

# “Transport of viruses and colloids in variably-saturated soil and groundwater” Training Workshop

.....Department of Hydrology, IIT Roorkee, 12-20 February 2019.....

## Overview

Surface water is often used for the recharge of aquifers used in drinking-water production. Surface water is often contaminated with pathogenic micro-organisms and viruses. These pathogens have to be removed to produce safe drinking water. Often chlorination is used as the most effective way for disinfection of drinking water. However, the use of chlorination is not permitted in the Netherlands. One effective way is the passage of surface water through soil, as is the case in bank filtration, dune recharge, and deep-well injection. Dune recharge is widely applied in The Netherlands, where surface water, after some pretreatment, is fed into canals in protected dune sands. Then, water is abstracted after 50 to 60m of passage through the soil. This is illustrated in the figure below.



Fig. 1, Aerial View of Castricum Dune Infiltration Area. Surface water, after some pretreatment, is fed into canals. Water is abstracted from a long row of wells between two canals (shown in red dashed lines)

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, etc.). In some parts of the world, use of grey water (e.g. kitchen/shower wastewater or treated wastewater) for agricultural purpose is practiced or is being considered. In such cases, it is essential to determine whether the infiltrating water will be devoid of pathogenic micro-organisms when it reaches groundwater. Even when water is produced from groundwater wells, it is important to have protection zones around drinking water wells in order to ensure that no pollution will reach the well. This will be achieved by enforcing a zone of protection around groundwater well. The proper determination of such a protection zone is essential. It should not be unnecessarily large as it will be costly; at the same time, it should be large enough to provide adequate protection.

In this short course, we present basic principles of groundwater flow and transport of dissolved matter, principles of virus and colloid transport, and an overview of all factors affecting fate of viruses. Results of a large number of laboratory and field experiments under both saturated and unsaturated conditions, for the study of movement of bacteriophages and colloids through soil will be presented. The development of a computational tool for fast calculation of protection zones of groundwater wells will be presented.

## Objectives:

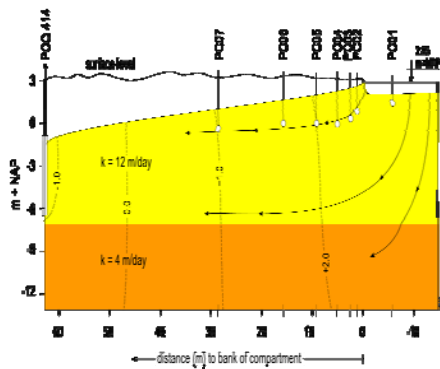
The key objectives of the course are for the participants to:

1. Develop a sound understanding of the fundamentals of physical, chemical, and biological principles involved in

- modelling of fate viruses in soil and groundwater.
2. Understand the challenges and opportunities, which exist in the use of the subsurface for the removal of micro-organisms from water destined for drinking water purposes.
  3. Develop capabilities to correctly evaluate the field conditions that ensure production of microbially-safe drinking water.

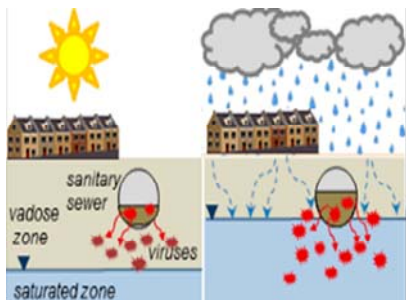
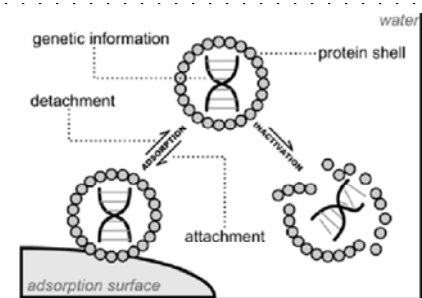
<b>Modules</b>	<p><b>A: Duration : Feb 12 - Feb 20, 2019</b>  <b>B: Venue : Department of Hydrology, Indian Institute of Technology Roorkee</b></p> <p><b>Number of participants for the course will be limited.</b></p>
<b>You Should Attend If...</b>	<ul style="list-style-type: none"> <li>▪ you are a student or faculty from academic institution dealing water related topics;</li> <li>▪ you are a civil/agriculture engineer, or environmental science interested in water quantity and quality issues in groundwater systems; interested in modelling of subsurface flow and solute transport.</li> <li>▪ you are a person from industry/research organization and interested in learning about Subsurface flow and solute transport and groundwater contamination modelling.</li> </ul>
<b>Fees</b>	<p>The participation fees for taking the course is as follows:  <b>Participants from abroad : US \$400</b>  <b>Industry : ₹ 10000</b>  <b>Academic Institutions/Research Organizations: ₹ 5000      Research scholar/student: ₹3500</b></p> <p>The above fee include all instructional materials, computer use for tutorials and assignments, Laboratory equipment usage charges, free internet facility.</p> <p>The participants will be provided with accommodation on payment and availability basis.</p>

# Course module



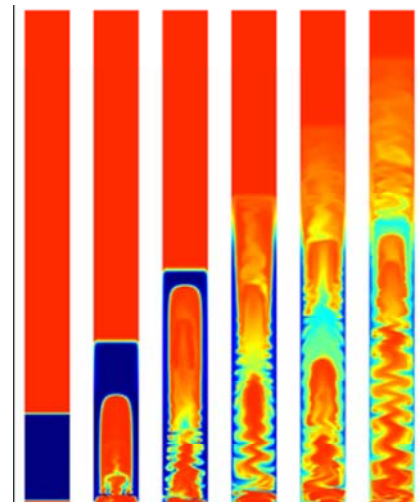
- Introduction to basics of flow in soil and groundwater; saturated and unsaturated flow; Darcy's law and Richards equation.
- Principles of Modeling: Finite Difference, Finite Element, The Drivers of Groundwater Flow: Boundary Conditions, Parameters
- Principles of transport of conservative solutes; concepts of advection, residence time, travel time, dispersion, Peclet Number.

- Principles of transport of non-conservative solutes; concepts of adsorption; decay, degradation, and inactivation.
- Principles of transport of non-conservative solutes; concepts of residence time and travel time for non-conservative solutes, Damkohler Number.
- Un-(saturated) flow and solute transport modeling in deep and heterogeneous vadose zone



- Capillarity in porous media on micro- and macro-scale
- Advances in theories of capillarity in porous media
- Non-equilibrium capillarity effect at different scales
- Experimental case study of water infiltration into dry soil; dynamic capillarity effects

- Principles of transport of colloids and viruses; Filtration theory.
- Removal of viruses from water by means of soil passage; The Netherlands case; Field studies
- Effect of water properties (pH, ionic strength, and temperature) on virus removal and inactivation.
- Development of a computational tool (based on MATLAB) for the study of protection of groundwater production wells.
- Hand on experience with the different existing Model like MODFLOW, MT3D/HYDRUS



## The Faculty



**Prof. S. Majid Hassanizadeh** is Professor of Hydrogeology at the Faculty of Geosciences of Utrecht University and Senior Advisor with Soil and Groundwater Department of Deltares, since January 2004. Graduated with honors from the Department of Civil Engineering of Pahlavi University in Shiraz, Iran, in 1975. Earned M.E. in 1976 and Ph.D. in 1979 at the Department of Civil Engineering of Princeton University.

Work experience as Assistant Professor with the Abadan Institute of Technology (Iran, 1979-1982), Project Manager with the Yekom Consulting Engineers (Iran, 1982-1984), Adjunct Assistant Professor with the Technical and Engineering University of Tehran (Iran, 1982-1984), senior researcher with the National Institute of Public Health and Environment, RIVM (Bilthoven, The Netherlands, 1984-1995), Adjunct Assistant Professor with the Department of Geology of Utrecht University (The Netherlands, 1990-1994), Associate Professor (1995-2001) and later Professor (2001-2003) with the Faculty of Civil Engineering and Geosciences, Delft University of Technology. More than 300 publications in journals, books, conference proceedings, or as technical reports, with a total citation of more than 9100. He is editor of *Advances in Water Resources* from 1991 till 2001. He is now on the editorial boards of *Transport in Porous Media* (since 1989), *Journal of Porous Media* (since 2009), *The Open Hydrology Journal* (since 2007), *Special Topics & Reviews in Porous Media; An International Journal*, (since 2010), and member of International Advisory Board of *Journal of Hydrologic Engineering* (since 2004). Member of American Geophysical Union, American Association for Advancement of Science, Soil Science Society of America, European Geophysical Union, International Association of Hydrological Sciences, US National Groundwater Association, and The Netherlands Hydrological Society. He has organized many conferences, workshops, and short courses. Invited or keynote speaker in a large number of international meetings.

**Dr. Brijesh Kumar Yadav** is an Associate Professor at Department of Hydrology, IIT



Dr. Yadav received his B.E. in Agricultural Engineering from CTAE Udaipur and completed M.Tech. in Civil Engineering (Water Resources) from IIT Delhi. Subsequently, he started his doctoral work at IIT Delhi on "Mathematical Model of Phytoextraction for Contaminated Soils". In November 2006, he moved to UNESCO-IHE (Institute for Water Education) Delft, Netherlands and worked on his PhD research with the

Pollution Prevention and Control group in the Environmental Resources Department for two years. Then he moved to Utrecht University, Netherlands for his postdoctoral work with Environmental Hydrogeology group in Department of Earth Sciences. Subsequently, he worked at University of California, Davis from July-December 2010 on subsurface modeling. From January 2011- June 2012, Dr. Yadav was working as a Ramanujan fellow in Department of Civil Engineering at IIT Delhi before joining the faculty position at IIT Roorkee.

He is teaching an undergraduate (Engineering hydrology) and postgraduate courses: 1) Groundwater hydrology, 2) Water resources system analysis, and 3) Soil-water contamination modelling along with supervision of PhD and MTech students at IIT Roorkee. His current research focuses on multiphase flow modelling, soil water flow and solute transport analysis, Nonpoint source pollutant movement through deep and heterogeneous vadose zone, Phytoremediation of heavy metal polluted sites, Bioremediation of hydrocarbon polluted soil and groundwater resources, CO<sub>2</sub> sequestration in subsurface and risk analysis. Dr. Yadav has published more than 25 peer reviewed international journals and made about 35 presentations at various international conferences/workshops. He has organized 10 training courses sponsored by GIAN, CPCP, QIP etc.

### ABOUT ROORKEE

Roorkee is a part of the State of Uttarakhand and is located at the foothills of Himalayas. Roorkee Railway Station is on the main line of Northern Railways having direct links to Delhi, Mumbai, Calcutta, Amritsar, Jodhpur and Shri Ganga Nagar. The place is also within easy reach by road from Delhi (200 km) and Chandigarh (180 km). It is located on Delhi – Haridwar and Delhi – Dehradun bus routes.



## Course Co-ordinator

**Dr. Brijesh Kumar Yadav**  
Associate Professor

Department of Hydrology  
Indian Institute of Technology Roorkee  
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[brijeshy@gmail.com](mailto:brijeshy@gmail.com)

**REGISTRATION AND  
ACCOMODATION REQUEST FORM**

**Department of Hydrology, Indian Institute of Technology Roorkee  
Roorkee, Uttarakhand**

After Completion, please send hard copy to:

<b>Dr. Brijesh Kumar Yadav,</b> <b>Department of Hydrology, IIT Roorkee</b> <b>Roorkee – 247 667 (Uttarakhand)</b> <b>Phone: (01332)284755, Fax: (01332) 2273560</b> <b>Email: gian2016dohiitr@gmail.com,</b> <b>brijeshy@gmail.com</b>	Affix passport size photograph
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1. Name of applicant (in block letters): Ms./Mr. ....
2. Designation .....
- 3a. Residential address with pin code  
  
Tel:  
Mobile:
- 3b. Official address with pin code  
  
Phone (Off.) Fax: Email:  
Fax: Email:
- 3c. Name of the Institute where employed
- 3d. Name of the Department
4. Highest Academic Qualification
5. Branch of Specialization
6. Teaching Experience in Years
7. Needs of Accommodation: Yes/No  
Types: AC Single/AC Double/Non-AC Single

**Date:**

**Signature of applicant**

**Note:**

- (i) Application should reach DOH Office at the above address latest by 30<sup>th</sup> Jan., 2019. Scanned copy must be sent by e-mail.
- (ii) Accommodation facilities will be provided inside the IIT Roorkee campus on payment basis only.
- (iii) Please come to Roorkee to attend the workshop, only if you have received intimation.