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Groundwater recharge simulation under the steady-state and transient climate conditions

S. Pozdniakov and N. Lykhina
Faculty of Geology Moscow State University, Moscow, Russia (lychinanastena@mail.ru)

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Diffusive groundwater recharge is a vertical water flux through the water table, i.e. through the boundary between the unsaturated and saturated zones. This flux features temporal and spatial changes due to variations in the climatic conditions, landscape the state of vegetation, and the spatial variability of vadoze zone characteristics. In a changing climate the non-steady state series of climatic characteristics will affect on the groundwater recharge..
A well-tested approach to calculating water flux through the vadoze zone is the application of Richard's equations for a heterogeneous one-domain porosity continuum with specially formulated atmospheric boundary conditions at the ground surface. In this approach the climatic parameters are reflected in upper boundary conditions, while the recharge series is the flux through the low boundary. In this work developed by authors code Surfbal that simulates water cycle at surface of topsoil to take into account the various condition of precipitation transformation at the surface in different seasons under different vegetation cover including snow accumulation in winter and melting in spring is used to generate upper boundary condition at surface of topsoil for world-wide known Hydrus-1D code (Simunek et al, 2008).
To estimate the proposal climate change effect we performed Surfbal and Hydrus simulation using the steady state climatic condition and transient condition due to global warming on example of Moscow region, Russia. The following scenario of climate change in 21 century in Moscow region was selected: the annual temperature will increase on 4C during 100 year and annual precipitation will increase on 10% (Solomon et al, 2007). Within the year the maximum increasing of temperature and precipitation falls on winter time, while in middle of summer temperature will remain almost the same as observed now and monthly precipitation.
For simulating climate input the weather generator LARSWG (Semenov and Barrow 1997) was trained for generation daily meteorological records for both steady state and transient climatic conditions and two 100 year of meteorological series of minimum and maximum of air temperature, solar radiation and precipitation were generated. The numerical experiment for studying of transient climate on groundwater was performed for typical vadoze zone parameters of western part of Moscow Artesian basin.
As the result, the 100 years series of recharge were simulated. Examination of stochastic properties of simulated time-series and comparative analysis series for the transient and for the steady state conditions shows the trend of increasing of recharge in this region in transient climate. Analysis of daily and monthly simulated water balance shows that this increasing is result of winter snow melting and winter infiltration into thaw topsoil.
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