Abstract

In the river flow the hierarchical system of the macroturbulent vortexlike structures can have a wide range of size from depth order to meander length order. These structures are formed due to interaction between flow and the channel bed. The river channel relief, which is also hierarchical system of dunelike features with the same range of size, is the "imprint" of the macroturbulence on the movable channel bed. Bed relief and channel morphological changes generates transformation of the flow structure.

The quantitative basement of stream flow - channel bed interaction description is the analysis of the initial instability of the wave-like structures of the flow and channel bottom relief. 3-D equations of momentum and conservation in curvilinear coordinates with depth-averaging following N.Kartvelishvily were used for this analysis. This approach allows to take into account the effects of the dynamic pressure vertical distribution and of the helical flow; and give possibility to linearize the equations for disturbance with minimal lost of terms. Standard procedure of stability analysis of these equations with nontrivial boundary conditions leads to solutions which predict the continuos (both in longitudinal and lateral directions) spectrum of amplitude growth of unstable in time channel bed waves.

The topography of this continuos spectrum is complex, the areas of five types of channel forms were defined: 1) 2- and 3-D ultramicroforms with the length of depth order, which increase with depth and Froude number; 2) 3-D isometric in plane microforms; 3) 3-D elongate mesoforms; 4) 3-D macroforms, whose length increase with depth and as Froude number and bottom resistance decrease; 5) long (up to 100 channel width) and narrow megaforms.

These unstable waves have their analogy in the relief of the river channel. The ripples in flumes and megaripples in the river channel correspond with ultramicroforms. The dunes of 1 and 2 order are correlated with microforms. The area of mesoforms is transitional between dunes and bars. The macroforms are correspondent to bars, island, channel meanders. Parallel braids are the natural analogy for megaforms. The main difference between theoretical and empirical spectra of river channel forms is related to nonlinearity of channel - flow interaction in the real river. One of such nonlinear processes is the secondary flow circulation which leads transformation of the bottom elevations due to channel meanders formation.