

The risk of river pollution due to washout from contaminated floodplain water bodies during high floods

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Today, the potential impact of extremely high floods, which in the last years have become a rather frequent weather-related disaster, is the problem of primary concern. In studies of the potential impact of floods the emphasis is placed first of all on the estimation of possible flood zones and the analysis of the flow regimes in these zones. However, in some cases the hydrochemical parameters related to changes in the chemical composition of water are more important than the hydraulic parameters. It is generally believed that the higher is the flow rate, the more intensive is the process of dissolution, i.e. the lower is the concentration of limiting contaminants in water. However, this statement is valid provided that flooding does not activate new sources of water pollution such as contaminated floodplain water bodies located in the vicinity of water supply systems. Being quite reliable and safe at small and moderate discharges, in the case of extremely high level of river waters they become intensive sources of water pollution, essentially limiting the water consumption schedule for downstream water consumers. It should be noted that compared to the well-studied mechanisms of waste discharge due to failure of hydraulic engineering structures by flood waves, the mechanisms of pollutant washout from the contaminated floodplain water bodies by the flood waves is still poorly understood.

We analyze the impacts of such weather-related events on the quality of water in the water intake system, taking as an example, the section of the Vyatka River located in the Prikamskaya lowland of the Russian Federation. The risk of river pollution due to washout from the contaminated floodplain water bodies during high floods is studied by hydrodynamical modeling in the framework of combined approach using one-, two- and three-dimensional hydrodynamic models are implemented and by in situ measurements.

It is shown that during high floods the removal of pollutants from the contaminated floodplain water bodies takes place. The washout process includes two stages. The first rapid stage lasts about two hours, during this stage the upper layer is washed out. During the second, longer stage, the concentration of contaminant in the floodplain water body remains nearly constant. The maximal concentration of contaminant in the river in the vicinity of water intake located 21 kilometers downstream is attained in 9 hours from the beginning of the flood; it can become several times larger than acceptable concentration. The calculations and in-situ measurements have also shown that the primary peak of contaminant concentration near the water intake is followed by a smaller second peak related to the contaminant propagation through inundated floodplain. After the second peak the concentration slowly decreases and reaches acceptable values in 30-40 hours.

Thus, during high floods, contaminated floodplain water bodies located near drinking water supply systems can become new sources of water pollution which has to be taken into account in downstream water consumption schedule.

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