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Study programme
Environmental Engineering

Information Event for Master in Environmental Engineering

16 March 2023

Prof. Jing Wang (Director of Studies)

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Todays Agenda

1.	**Begrüssung** **Einführung zum Masterstudium** **Überblick über die Masterstruktur**	**Prof. Wang**	**10'**
2.	**Überblick über die Vertiefungsrichtungen** (Profile)		
	Umwelttechnologien	Prof. Wang	**5'**
	Ressourcenmanagement	Prof. Hellweg	**5'**
	Siedlungswasserwirtschaft	Prof. Morgenroth	**5'**
	Wasserwirtschaft	Prof. Stocker	**5'**
	Fluss- und Wasserbau	Prof. Boes	**5'**
	Modul Remote Sensing and Earth Observation	Prof. Hajnsek	**3'**
	Modul Soil	Prof. Carminati	**3'**
3.	**Fach- und Computerlabor**	D. Braun	**5'**
4.	**Fragen & Antworten inkl. Postersession**	**Alle**	

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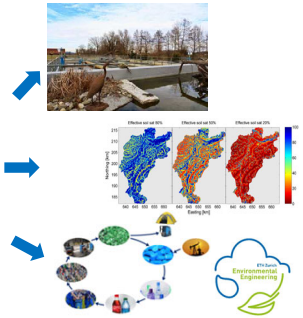
What is environmental engineering?

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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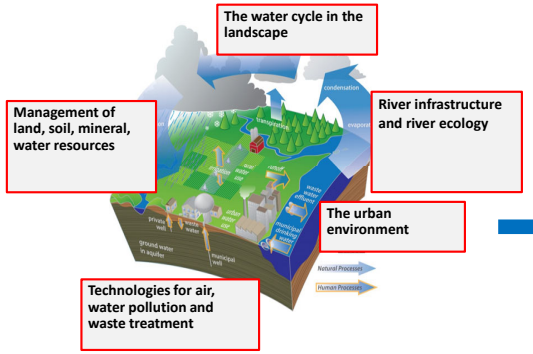
What is environmental engineering?



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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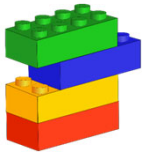
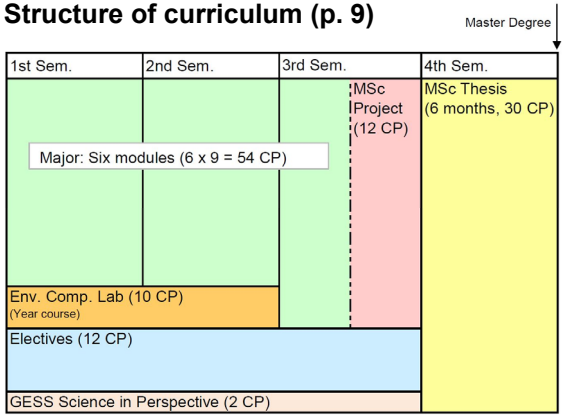
Structure of curriculum (p. 9)





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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 (partly in German)					●
Hydraulic engr. (partly in German)					●
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 MS 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.

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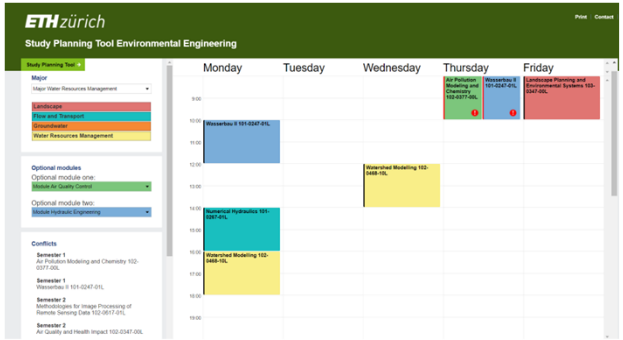
How do you schedule your own Master ?

https://www.bi.id.ethz.ch/tfsp/studyPlanning.view



The schedule planning tool is useful to identify conflicts between courses for each semester.

Please try it out!

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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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www.umwelting.ethz.ch

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Chairs at IfU & Lab

IfU = Institute of Environmental Engineering

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1. Environmental Technologies

Wang, Hellweg, Morgenroth, Maurer

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Profile: Environmental Technology



AIR	ProcUWM	SysUWM	WASTE
3 lectures (9 cts) 1 lab (2 cts)	2 lectures (9 cts) 1 lab (2 cts)	2 lectures (9 cts) 1 lab (2 cts)	3 lectures (9 cts) 1 lab (2 cts)
• Understand air pollution sources and impacts • Hands-on knowledge of state-of-the-art air quality monitoring instruments • Apply control technologies	•Study the biological, chemical and physical processes in water technology • Apply them to wastewater and drinking water treatment applications	•Learn to develop mathematical models, to plan experiments, to evaluate error propagation in the field of urban water management	•Understand biomass and waste materials •Study waste treatment and recycling technologies and evaluate the designs

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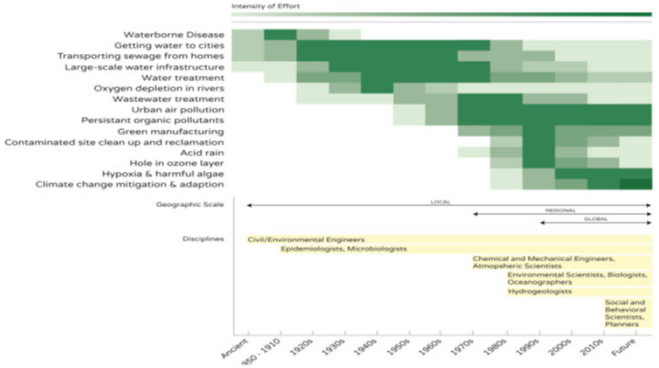
Environmental Engineering Efforts



Timeline of major U.S. environmental engineering efforts, highlighting the broadening scale and complexity of the challenges and the expanding numbers of disciplines involved.

Environmental Engineering for the 21st Century: Addressing Grand Challenges, p.79, THE NATIONAL ACADEMIES PRESS, 2018.

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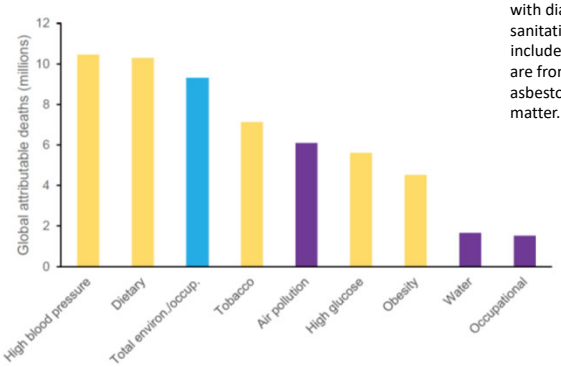
Global Estimated Risk Factors



Global estimated deaths by risk factor and by total environmental and occupational causes. Air pollution–attributable deaths are primarily linked to particulate matter pollution and indoor burning of solid fuels. Water-related risks are associated with diarrheal disease from unsafe water and poor sanitation. The estimated occupational deaths include 0.33 million from injury, but the remainder are from pollution-related causes, such as asbestos, carcinogens, and airborne particulate matter.

Environmental Engineering for the 21st Century: Addressing Grand Challenges, p.47, THE NATIONAL ACADEMIES PRESS, 2018.

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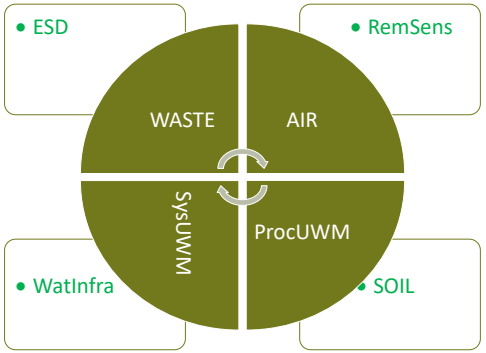
Required modules: AIR (Air quality control), ProcUWM (Proc. Engr. in Urban Water Managt.), SysUMW (Syst. analysis in Urban Water Mangt.), WASTE (Waste Management).



Recommended elective modules: ESD (Ecological Systems Design), RemSens (Remote sensing and earth observation), SOIL, WatInfra (Water Infrastr. Plan. & Stormw. Mangt.).

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Job profiles and opportunities

Industry	• EHS experts, engineers • Waste and wastewater companies • Air quality companies
Consulting	• Measurement specialist • Instrument companies
Administration	• Air, water, soil quality monitoring • Waste and wastewater regulation • BAFU, SUVA, BAZL, EU
Research	• ETH, other universities • Eawag, Empa, JRC, other institutions

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2. Resources Management

Hellweg, Burlando, Molnar, Stocker

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Major «Resource Management»

Motivation:

- Some resources are scarce, in quantity and/or in quality, and need a careful and proactive management
- Resource extraction, use and disposal induces major environmental impacts that should be minimized
- Waste needs to be treated, but at the same time can also be used as a resource to substitute primary resources.

This Major equips students with the abilities to manage resources optimally, preventing scarcities and minimizing environmental impact.

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Major «Resource Management» Skills after completing this Major

- Modeling availability and use of resources (water, materials, energy and other resources)
- Optimizing the management of resources, considering scarcity and environmental impacts
- Solving complex problems from a system-oriented perspective
- Knowledge of tools that are used in water resource planning and management
- Understanding of (re)cycling and waste treatment technologies, including valorization concepts for biomass and organic waste

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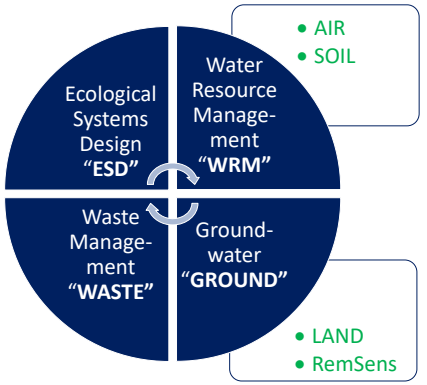
Required modules and recommended elective modules



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Job profiles and opportunities

Industry	• EHS experts • Sustainability expert (larger companies) • Supply-chain-management/product stewardship
Consulting	• Environmental engineering • Strategic consultancy, services in sustainability • Software solutions in sustainability
Administration	• BAFU • Cantonal authorities • UNEP
Research	• ETH, other universities • Empa, JRC, Eawag, other research centers
NGO's	• E.g. My climate, WWF

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3. Urban Water Management

Morgenroth, Maurer, Hellweg

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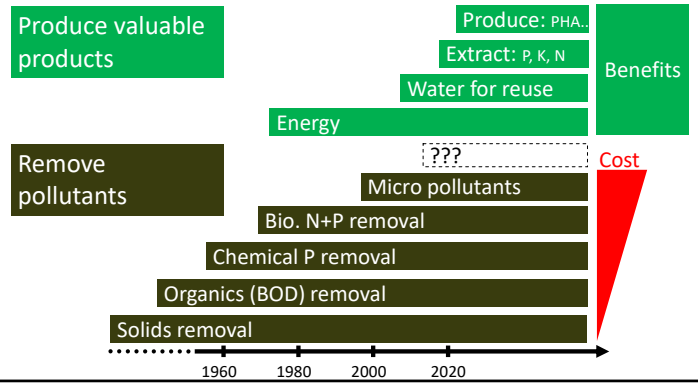
From removal of pollutants to the production of valuable products



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More than just optimizing treatment processes

≈ 200'000 km water and wastewater pipes in Switzerland alone require **4.4 Billion CHF/year** maintenance.

Worldwide 2'500 Mio. people don't have access to clean water and sanitation.

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Four required modules

Overall planning and assessment	Treatment processes
System integration	***Fundamental processes, modeling, and critical evaluation***
▪ Module #1: Water Infrastructure Planning & Stormwater Management ▪ Module #2: Ecological Systems Design	▪ Module #3: Syst. analysis in Urban Water Management ▪ Module #4: Proc. Engr. in Urban Water Management

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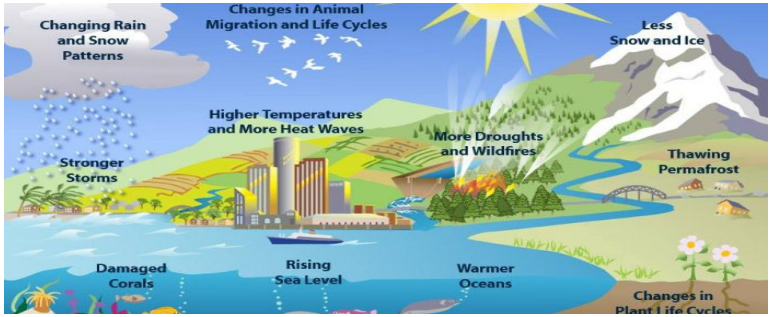
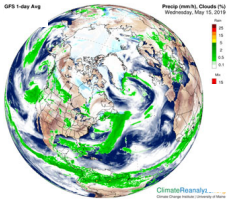
4. Water Resources Management

Burlando, Stocker, Molnar



What is the Water Resources Management major?

Acquire the theoretical background, numerical modeling and data analysis skills to solve hydrological, hydraulic and water resource problems, from pore scales to river basins.



- Hydrological processes govern the **water distribution around the globe.**
- The **sustainable use of water** presents many technical, environmental and management challenges.
- A key challenge is to **predict water availability and flow** (in oceans, aquifers, lakes and rivers) today and in the future

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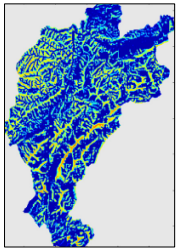

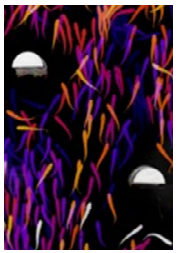

What will I learn ?

- **How fluxes of water work –** in soil, on the surface (rivers), from vegetation (evapotranspiration) – and how they will change in the future (climate change)
- **How to measure hydrological processes** with state-of-the-art technology.
- **How to assess available water resources and optimally manage them** (competitive water uses)
- How to **develop and run numerical models** of flow and transport processes, from small to large scales
- **What the consequences of flow and water management on ecosystems and organisms are** (vegetation, fish, microorganisms).
- **How to analyze data** using advanced statistical methods and how to evaluate technical solutions.

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What modules will I take?

- **Groundwater [GROUND]**
  → flow and pollutant transport in soil and groundwater
- **Water Resources Management [WRM]**
  → hydrology, watershed modelling, water resources management
- **Flow and Transport [FLOW]**
  → numerical hydraulics, ecohydraulics, morphodynamics
- **Landscape [LAND]**
  → land surface observation, fluvial system change, landscape planning

Examples of complementary elective modules:

• urban hydrology	[WatInfra] + [SysUWM]
• river engineering	[RIVER] + [HydEng]
• soil processes	[SOIL]
• global hydrology	[RemSens]
• environmental impacts	[ESD]

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What jobs will this major prepare me for?

- develop *master water provision plans* for countries, regions, cities
- prepare and run hydrosystem *numerical models* for prediction and forecasting

private engineering and consulting companies; water resources and environment agencies, international governmental organizations

- develop *climate change impact scenarios* and adaptation plans
- design *river restoration projects* and *monitoring systems* (collect field data)
- assess *natural hazard risks* and develop *mitigation strategies*

environmental divisions of national agencies (e.g. BAFU, BFE, AWEL, …), environmental NGOs, (re)insurance companies

- develop *optimal water allocation* strategies
- design *integrated systems* with stakeholders and decision-makers

WR authorities, hydropower companies, WR divisions of corporations

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5. River and Hydraulic Engineering

Boes, Stocker, Burlando, Molnar

MSc-EE: Major «River and Hydraulic Engineering»

Foto: Vercasca SA

ETH zürich 16.03.2023 Laboratory of Hydraulics, Hydrology and Glaciology & IfU Institute of Environmental Engineering

ETH zürich **MSc-EE: Major «River and Hydraulic Engineering»**

Schutzwasserbau Revitalisierung Nutzwasserbau

IRM

Energie-strategie 2050

ETH zürich Arbeitsgebiete und Arbeitgeber

Schutzwasserbau, Gewässerrevitalisierung

Auftraggeber
Bundesamt für Umwelt (BAFU)
Kantonale Ämter (z.B. AWEL, Kt. ZH)
Kommissionen / Verbände (z.B. IRR)

Auftragnehmer
Ingenieurbüros (national)

Nutzwasserbau

Auftraggeber
Energieversorger: z.B. Alpiq, Axpo, BKW, ewz, Repower, SBB
Bundesamt für Energie (BFE)
Kantonale Ämter

Auftragnehmer
Ingenieurbüros (national + international)

Forschung / Lehre

Angewandte Forschung — Grundlagenforschung

z.B. VAW, LCH (EPFL), eawag, WSL, SLF, FHs (national) + international

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Herausforderungen im Fluss-/Wasserbau

Waters protection

Sediment management

Energy transition

Climate change adaptation

Ageing structures

Safety & resilience

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Pflichtmodule

[RIVER] River Systems

"describe, analyze and manage river systems including sediment transport and river morphology"

- River Engineering (Weitbrecht et al.)
- River Restoration (Weitbrecht et al.)
- River Basin Erosion (Molnar)

[HydEngr] Hydraulic Engineering

"layout of hydraulic schemes with regard to economic efficiency and structural safety; flood protection concepts and practical planning methods"

- Wasserbau II (Boes) 6 CP mainly
- Hochwasserschutz (Boes & Eberli)

[FLOW] Flow and Transport

"basics of numerical modelling of flow including wave propagation and turbulence modelling; applications to rivers"

- Numerical Hydraulics (Holzner)
- River Morphodynamic Modelling (Vetsch et al.)
- Ecohydraulics and Habitat Modelling (Stocker et al.)

[WRM] Water Res. Management

"advanced knowledge of rainfall-runoff processes including stochastic hydrological modelling, decision-making processes, and optimal water management techniques"

- Watershed Modelling (Molnar) 6 CP
- Water Resources Management (Castelletti)

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Modulkombinationen

Vorgegeben:

- **[RIVER] River Systems**
- **[HydEngr] Hydraulic Engineering**
- **[FLOW] Flow and Transport**
- **[WRM] Water Resources Management**

Empfohlen:

- [WatInfra] Water Infrastructure Planning & Stormwater Management
- [SysUWM] System Analysis in Urban Water Management
- [LAND] Landscape
- [RemSens] Remote Sensing & Earth Observation

Projekt- und Masterarbeiten

Projektstudie: Wasserkraftanlage / Hochwasserschutz

experimentell: z.B. Flussmorphologie, Schwemmholzrechen

numerisch: Freispiegelabfluss 1D / 2D, stationär/instat., Geschiebe

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Voluntary (Optional) Modules

- **Remote Sensing and Earth Observation**
- **Soil**

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Module: Remote Sensing and Earth Observation
Chair: Prof. I. Hajnsek

Lecture Course	Semester	ECT	Comments
102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications	5	3	Introduction into Synthetic Aperture Radar and applications
102-0617-01 G Methodologies for Image Processing of Remote Sensing Data	6	3	Introduction into remote sensing methods
102-0627-00 G Applied Radar Remote Sensing	7	3	Computer Lab

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Relevance for Environmental Engineers:
Societal Challenges of Global Dimension

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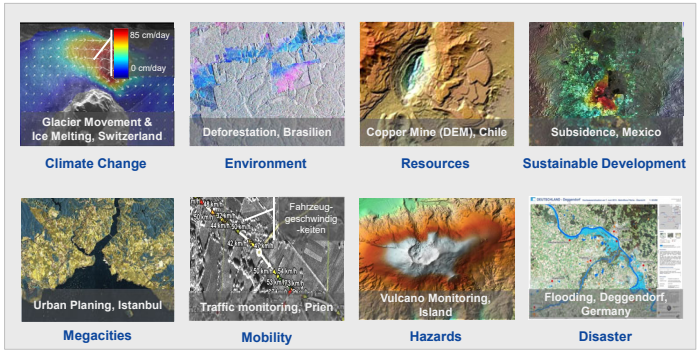
Relevance for Environmental Engineers:
SAR RS and Global Societal Challenges



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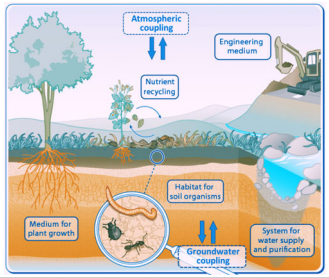
SOIL MODULE - objectives

- understand composition and structure of soil
- study key processes in soils and their relation to soil architecture
- quantify role of soils on climate, stability, and water balance
- measure and model mass and energy fluxes in soils (water, air, nutrients and pollutants)
- characterizing the interactions between soil and vegetation in terrestrial systems

soil regulating and provisioning services



contact:

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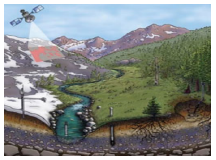
Courses in SOIL module



Vadose Zone Hydrology

Andrea Carminati & Peter Lehmann – Fall Semester (1)

Theoretical basis for quantifying physical and hydrological properties of soils and other porous media; quantification of driving forces and resulting fluxes of water, solute, and heat in soils

Soil Mechanics (for Environmental Engineers)

Ioannis Anastasopoulos - Spring Semester (2)

Fundamentals of soil mechanics including key processes; parameters essential for classification and description of soil (stiffness and strength).

Soil and Plant Water Relations

Andrea Carminati – Fall Semester (3)

Impact of soil hydraulic processes on plant growth, transpiration and photosynthesis; physics of water flow in plants and their response to soil water stress and drought

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Soil project of Experimental and Computer Laboratory I)




Recommended as elective modules in majors:

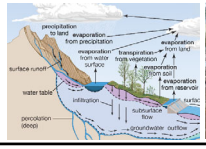
Environmental Technologies
Linking waste management with soil protection

Resource management:
Quantifying and protecting soil resources

Water resources management:
Role of soil in hydrologic cycle (storage and fluxes)

River and hydraulic engineering:
Preventing/mitigating effects of natural hazard processes





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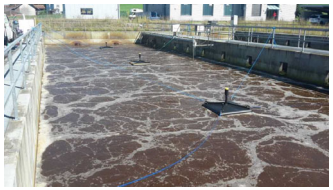
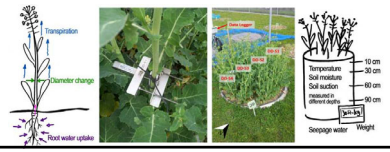
Experimental and Computer Lab
Year Course, 1. and 2. Semester
Organized by *Braun and von Känel*

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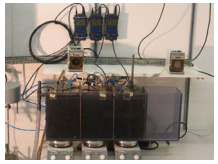
Learning Objectives

- Application of theoretical knowledge in practice
- Appling 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 Experimental and Computer Lab

Profiles → / ↓ Modules	Urban Water Management	Environmental Technology	Resources Management	Hydrology and Water Resourc.	River and Hydraulic Eng.	selectable as add. project	Projects
WatInfra (2CP)	•					o	Water Infrastructure
SysUWM + ProcUWM (2+2=4 CP)	•	•				o	Operation of Lab-WWTP
	•	•					Simulation of Lab-WWTP
AIR (2CP)		•				o	Air Quality Measurements
WASTE (2CP)		•	•			o	Anaerobic Digestion
ESD (2CP)	•		•			o	Environmental Assessment
GROUND (2CP)			•	•		o	Groundwater Field Course Kappelen
WRM (2CP)			•	•	•	o	Optimal Water Allocation
FLOW (2CP)				•	•	o	1D/2D Open Chanel Flowmodelling
LAND (2CP)				•		o	Landscape Planning and Environmental Systems
RIVER (2CP)					•	o	Runoff Measurements
HydEngr (2CP)					•	o	Hydraulic Experiments
RemSens (2CP)						o	Earth Observation and Landscape Planning
SOIL (2CP)						o	Soil and Environmental Measurements Lab
1 additional Project, (2CP)	•	•	•	•	•		

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Questions