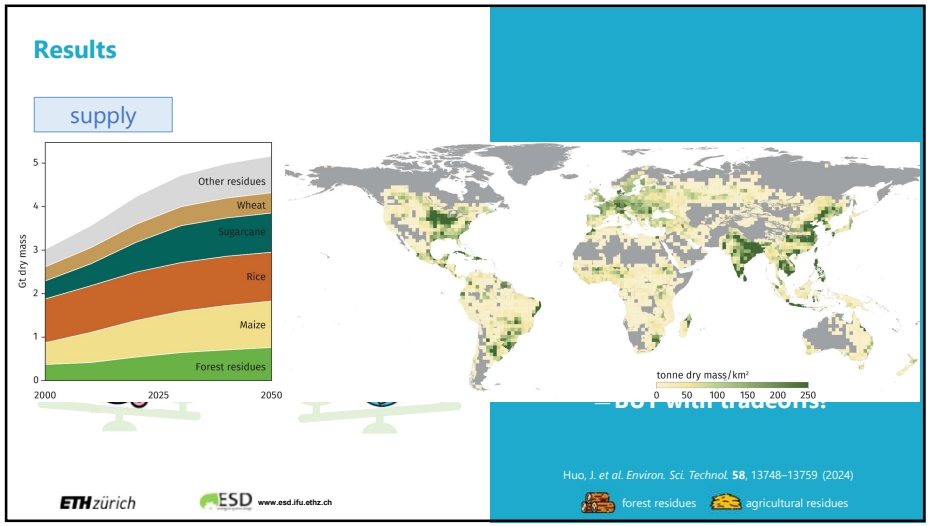
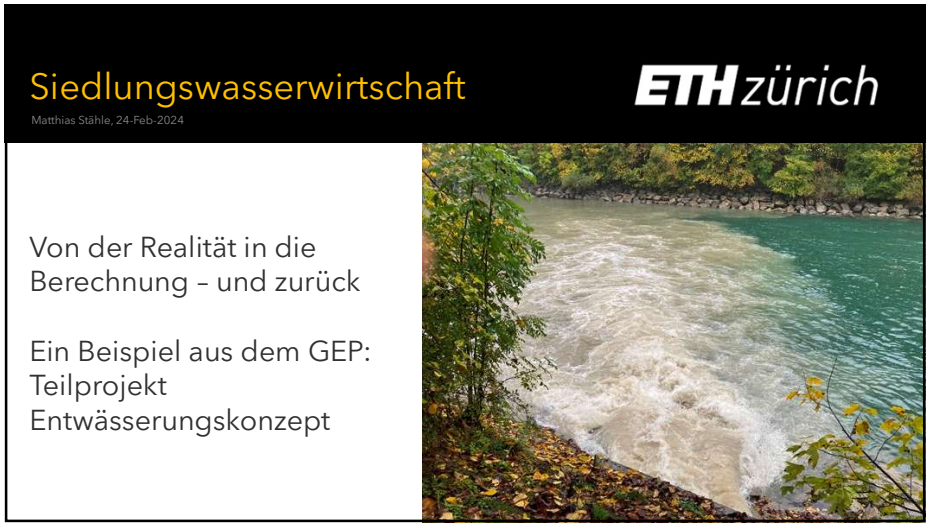
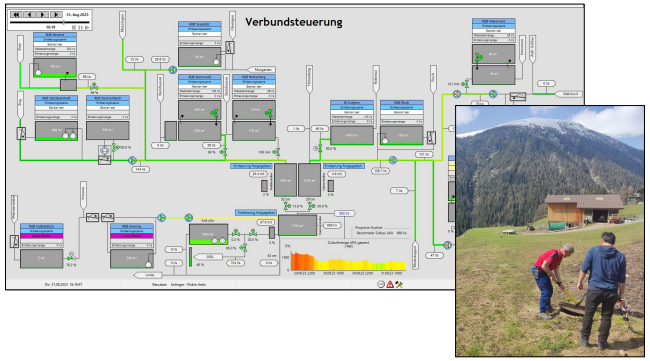
ESD
www.esd.ifu.ethz.ch


Results
supply
Other residues
Wheat
Sugarcane
Rice
Maize
Forest residues
Gt dry mass
2000
2025
2050
tonne dry mass/km²
0
50
100
150
200
250
Huo, J. et al. Environ. Sci. Technol. 58, 13748–13759 (2024)
forest residues
agricultural residues
ETH zürich
ESD
www.esd.ifu.ethz.ch


ETH zürich
ESD
www.esd.ifu.ethz.ch
Thank you!
Follow the research progress of ESD:
Swiss National Science Foundation
This project was created as part of NCCR Catalysis, a National Centre of Competence in Research funded by the Swiss National Science Foundation.
Icons in this presentation credit to flaticon


Siedlungswasserwirtschaft
Matthias Stähle, 24-Feb-2024
ETH zürich
Von der Realität in die Berechnung – und zurück
Ein Beispiel aus dem GEP: Teilprojekt Entwässerungskonzept

1: Systemverständnis

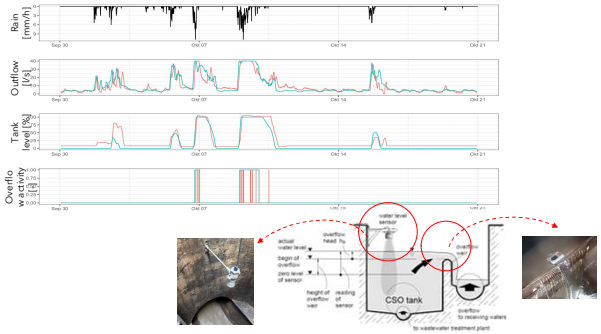


Eingesetzte Fertigkeiten aus dem Master

- Verfahrenstechnik
- Systemanalyse
- Geodatenverarbeitung
- …

→ Begehungen, Datenbestandsanalyse (Kataster, Instrumentierung, …), Analyse Prozessleitsystem

2: Datenanalyse / Messkampagnen

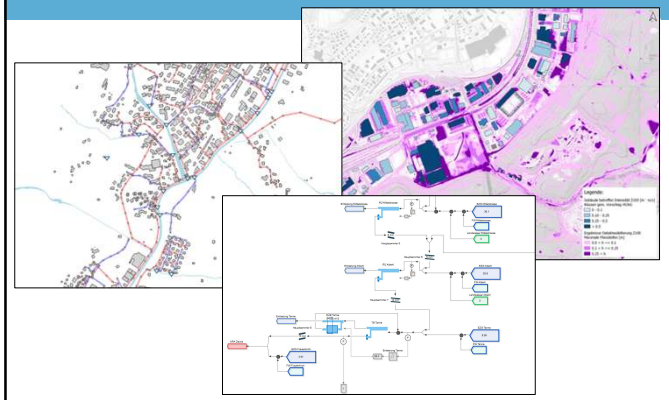


Eingesetzte Fertigkeiten aus dem Master

- Umgang mit realen Messdaten
- Sensortechnologie
- Messaufbauten
- Datenanalyse
- …

→ Auswertung bestehender Datensätze, Messkampagnen, Installation neuer Messungen

3: Modellierung / Berechnung



Eingesetzte Fertigkeiten aus dem Master

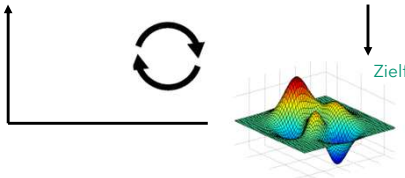
- Modellierung
  - Hydrodynamisch
  - Hydrologisch
  - 2D
- Datenaufbereitung
- Datenaggregation
- Visualisierungen
- …

→ Identifikation von Engpässen und Gefahren

4: Variantenstudium

Stellgrössen
- Volumen
- Statische Weiterleitmengen
- Koordinierte Entleerung
- Dynamische/Modellprädikative Netzregelung
- …

Zielgrössen:
- Gewässerschutz
- ARA-Betriebssicherheit
- Robustheit
- Kosten
- …

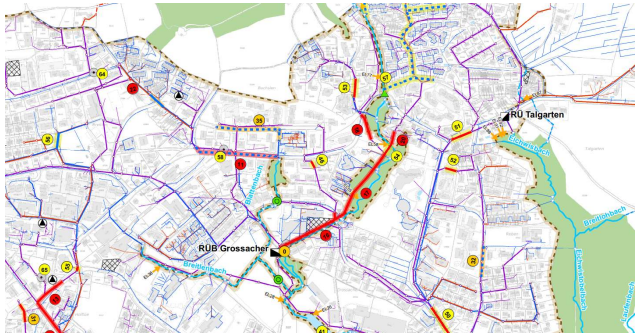


Eingesetzte Fertigkeiten aus dem Master

- Multi-Criteria Decision Analysis (MCDA)
- Regelungstechnik
- Wirtschaftlichkeits-analyse
- Systemanalyse (Sensitivität, Parameteridentifikation, Fehlerfortpflanzung, Monte Carlo, …)
- …

→ Optimierung im Sinne des Gesamtsystems

5: Konkrete Umsetzung (Massnahmenplan)



Eingesetzte Fertigkeiten aus dem Master

- Problemidentifikation
- Entscheidungsfindung
- Teamarbeit
- Kommunikation
- Schriftliche und visuelle Resultataufbereitung
- …

→ Kapazitätserweiterungen, Überflutungsschutz, Gewässerschutz, Neubauten (Pumpwerke, Retentionen), Kanalnetzregelungen → Realer Einfluss auf den Wasserkreislauf einer Gemeinde

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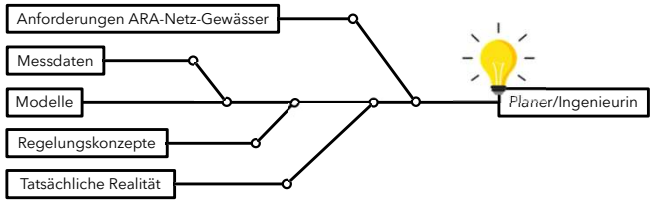
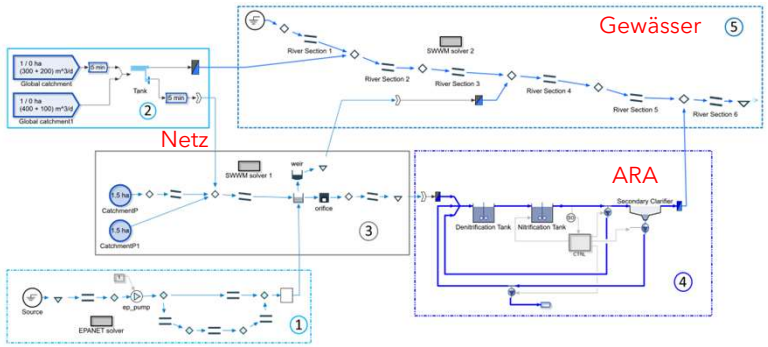
Fazit



Ich konnte das, was ich an der ETH gelernt habe
- 1:1 in der Praxis anwenden
- für die Findung neuer Lösungen einsetzen

38

Aussicht



→ Vernetzte Zukunft über den ganzen Wasserhaushalt

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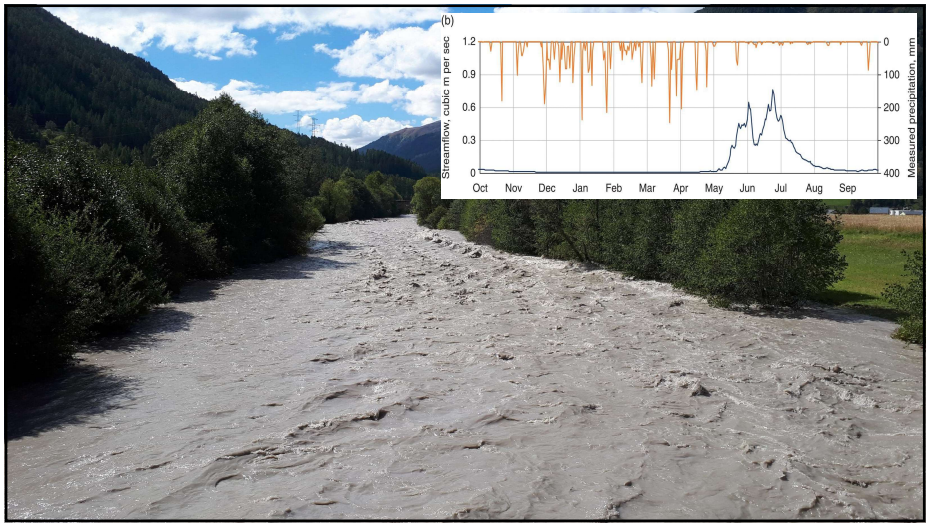
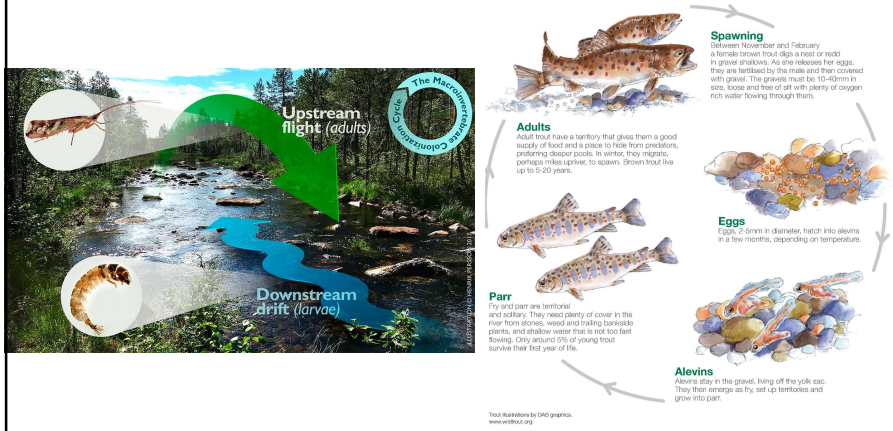


Drift is a fundamental part of the life cycle of aquatic biota



Drift is a fundamental part of the life cycle of aquatic biota

How can aquatic organisms respond to unnatural flow fluctuations?

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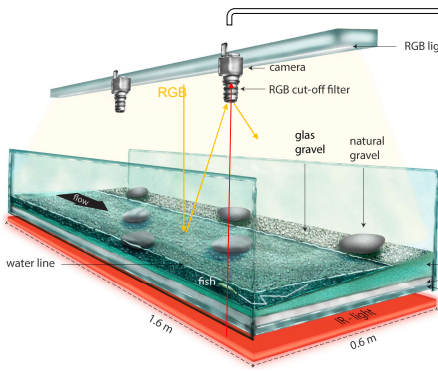
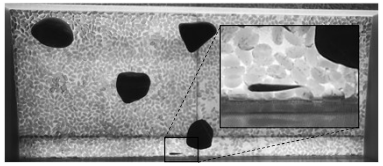
Innovative imaging setup for flume experiments

Topview: infrared spectrum





Naudascher et al. (2024); Scien. Tot. Environ.

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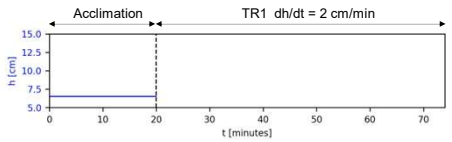
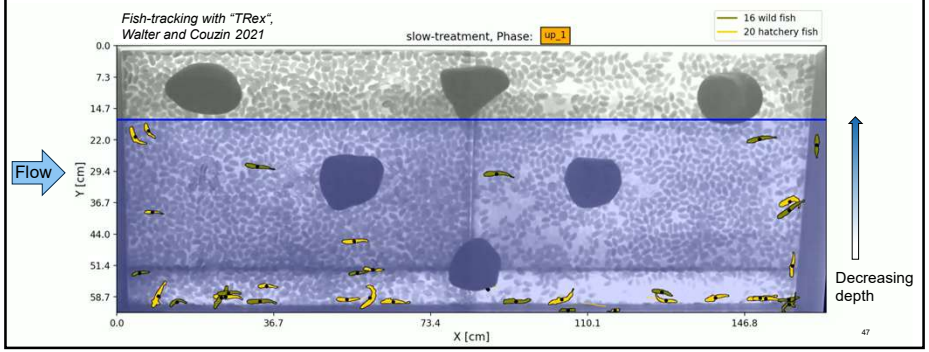
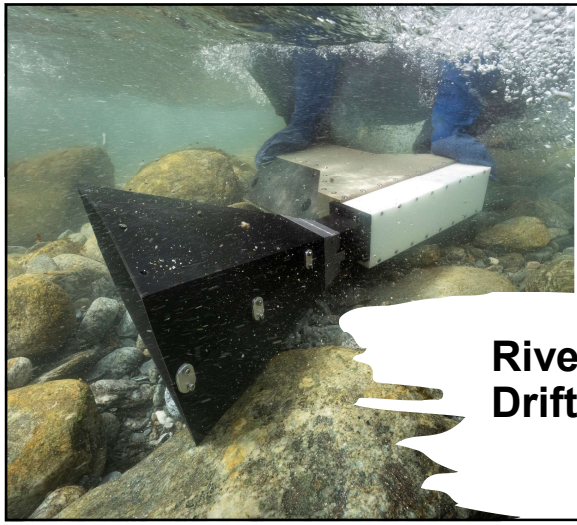
Trout behavioral response

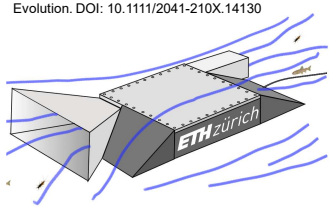
Naudascher et al. (2024); Scien. Tot. Environ.



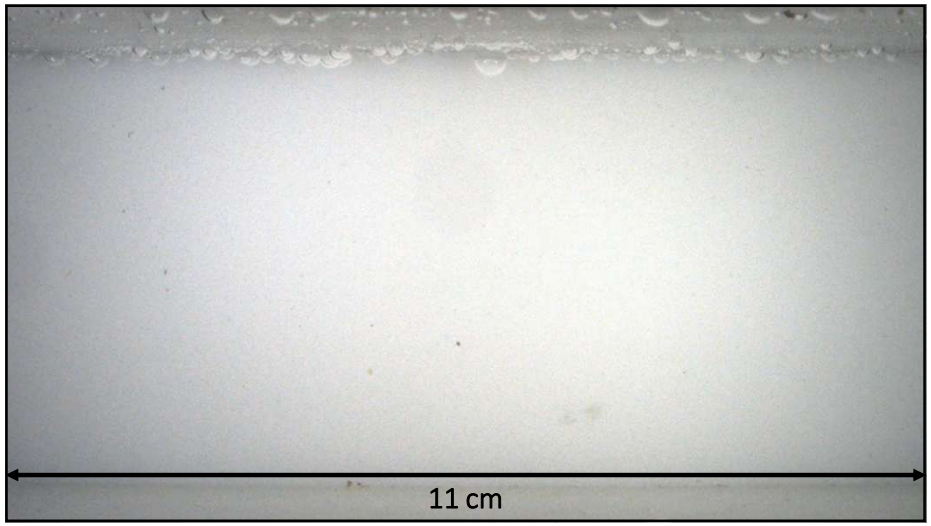




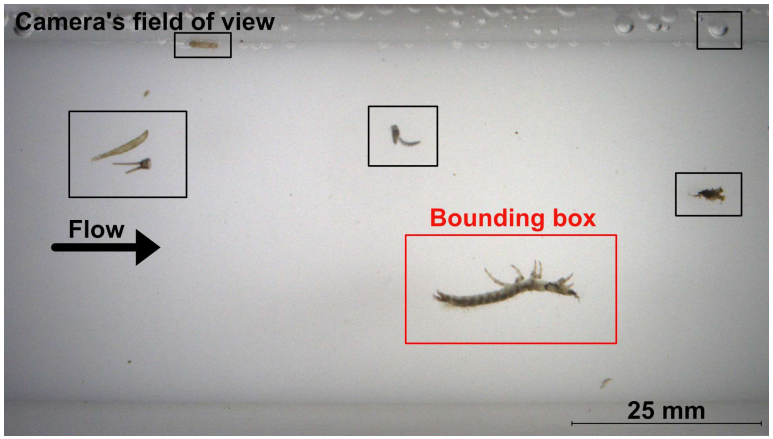
de Schaetzen et al. (2023); Methods in Ecology and Evolution. DOI: 10.1111/2041-210X.14130



Riverine Organism Drift Imager (RODI)



Artificial intelligence – automated identification



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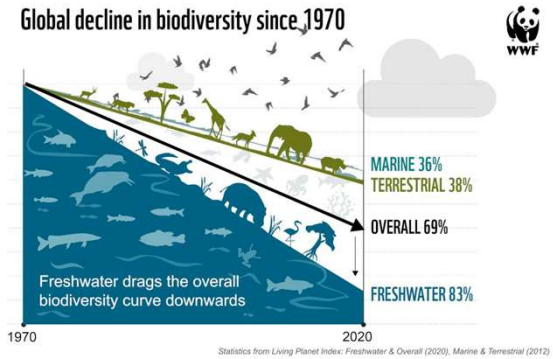
The relevance

Source: BAFU



Hydropower mitigation

Hydropeaking, bed load transport, fish passage.

Deadline: 2030

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51

Thank you

Photo: Jonas Steiner

52

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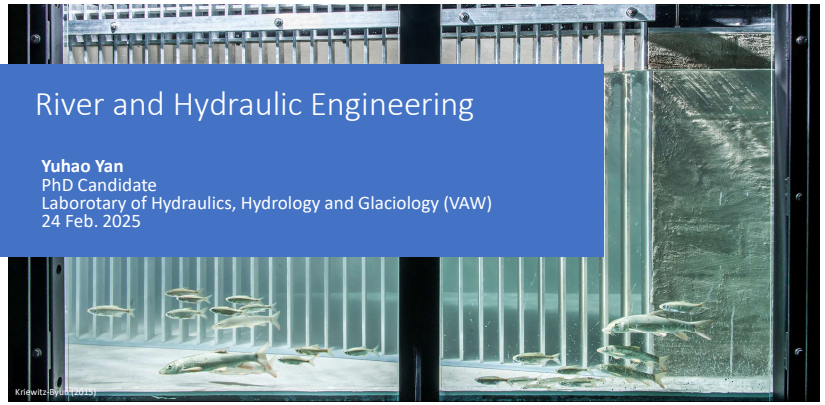


River and Hydraulic Engineering

Yuhao Yan
PhD Candidate
Laboratory of Hydraulics, Hydrology and Glaciology (VAW)
24 Feb. 2025

Kriewitz (2015)

Sustainable Hydropower

Safe fish up – and downstream movement

Bedload transport

Hydropeaking

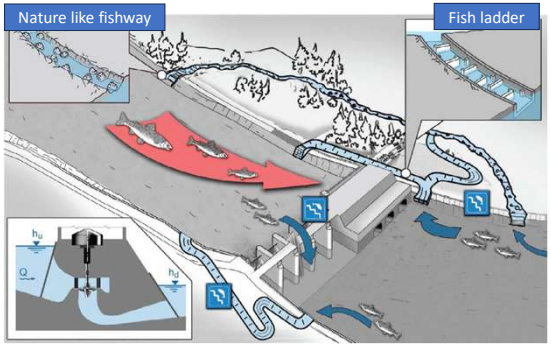
Approximately 700 barriers in Switzerland

Bildquelle: https://www.bafu.admin.ch/bafu/de/home/themen/wasser/fachinformationen/massnahmen-zum-schutz-der-gewaesser/renaturierung-der-gewaesser/fischgaengigkeit.html

Downstream migration via Hydropower Plants

Nature like fishway

Fish ladder



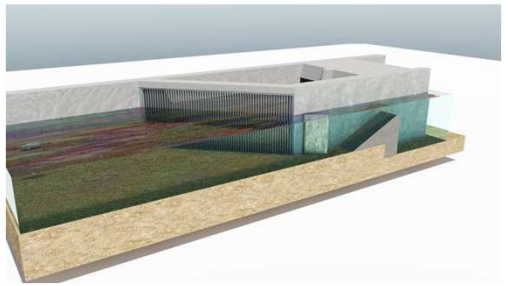
Kriewitz (2015)

Turbine passage
- Direct mortality
- Indirect mortality

Safe downstream movement
- Prevent swimming into turbines
- Guide fish to a safe corridor

Fish Guidance Rack – Bypass System

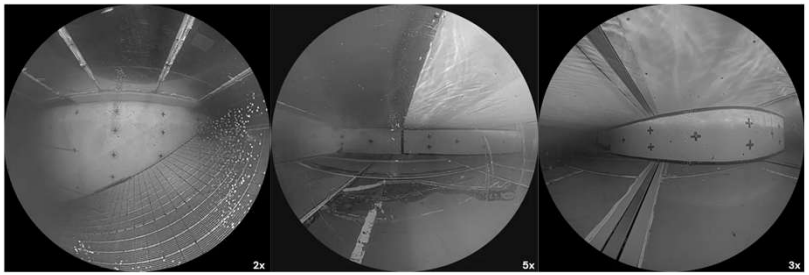
- The Fish Guidance Rack (FGR) guides the fish to the bypass Inlet
- Bypass system (BS) attracts, collects and transports fish back to the river downstream of the obstacle



VAW, ETH Zurich

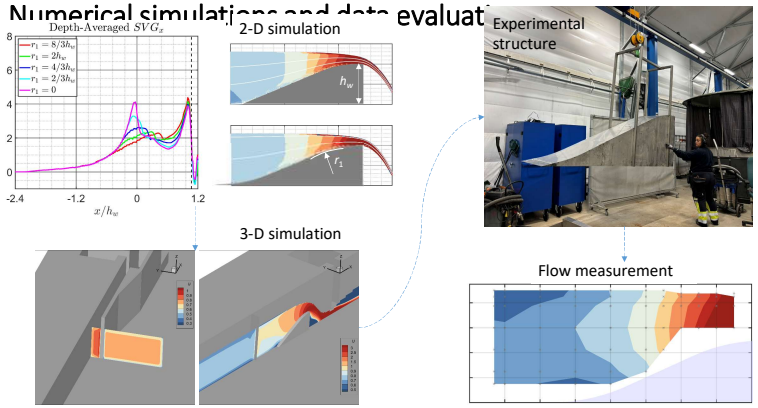
The ‚ideal' fish

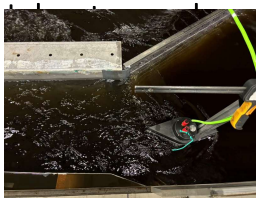
- The Fish Guidance Rack (FGR) guides the fish to the bypass Inlet
- Bypass system (BS) attracts, collects and transports fish back to the river downstream of the obstacle



Vattenfall R&D, Sweden

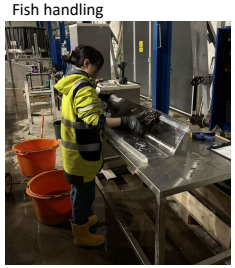
Numerical simulations and data evaluat





Flow measurement

Fish handling



More…

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VAW Laboratory of Hydraulics, Hydrology and Glaciology

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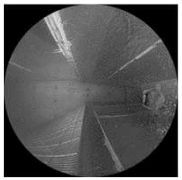
yan@vaw.baug.ethz.ch



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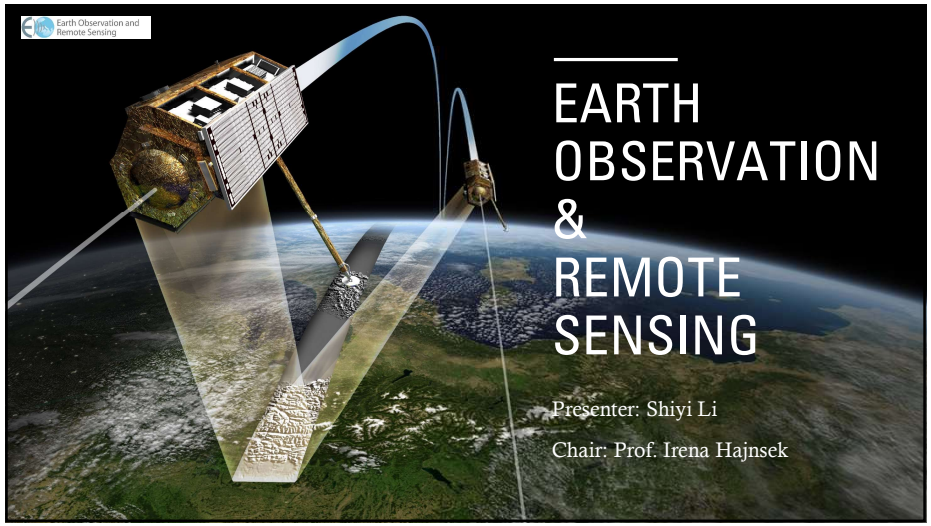
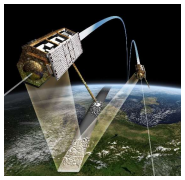


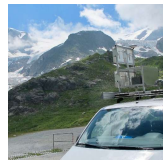
Research Fields

- Radar remote sensing for environmental parameters monitoring:
  - Agriculture & Forest
  - Infrastructure & Ground deformation
  - Cryosphere
- Instruments:
  - Spaceborne Radar
  - Ground-based Radar
  - Airplane / Car / UAV Radar

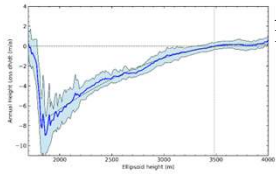

TanDEM-X Mission (DLR)

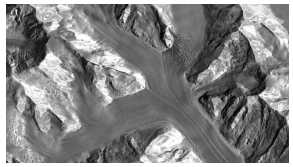

Sentinel-1 (ESA)

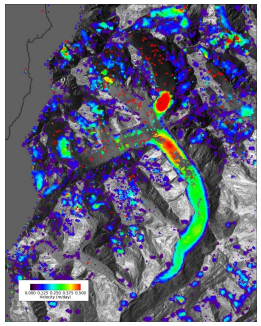

Ground-based Radar System


Car SAR System

Research Example: Aletsch Glacier

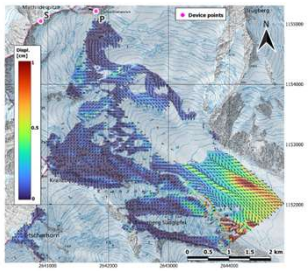

Annual Surface Elevation Height Loss


Glacier Flow Animation



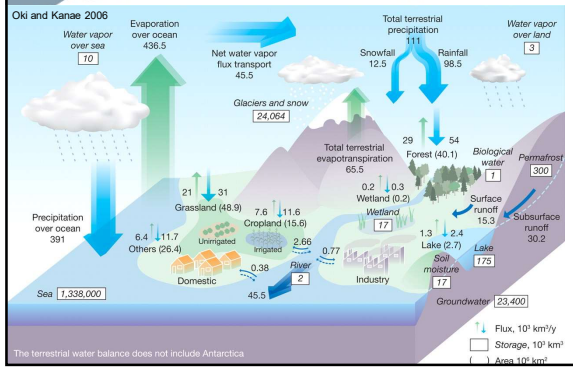
Research Example: Aletsch Glacier

Campaign @ Jungfraujoch



Why to study soils?

Plants are a major contributor to the water cycle

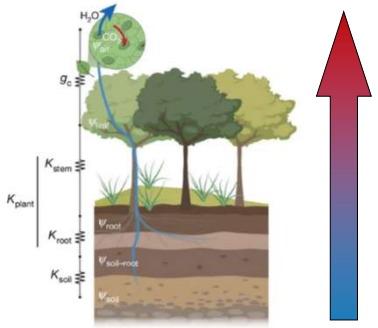


90% of terrestrial evapotranspiration comes from transpiration.
Jasechko et al (2013)

→ 53% of terrestial precipiation stems from transpiration

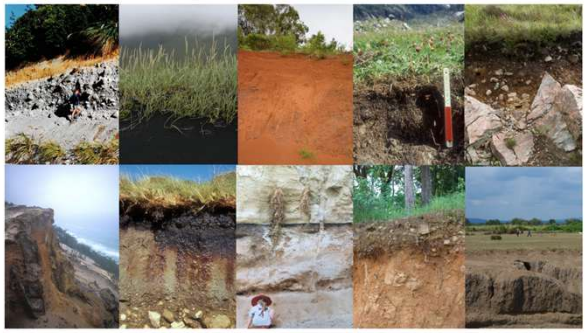
→ Transpiration is increasingly constrained by soil moisture limitations

Plants bridge the soil and the atmosphere



Increasing dryness

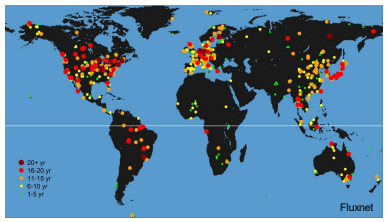
Soils are diverse – yet plants still thrive

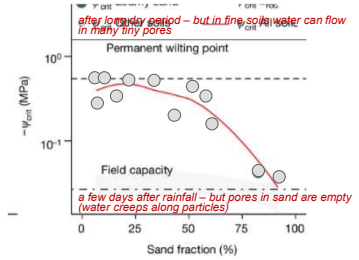


https://www.manchester.ac.uk/about/news/why-soil-matters-more-to-life-than-we-realise/

Nevertheless: Soils restrict plants

When the water flow through the soil is too slow stomatal close and transpiration is reduced





Wankmuller et al (2024)

Further projects

Soil Moisture Network

Plant response to drought

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Environmental Engineering Laboratory

Experimental and Computer Laboratory

Year Course, 1. and 2. Semester

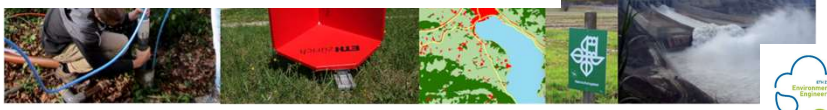
Organized by Environmental Engineering Laboratory
Daniel Braun, Luzia von Känel

ETH zürich

Environmental Engineering Laboratory

Learning Objectives

- Application of theoretical knowledge in practice
- Apply modern measurement techniques in environmental sciences
- Hands-on experience with numerical simulation
- Error analysis and sensitivity analysis in real world applications
- Critical assessment of model structure and model complexity



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Projects in the Experimental and Computer Lab

Major → / ↓ Modules	Urban Water Management	Environmental Technologies	Resources Management	Hydrology and Water Resources	River and Hydraulic Engineering	selectable as additional project	Project Title
WatInfra (2CP)	•					o	*Water Network Management*
UWM: SysUWM + ProcUWM (2+2=4 CP)	•	•				o	*Operation of Lab-WWTP*
	•	•					
AIR (2CP)		•				o	*Air Quality Measurements*
WASTE: WasteBio or WasteRec (2CP)		•				o	*Anaerobic Digestion*
			•			o	*Plastic Recycling*
ESD (2CP)	•		•			o	*Environmental Assessment*
GROUND (2CP)			•	•		o	*Groundwater Field Course Kappelen*
WRM (2CP)			•	•	•	o	*Optimal Water Allocation*
FLOW (2CP)				•	•	o	*1D Open Channel Flow Modelling*
LAND (2CP)				•		o	*Landscape Planning and Environmental Systems*
RIVER (2CP)					•	o	*Discharge Measurements*
HydEng (2CP)					•	o	*Hydraulic Experiments*
RemSens (2CP)						o	*Radar Interferometry*
SOIL (2CP)						o	*Soil and Environmental Measurements Lab*
1 additional Project, dependent on selected modules (2CP)	•	•	•	•	•		

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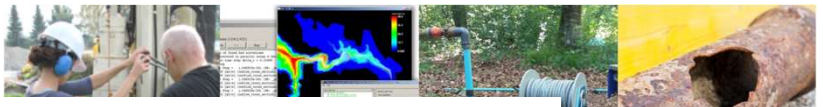
Environmental Engineering Laboratory



Questions?