SIMULATION OF FLOW' FORMING IN TWIN FIELD AND WOOD CATCHMENTS OF THE EUROPEAN PART OF RUSSIA

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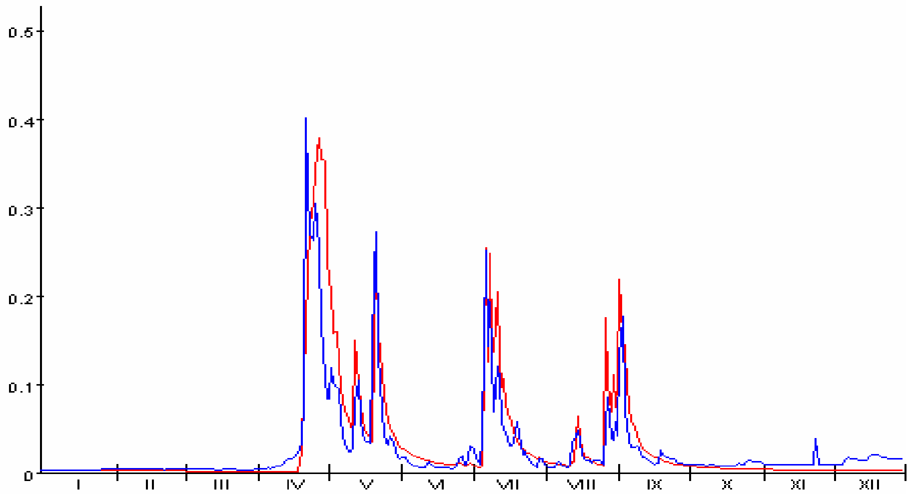
Abstract
The results of simulation of flow 12 twin field and wood catchments in the European part of Russia are introduced. Catchments belong to basins of rivers: Moscow, Vetluga, Klyazma, Sura, Vitebety, Vyatka, Vologda. The objects of simulation are posed in different geographic zones. We used 10-year's period for simulation. The analysis of results has allowed to make the pre-deductions about differences of flow' forming and look after differences of arguments on field and wood catchments. The proportion of underground and surface flow on field and wood twin catchments, which one was estimated, due to opportunities of model «Hydrograph» it is possible to section objective enough.
This research is a first step in study and ordering of parameters of model «Hydrograph». The model included all kinds of flow and can be used for any geographic district, and basin of any size. The model include three parts – flow-erosion-pollution. There are various numerical coefficients at algorithm of model. Among them differ: constants, empirical coefficients, characteristics of basin, characteristics SFK (flow-forming complex), parameters SFK. The parameters name numerical coefficients in algorithmic system of models set in relation to the given object as a constant, but changed from SFK to SFK and from basin to basin.

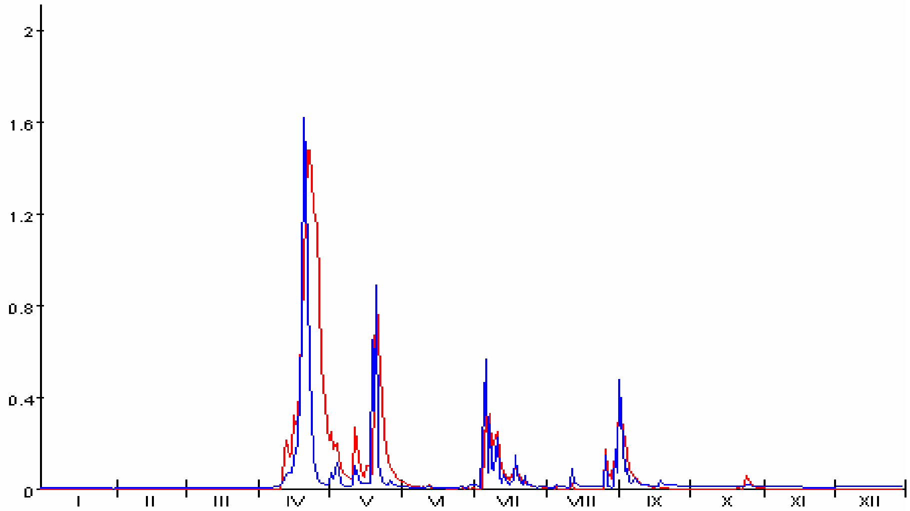
Introduction
The modeling the runoff formation processes is the main task of modern hydrology.
For getting results that are adequate to nature it is necessary to study all elements of runoff formation complex. Field observations of those elements are convenient to carry at basins of small areas with homogenous characteristics of soil-vegetation cover. In the 70-th years of last century water balance research stations with twin catchments were organized at the territory of former Soviet Union. Daily precipitation and flow discharges were measured at every experimental basin. Data for the 10 years period were published. It contains detailed information about soil and vegetation cover, which is used for model "Hydrograph".

Methodology
The model of runoff formation named "Hydrograph" is the universal deterministic model system with distributed parameters. The model can be used for any geographic region. The parameters of the model reflect all features of the modeled areas and have concrete physical determination. The model calculates heat and water exchange between the basin surface and atmosphere and in the soil column (1). The model input is daily meteorological information such as temperature, moisture deficit, precipitation layer and duration of liquid precipitation. The model output consists in runoff hydrograph and variable states reflecting temperature, moisture and frost penetration in soil, snow cover. If the corresponding information is available the model can be used for simulation of pollutant flow and its distribution around the basin (2).
The modeling of runoff formation processes was carried for twelve twin field and wood catchments situated in European part of Russia but in different geographical areas. The river

Mituva is situated in Lithuania, the lake Naroch is situated in Byelorussia, the rivers Vytebet, Nygr, Moscow, Vetluga, Klyazma and Sura – in the upper basin of the river Volga. The rivers Vologda and Sysola are situated in the North Krai, and the river Bolshoy Cheremshan – near Ural. Altogether the simulation was carried for 24 catchments. The area of modeled catchments averages as 3-5 km^2, with the exception of the river Mituva (12-13 km^2) and the river Bolshoy Cheremshan (260-300m^2). Each experimental basin represents one Runoff Formation Complex (RFC) with homogeneous properties of soil and vegetation cover. Therefore the parameters remain constant throughout the whole basin.
The simulation was realized for ten years period (01.09.1973 – 31.12.1983). The meteorological model input is daily data of meteorological and precipitation stations. The data of the nearest one or two meteorological stations were used for twin catchments. Therefore daily temperature and moisture deficit are the same for twin catchments.The data of field observations were used for determination of the parameters reflecting geographical location of the basins, soil-vegetation cover, and structure of drainage network. The water discharges, temperature and moisture of soil column were set as initial conditions.
The main result of the modeling is flow hydrographs. The Picture 1 and 2 represent simulated and observed hydrographs.



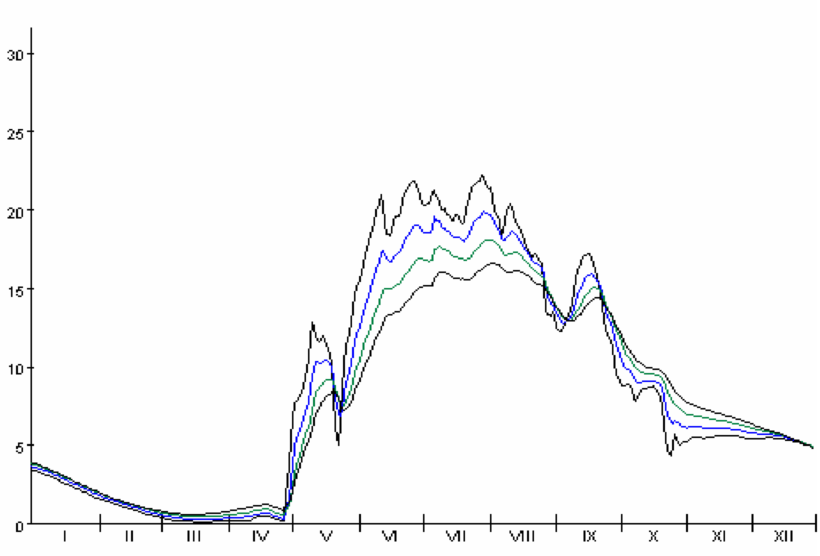
Picture 1. Hydrograph. Wood catchment (r. Vetluga) – 1980 year



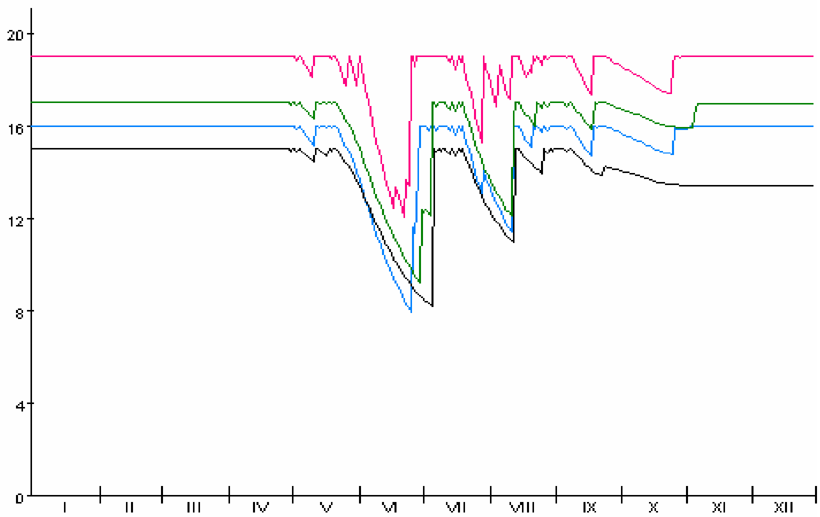
Picture 2. Hydrograph. Field catchment (r. Vetluga) – 1980 year

Simulated flows (m^3/sec)
Observed flows (m^3/sec)

The simulated variable states (such as density and thickness of snow cover, temperature and moisture of the soil, effective air temperature) are represented at the Picture 3 and 4.



Picture 3. Temperature of the soil(C^0). Field catchment (r. Vetluga) – 1980 year

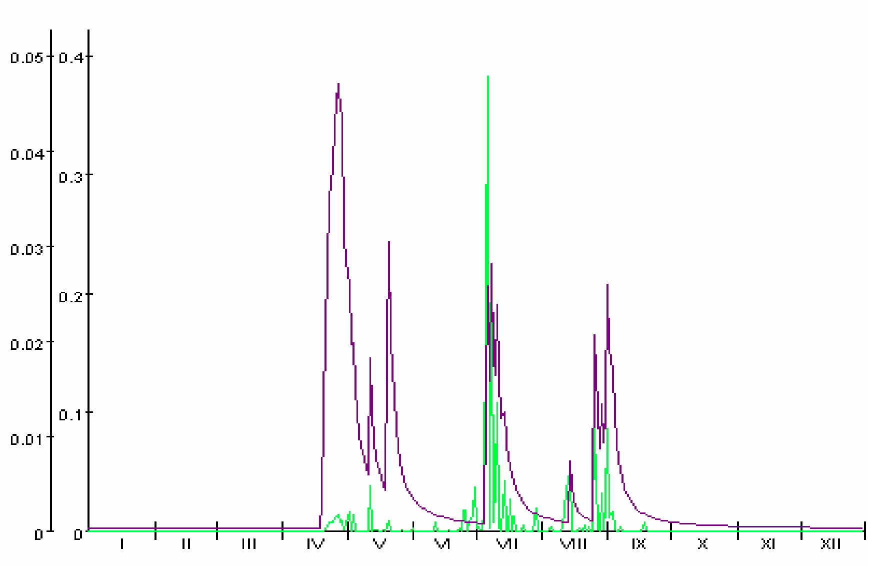


Picture 4. Moisture of the soil(mm). Wood catchment (r. Vetluga) – 1980 year
Color line - in depth 30, 50, 70, 90 centimeter of profile of soil.

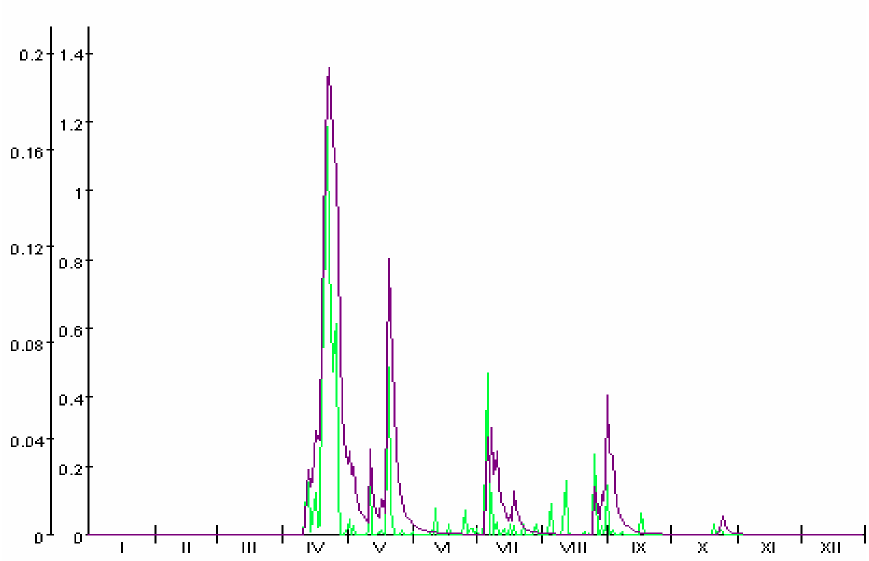
In the course of numerical experiments there were corrected following parameters:

- the value of snow layer on the filed basins – great errors are possible in the measured values of snow layer because of they wind over the open areas;
- the coefficients of filtration;
- the coefficients of evaporation from the soil and vegetation cover.

The potentialities of the model “Hydrograph” allow dividing surface and groundwater flows(3). The relation between surface and groundwater flows on paired wood and field catchments are represented at the Picture 5 and 6.



Picture 5. Surface and groundwater flows. Wood catchment (r. Vetluga) – 1980 year



Picture 6. Surface and groundwater flows. Field catchment (r. Vetluga) – 1980 year

Surface flows

Groundwater flows

Conclusion

The analysis of simulated hydrographs of twin catchments indicates that maximum flow peaks on field catchments are stronger expressed than on wood catchments and the reason for that is essential interception of water by soil and vegetation at the wood catchments. The simulations have not confirmed the opinion of several hydrologists that surface flow dominates over subsurface flow at the field catchments. It is determined by fact that some areas of experimental catchments were used for agriculture. Sharply increasing filtration coefficients lead to fast subsoil flow. Therefore more accurate research of filtration coefficients and coefficients of evaporation from the basin cover are necessary, especially under conditions of anthropogenic factors. These parameters strongly determine flow regime and its value.

Daily data of moisture deficit or relative humidity is important for accurate hydrological calculations. Unfortunately this significant meteorological element is often ignored in different complex water balance measurements.

References:

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