Geophysical Research Abstracts,
Vol. 11, EGU2009-854, 2009
EGU General Assembly 2009

The impasses of modern "physically-based" hydrological modelling: example of an alternative approach

Yu. B. Vinogradov and O. Semenova

State Hydrological Institute, Department of Experimental Hydrology and Modelling of Hydrological Processes, St. Petersburg, Russian Federation (omakarieva@gmail.com)

The following five stubborn problems are distinguished in physically based distributed hydrological modelling (K.Beven, 2001) – nonlinearity, uniqueness, uncertainty, equifinality and scale. Mainly they are related to methods of mathematical description of water movement from the places of runoff generation to the basin outlet. Three main tasks of which a correct methodological solution has principal significance are: 1) infiltration, water movement in the soil layer, formation of classical surface and subsurface flow; 2) slope (surface, subsurface and underground) inflow to channel network; 3) channel flow and lag time.

An initial and at the same time an important stage of mathematical model construction is getting a clear idea about the modelling object formulated in the language of hydrology. The chief requirement (as a matter of fact, the modelling law) which can be demanded of the mathematical model is its adequacy to a real object, process, or phenomena. Therefore, it is inadmissible to apply the principles and approaches which are successfully used for description of phenomena of completely different character to the specification of other processes that have only formal resemblance.

We consider the use of the following equations widely spread in hydrology – the Richard's equation, the Saint-Venant or kinematic wave equations and the Boussinesq equation – to be the direct violation of this law. We believe that the idea of developing approaches to calculate the runoff movement at the slopes, channel net and aquifers using non-existent data about inclinations, morphometry, roughness and etc. is utopic. The methodology of reverse estimation leads to unreserved illusions since parameters of applied models evaluated in such a way are the subject not of systematization, nor generalization, neither normalization; often they are not even realistic.

Different idealization of runoff generation and its transformation phenomena is the basis of alternative approach which is realized in the distributed hydrological model "Hydrograph". Two main ideas are constantly being taken into account while designing and constructing this model. They are:

• The necessity to reach relative balance in searching for the simplest solutions while aiming to describe the natural processes and laws adequately;

• The maintenance of a general approach; that is, the description of the whole set of any possible situations in runoff formation processes; basins of any scale (from water-balance plot to the Earth land surface); mountains and plains; any geographical zone; use of minimum standard meteorological information.

The concept of runoff elements is the base of proposed model. It offers the possibility of a unified methodological approach to modelling the surface, subsurface and underground runoff of different layers and gives the solution of the multiple-scale problem by means of directly including the basin area into the algorithms of conversion of runoff elements parameters into coefficients of main calculating equations. The probable idealization – hierarchical sequence of layers of runoff elements arrangement which take part in river inflow – is proposed. The following empirical facts are taken into account: the decrease of infiltration capacity of water-holding rocks and outflow rate and the simultaneous increase of water storage with the depth in groundwater aquifers. Each level in the system of runoff elements is characterised by the proposed values of two hydraulic parameters, relaxation time and rate of outflow, water storage.

The main approaches which are used in the proposed model will be discussed in this presentation.