



## S. Majid Hassanizadeh,

Ph.D., is professor of hydrogeology at the faculty of geosciences at Utrecht University since 2004 and is the senior adviser with the Soil and Groundwater Department of Deltaresearch institute.

He earned his B.Sc. from Pahlavi University in Iran, and his M.E. and Ph.D. from Princeton University; all three degrees are in civil engineering. Hassanizadeh has worked at Abadan Institute of Technology and Yekom Consulting Engineers, both in Iran, and the National Institute of Public Health and Environment and Delft University of Technology in the Netherlands, the latter of which named him an Antoni van Leeuwenhoek professor in 2001-2003. He has also held visiting faculty positions at the University of Notre Dame; University of Bordeaux, France; EPF Lausanne, Switzerland; and Stuttgart University, Germany.

Hassanizadeh served as editor of *Advances in Water Resources* (1991-2001) and associate editor of both *Vadose Zone Journal* (2002-2009) and *Water Resources Research* (2004-2009). He is a member of the International Advisory Board of the *Journal of Hydrologic Engineering* (since 2004), and on the editorial boards of *Transport in Porous Media* (since 1989), *Journal of Porous Media Special* (since 2009), *Topics & Reviews in Porous Media* (since 2010), and *The Open Hydrology Journal* and *The Open Civil Engineering Journal* (the latter two since 2007). In addition, Hassanizadeh is active as a session organizer or a member of various committees for the Netherlands Royal Academy of Arts and Sciences, the Netherlands Organization for Scientific Research, American Geophysical Union, Soil Science Society of America, European Geophysical Union, and the International Association of Hydrological Sciences. He is a founding member and managing director of the International Society for Porous Media (InterPore).

Hassanizadeh has published close to 200 times in journals, books, conference proceedings, and technical reports. He's cosupervised more than 35 graduate students, coorganized a large number of international conferences, workshops, and short courses, and he's given more than 50 invited/keynote lectures in international meetings. He is a Fellow of both the American Geophysical Union (2002) and American Association for Advancement of Science (2007). He was awarded the honorary degree of Doktor-Ingenieur from Stuttgart University in 2008 and received the von Humboldt prize in 2010.

Hassanizadeh's research focuses on flow and transport in porous media through theory development, experimental studies, and modeling work. His current research includes pore-network modeling and experimental studies of two-phase flow, pore-network modeling of adsorbing solutes in unsaturated soil, transport of colloids and microorganisms in variably saturated soil, and novel remediation methods for NAPL-polluted soils.

### Contacts

The lectures have no admission fee, however participants are invited to register, to facilitate participation of everyone.

Ph.D. students from Politecnico should register via Portale della Didattica of Scudo.

External participants can register by sending an email to:

- Guido Musso  
DISEG – Politecnico di Torino  
C.so Duca degli Abruzzi 24, 10129 Torino – Italy  
E-mail: [guido.musso\[at\]polito.it](mailto:guido.musso[at]polito.it)
- Rajandrea Sethi  
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## The 2012 DARCY LECTURES



# TRANSPORT OF VIRUSES IN PARTIALLY SATURATED SOIL AND GROUNDWATER

## CAPILLARITY IN POROUS MEDIA, ON MICRO- AND MACRO SCALE, REVISITED

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Universiteit Utrecht

The 2012 Darcy lectures  
at Politecnico di Torino

Lecturer: S.M Hassanizadeh

Torino – June 29, 2012

# Darcy lecture on “Transport of Viruses in Partially Saturated Soil and Groundwater”

Friday 29<sup>th</sup> June , 8.45 a.m.

Surface water is often used for recharge of aquifers used in drinking water production. But it can be contaminated with pathogenic microorganisms and viruses from wastewater discharges or manure runoff.

These pathogens have to be removed to produce safe drinking water such as passing surface water through soil. However, to assure production of safe drinking water from surface water, adequate travel times and travel distances are needed.

In this regard, it is important to determine various factors that affect the rate of removal of pathogenic viruses during soil passage. These factors include hydraulic conditions (such as flow velocity and saturation) and geochemical conditions (pH, ionic strength, concentration of calcium).

In this lecture, Hassanizadeh will:

- present the results of a large number of laboratory and field experiments involving bacteriophages (viruses affecting bacteria), which were carried out under a variety of conditions under steady-state flow settings.
- show how the data from the experiments was used to derive (empirical) relationships between removal rate coefficients and geochemical conditions as well as saturation.
- explain how in the case of unsaturated flow, the role of air/water interfaces in the removal of viruses was also investigated
- present findings from experiments performed under transient flow conditions where saturation has been changed significantly.

- show how the experiments, as well as other researchers' results, have demonstrated that both drainage and imbibition fronts cause a remobilization of adsorbed viruses.

- discuss the mechanisms behind this remobilization.

- provide evidence from pore-scale visualization experiments performed in a micromodel.

# Darcy lecture on “Capillarity in Porous Media, on Micro- and Macro Scale, Revisited”

Friday 29<sup>th</sup> June , 11.00 a.m.

In many soil and aquifer systems, one encounters simultaneous movements of two or more immiscible fluids. These systems are modeled using a modified form of Darcy's law, mass or volume balance equations, and an empirical relationship between capillary pressure and saturation.

In this lecture, Hassanizadeh will:

- explain the general understanding that capillary pressure is equal to the difference in pressures of two fluids. At microscale, this difference is given by the Young-Laplace equation, which prescribes an inverse relationship with the mean radius of curvature. At macroscale, the difference in fluid pressures is assumed to be an algebraic empirical function of saturation, as mentioned above;
- provide a unifying approach to the theory of capillarity based on rational thermodynamics.
- present alternative definitions of capillary pressure on both micro- and macroscales. In particular, Hassanizadeh will make a clear distinction between capillary pressure and pressure difference of fluids;

- show that the difference in fluid pressures is a function of boundary conditions and dynamic properties of the system, such as flow rate or dynamic viscosities, based on theoretical, experimental, and computational results;

- propose that the capillary pressure must be an intrinsic property of the fluids/solid system and independent of dynamics of the system;

- introduce specific interfacial area (area of fluid/ fluid interfaces per unit volume of porous medium) as a new state variable to account for the fact that capillary pressure is a surface phenomenon and not a volumetric one;

- present theoretical, experimental, and computational evidences that show the empirical capillary pressure-saturation curve should be replaced with the capillary pressure-saturation-interfacial area surface rooted in thermodynamic theory.

## Venue

The lectures will be held in **Albenga Room, DISEG**, in the main building of **Politecnico di Torino**, Corso Duca degli Abruzzi 24, Torino.

