Introduction to Soil Science

How does water move in soils? How do physics and biology interact in the soil? What is the role of soils in droughts, the climate system, the carbon cycle and the future of agriculture?

A week-long short course for anyone curious and interested!
Drop in or take it for 2 credits!

Lecturer: **Prof. Dani Or** (Google Scholar)
ETH Professor Emeritus, now at Desert Research Institute
Caltech Moore Scholar 2022-2023

Time: Sept. 19th - 23rd, 2022 (mornings)

	9/19	9/20	9/21	9/22	9/23
9:00-10:15	Introduction	Lecture 2	Lecture 4	Lecture 6	Lecture 8
10:15-10:30	Coffee break				
10:30-11:45	Lecture 1	Lecture 3	Lecture 5	Lecture 7	Lecture 9

Course Number: ESE200 or Ge197 (If you want to take it for credit)

Sign up link (Caltech ID required): https://forms.gle/T5GgeoFJncaKDnPJA

Location: in-person, room TBD (use the sign up link to stay informed)

Topics covered: see next page for course syllabus.

This course is supported by the Resnick Institute of Sustainability and the Moore Distinguished Scholar program at Caltech and organized by the Caltech Critical Zone Initiative.

Lecture 1: **The role of soil in the biosphere -** soil ecosystem services, soil formation time scales and factors, soil constituents and their arrangement (soil texture and structure)**,** the soil colloidal fraction; definitions and climatic/regional perspective.

Lecture 2: **Soil water balance, water content and measurement methods -** Definitions; measurement methods - gravimetric, heat dissipation, dielectric methods; links to remote sensing; estimates of soil water storage and plant available water, water balance across scales.

Lecture 3: **Water potential - how water is held in soil?** The energy state of soil water; water potential and its components; properties of water; capillarity in porous media; soil water characteristic curves models and measurements, water configuration at small scales, parameterization for regional and global applications – PTFs, CoGTF and data bases.

Lecture 4: **Water Flow in unsaturated soil, infiltration-runoff -** Buckingham-Darcy and hydraulic conductivity, Richardson-Richards Eq., parameterization, infiltration, time to ponding and runoff, time compression, infiltration/runoff vegetated landscapes with soil structure.

***Lecture 5*:** **Soil evaporation (as part of land-atmosphere interactions)**
Radiation and energy balance, ET and its components E and T. Focus on E-dynamics and resistances to evaporation. Evaporation and rainfall partitioning (arid regions).

Lectures 6-7: **Soil biophysical processes** - microbial life in soil, aqueous-phase connectivity, counting niches, cell motion, microgeography, large scale – biomes. Bioturbation by earthworms and roots – mechanics and energetics. Consequences for soil reinforcement, soil structure development – aggregation to biopores. Impacts on large-scale hydrology, biogeochemical fluxes.

Lecture 8: **The role of soil processes in global carbon cycle -** Overview of above and below-ground biological activity (canopies, plant roots, microbial processes, etc.), transpiration and GPP vs. respiration, rates of SOC accumulation, turnover times, land use changes and SOC dynamics.

Lecture 9: **Measurement of soil processes (group lecture) –** soil texture, bulk density, water content (dielectric, links to remote sensing), water potential (tensiometer, heat dissipation, psychrometers), hydraulic conductivity, water diffusivity, thermal conductivity, fluxes – lysimeters, eddy covariance, soil chambers for CO2 fluxes (other measurements?).

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