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Soil and Water Res

Simulating nonequilibrium movement of water, solutes and particles using hydrus – a review of recent applications

J. Šimůnek, M. Köhne, R. Kodešová, M. Šejna

https://doi.org/10.17221/1200-SWR

Citation: Šimůnek J., Köhne M., Kodešová R., Šejna M. (2008): Simulating nonequilibrium movement of water, solutes and particles using hydrus – a review of recent applications. Soil & Water Res., 3: S42-S51.

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Water and contaminants moving through the vadose zone are often subject to a large number of simultaneous physical and chemical nonequilibrium processes. Traditional modeling tools for describing flow and transport in soils either do not consider nonequilibrium processes at all, or consider them only separately. By contrast, a wide range of nonequilibrium flow and transport modeling approaches are currently available in the latest versions of the HYDRUS software packages. The formulations range from classical models simulating uniform flow and transport, to relatively traditional mobile-immobile water physical and two-site chemical nonequilibrium models, to more complex dual-permeability models that consider both physical and chemical nonequilibrium. In this paper we briefly review recent applications of the HYDRUS models that used these nonequilibrium features to simulate nonequilibrium water flow (water storage in immobile domains and/or preferential water flow in structured soils with macropores and other preferential flow pathways), and transport of solutes (pesticides and other organic compounds) and particles (colloids, bacteria and viruses) in the vadose zone.

Keywords:

nonequilibrium flow and transport; physical nonequilibrium; chemical nonequilibrium; numerical models; preferential flow; reactive transport; HYDRUS; review of recent applications

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Impact factor (Web of Sc Thomson Reuters)

2017: 0.882

5-Year Impact Factor: 1.11

SJR (SCImago Journal Ra SCOPUS)

2017: 0.379 – Q3 (Aquatic Q3 (Aquatic Science)

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Contact

Ing. Markéta Knížková
Executive Editor
phone: + 420 227 010 373
e-mail: swr@cazv.cz

Address

Soil and Water Research
Czech Academy of Agricu
Sciences
Slezská 7, 120 00 Praha 2,
Republic