Vistula River bed erosion processes and their influence on Warsaw's flood safety

ARTUR MAGNUSZEWSKI[1] & SHARON MORAN[2]

1 University of Warsaw, Faculty of Geography and Regional Studies, Hydrology Department, Krakowskie Przedmiescie 30, 00-927 Warszawa, Poland
asmagnus@uw.edu.pl
2 State University of New York College, Department of Environmental Studies, 220 Marshall Hall, 1 Forestry Drive, Syracuse, New York 13210-2787, USA.

Abstract Large cities have historically been well protected against floods as a function of their importance to society. In Warsaw, Poland, located on a narrow passage of the Vistula River valley, urban flood disasters were not unusual. Beginning at the end of the 19th century, the construction of river embankment and training works caused the narrowing of the flood passage path in the downtown reach of the river. The process of bed erosion lowered the elevation of the river bed by 205 cm over the 20th century, and the consequences of bed lowering are reflected by the rating curve change. Conditions of the flood passage have been analysed by the CCHE2D hydrodynamic model both in retro-modelling and scenario simulation modelling. The high water mark of the 1844 flood and iterative calculations in retro-modelling made possible estimation of the discharge, $Q = 8250 \text{ m}^3 \text{ s}^{-1}$. This highest observed historical flood in a natural river has been compared to recent conditions of the Vistula River in Warsaw by scenario modelling. The result shows dramatic changes in water surface elevation, velocities, and shear stress. The vertical velocity in the proximity of Port Praski gauge at km 513 can reach 3.5 m s^{-1}, a very high value for a lowland river. The average flow conveyance is improving due to channel erosion but also declining in the case of extreme floods due to high resistance from vegetation on the flood plains.

Key words Vistula River; Warsaw; erosion; rating curve; hydrodynamic modelling; flood