Course: Modeling Soil Processes

Identification

Code: SOL 855
Credits: 4 (3 hours lecture - 1 hour laboratru)
Level: Master's/Doctorate
Professors: Paulo Ivonir Gubiani, José Miguel Reichert, and Dalvan José Reinert
System: Annual (I Semester)

Discipline objectives

Demonstrate the basic elements for modeling in soil science, discuss the equations that describe physical, chemical, and biological processes in soil, and demonstrate the effects of land management and land use on describing and understanding these processes.

Syllabus

The course presents the main processes and equations of transfer and transformation of matter and energy in the soil that enable the application and development of mathematical models.

Methodology and teaching instruments

Individual seminars, lectures, and practical classes. Laboratory, overhead projector, and blackboard.

Forms of evaluation

Written exams, seminars, class participations, and a monograph.

Program: Title and Breakdown of Units

Unit 1

Matter and energy transfer processes in agricultural systems

1.1 - Physical processes of matter and energy transfer in soil
- 1.1.1 - Soil water energy state
- 1.1.2 - Water movement in the soil
- 1.1.3 - Saturated and unsaturated soil water flow
- 1.1.4 - Soil temperature and heat flow

1.2 - Chemical processes and solute movement in the soil
- 1.2.1 - Solute transport in the soil
- 1.2.2 - Convection and solute dispersion

1.3 - Biological processes in the soil: organic matter dynamics and greenhouse gases
- 1.3.1 - Content and functions of organic matter in the soil
- 1.3.2 - Soil carbon dynamics
- 1.3.3 - Greenhouse gases

1.4 - Spatial variability of soil properties and geostatistical analysis
- 1.4.1 - Factors controlling the spatial and temporal variability of soil properties
- 1.4.2 - Geostatistical techniques

1.5 - Empirical, conceptual, and physically-based models
- 1.5.1 - Introduction to modeling
- 1.5.2 - Models classification
- 1.5.3 - Criteria for applying models in agricultural systems
- 1.5.4 - Modeling steps

Unit 2

Modeling in agricultural systems

2.1 - Modeling heat and gases in the soil
- 2.1.1 - Equations and models for heat and gas transfer in soil

2.2 - Modeling subsurface soil water flow
  2.2.1 - Input and redistribution of matter and energy
  2.2.2 - Infiltration models
2.3 - Surface water runoff modeling
  2.3.1 - Hydrological cycle
  2.3.2 - Empirical and physically-based models
  2.3.3 – Modeling processes in catchments
2.4 - Erosion and sedimentation modeling
  2.4.1 - Erosive processes, redistribution, and transport of sediments
  2.4.2 - Empirical and physically-based models
  2.4.3 - Modeling processes in catchments
2.5 - Solute modeling (ions and organic molecules) in soil
  2.5.1 - Basics of solute behavior modeling
  2.5.2 - Reactivity models
  2.5.3 - Transport models
2.6 - Soil organic matter modeling
  2.6.1 - Simulation models of soil organic matter dynamics
  2.6.2 - Multicompartmental characteristics

Recommended literature

CAMPBELL, G.S. **Soil physics with basics: Transport models for soil-plant systems.** Amsterdan: Elsevier, 1985. 149p.

CHANG, H.H. **Pesticides in the soil environment: Processes, impacts and modeling.** Madison: Soil Science Society of America, 1990. 530p.

DAGAN, G. **Flow and transport in porous formations.** New York: Springer-Verlag. 1989. 465p.

GISH, T.J., SHIRMOHAMMADI, A. **Preferential flow.** St Joseph: American Society of Agricultural Engineers, 1991. 408p.

HANKS, J.; RITCHIE, J.T. **Modeling plant and soil systems.** Madison: ASA, 1991. 535p.

HILLEL, D. **Environmental Soil Physics: Fundamentals, Applications, and Environmental Considerations.** Academic Press, 1998. 771p.

JURY, W.A.; GARDNER, W.R.; GARDNER, W.H. **Soil physics.** 5. ed. Ney York: John Wiley & Sons, 1991. 328p.

KIRKHAM, D. & POWERS, W.L. **Advanced soil physics.** New York: John Wiley & Sons, 1972. 534p.

LIBARDI, P.L. **Dinâmica da água no solo.** Piracicaba: O Autor. 1999. 491p.

NIESEN, D; WENDROTH, O. **Spatial and Temporal Statistics - Sampling Field Soils and Their Vegetation.** Catena Verlag. 2003. 614p.

RICHTER, J. **The soil as a reactor: Modeling processes in the soil.** Cremlingen: Catena-Verlag, 1987. 192p.

ROSE, C.W. **An Introduction to the Environmental Physics of Soil, Water and Watersheds.** Cambridge University Press, 2004. 454p.