Geophysical Research Abstracts
Vol. 20, EGU2018-10370-1, 2018
EGU General Assembly 2018

Modeling of flooding characteristics of the residential area

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River floods are amongst the most dangerous natural disasters. Evaluation of the possible damage, outlining of flooding zones and revealing of factors affecting on runoff formation during the floods are increasingly performed using methods of mathematical modelling.
The river reach of Northern Dvina, from the confluence with the Youg River to the town of Kotlas, has been chosen as an object for research. Floods occurs regularly in this reach due to ice jams formation, so annual spring floods accompanied by floodplain inundation requires careful study.
In this paper, we used the STREAM-2D model (developed by V. Belikov) as a two-dimensional model, based on the solution of the Saint-Venant equation in two-dimensional schematization.
In addition to calculation of real hydrographs, two-dimensional hydrodynamic models allow conduction of experiments to analyse the sensitivity of characteristics that determine the severity of flooding (depth of flooding, flow velocity, flooding area) to changes of natural (increase in runoff, change in roughness coefficient, ice jams) and anthropogenic factors (presence/absence of roads and road embankments on the floodplain, the presence/absence of buildings).
The experiment consisted of water releases at a rate of 1,000 m3/s, in the interval from 1,000 m3/s to 11,000 m3/s. The water level at the lower boundary of the model was set according to the curve Q=f(H) constructed from a series of observations in the years with no ice jams. After completion of the calculation, the main characteristics were averaged using the special program 'AverageInRegion', developed in the Water Problem Institute of Russian Academy of Science. In the course of numerical experiments, scenarios were considered with the channels' roughness factors of 0.02, 0.024, 0.03. The roughness factors of the floodplains were changed separately: 0.04, 0.06, 0.08 and 0.1.
The modeling results showed that all flow characteristics determining severity of flooding are sensitive to changes in the riverbed roughness factor. Thus, with an increase in the roughness factor from 0.024 to 0.028 at the discharges corresponding to flooded floodplains (in the range of 5,000–11,000 m3/s), the average depth of flooding increases by 10–18 cm, the average flow velocity decreases by 0.05 m/s, the area of flooding increases by 2–4%. The change in the channels' roughness factor from the lowest to the highest in the considered range (from 0.02 to 0.032) at the water discharges corresponding to floodplain flooding will result in increase in the average flow depth in the modeling area by 0.4–0.5 m, flood areas increase by 6–9% and flow velocity decrease by 0.15 m/s. The sensitivity of the flow characteristics determining the severity of flooding to changes in the floodplains' roughness factor is slightly lower: with an increase in the roughness factor of the floodplain from 0.04 to 0.1, the average depth of flooding increases by 0.16–0.25 cm, the flooding area increases by 2–4%, the flow velocity decreases by 0.05–0.07 m/s.
The study was supported by RSF grants (Project No. 17-11-01254 - analysis of hydrological information), RFBR (projects No. 18-35-00498 mol_ and 17-05-01230).