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Suspended sediment flow features of volcanic territories' rivers

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Territories of modern volcanic activity are specific regions as to conditions of sediment flow forming. Friable volcanic deposits determine peculiar features of rivers' hydrological regime, sediment inflow and transport. Rivers with heightened turbidity are formed there.

Sediment flow estimation based on tradition approaches leads to underestimate of some factors in these specific conditions. As the result sediment flow could be estimated with errors. Thus it's challenging to design methods of suspended sediment flow estimation for rivers with heightened turbidity.

The source data for decision of the problem are results of field works, observations at permanent hydrological stations, published works and cartographic materials. Rivers of modern volcanic territories are studied by the example of Kamchatka peninsula (Avachinskaya and Kliucevskaya volcano groups and Shiveluch volcano, Russia).

Characteristic features of volcanic rivers hydrological regime are shown in daily, annual and long-term flow fluctuations. Daily flow fluctuations of volcanic rivers depend on ice and snow melting and transform at the expense of filtration. Water content and sediment flow changes are accompanied with riverbed transformations which rate is the highest one. Within-year variability is also very irregular. During the law-water season most part of volcanic rivers doesn't reach their receiving basins because of high infiltration. The main sediment removal occurs during the flood time; its duration is 3 months for this territory. Fluctuations of high-water, low-water and water-average periods are determined by climatic factors and internal causes. High-water periods are often coincided with volcanic eruptions in winter when huge amount of ice and snow melts. Considerable eruptions are reasons of law-water periods whereas the source of water feeding could be diminished or destroyed.

Standard method of suspended sediment flow estimation from unstudied territories in hydrology is regression model. Design of regression model for suspended sediment flow estimation of Kamchtkan volcanic rivers was based on field data in summer 2009.

The main parameters influenced on specific rate of suspended sediment transport M_R, t/km^2•year are: unit discharge of water M_Q, l/sec•km^2; catchment area F, km^2; coefficient of friable volcanic rocks availability $\frac{F_{\text{vol}}}{F}$ on catchment basin.

As the result the following regression model was designed for volcanic territories of Kamchatka:

$$M_R = 519M_Q - 3390 \lg F - 2310\frac{F_{vol}}{F} + 2610.$$

Suspended sediment flow of volcanic territories W_{vol}, t/year is estimated as

$$W_{vol} = M_R \cdot F \cdot \frac{T_f}{12},$$

F– catchment area of a river, km^2, T_f – duration of flood time (3 months).

Relative errors of specific rate of suspended sediment transport estimation are between 0.2 and 13of method is described by factor S/σ, where S – standard error, σ – standard deviation. It's good and makes up 0.56.

Estimation is made for 62 basins; sediment flow of Avachinskaya volcano group rivers is 0.9 mil t/year and of Kliucevskaya volcano group and Shiveluch volcano rivers is 2.6 mil t/year.

The total sediment flow into Pacific Ocean from the eastern coast of Kamchatka is 10.2 mil t/year. Sediment inflow to the ocean at the expense of volcanic rivers (its total basin area is 5620 km^2 and about 3% of eastern part of the peninsula area) is 3.5 mil t/year or 35 % of the total sediment flow. Regional sediment flow of eastern coast without volcanic rivers with heightened turbidity in average is 35 t/km^2·year. For territories of modern volcanic activity its value is 485 t/km^2·year. Weight average specific rate of suspended sediment transport for the whole eastern coast

of Kamchatka is 51.8 t/km^2·year. Thereby at the expense of areas with heightened washout the regional specific rate of suspended sediment transport is raised in 48 %.