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Sediment processes modelling below hydraulic mining: towards environmental impact mitigation

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Placer mining sites are located in the river valleys so the rivers are influenced by mining operations. Frequently the existing mining sites are characterized by low contribution to the environmental technologies. Therefore hydraulic mining alters stream hydrology and sediment processes and increases water turbidity. The most serious environmental sequences of the sediment yield increase occur in the rivers populated by salmon fish community because salmon species prefer clean water with low turbidity. For instance, the placer mining in Kamchatka peninsula (Far East of Russia) which is regarded to be the last global gene pool of wild salmon Oncorhynchus threatens the rivers ecosystems. System of man-made impact mitigation could be done through the exact recognition of the human role in hydrological processes and sediment transport especially.

Sediment budget of rivers below mining sites is transformed according to the appearance of the man-made non-point and point sediment sources. Non-point source pollution occurs due to soil erosion on the exposed hillsides and erosion in the channel diversions. Slope wash on the hillsides is absent during summer days without rainfalls and is many times increased during rainfalls and snow melting. The nearness of the sources of material and the rivers leads to the small time of suspended load increase after rainfalls. The average time of material intake from exposed hillsides to the rivers is less than 1 hour. The main reason of the incision in the channel diversion is river-channel straightening. The increase of channel slopes and transport capacity leads to the intensive incision of flow. Point source pollution is performed by effluents both from mining site (mainly brief effluents) and from settling ponds (permanent effluents), groundwater seepage from tailing pits or from quarries. High rate of groundwater runoff is the main reason of the technological ponds overfilling. Intensive filtration from channel to ponds because of their nearness determines the water mass increase inside mining site.

The predictive models were suggested to assess each of the mane-made processes contribution into the total sediment budget of the rivers below mining sites. The empirical data and theoretical and laboratory-derived correlations were used to obtain the predictive models for each processes of sediment supply. It was challenging to estimate specific erosion rate of washed exposed hillsides, channel incision, water supply conditions. Climatic and anthropogenic changes of water runoff also were simulated to decrease uncertainty of the proposed model. Application of the given approach to the hydraulic platinum-mining located in the Kamchatka peninsula (Koryak plateau, tributaries of the Vivenka River) gave the sediment budget of the placer-mined rivers and the total sediment yield supplied into the ocean from river basin. Polluted placer-mined rivers contribute about 30 % of the whole sediment yield of the Vivenka River. At the same time the catchment area of these rivers is less than 0,03 % from the whole Vivenka catchment area. Based on the sediment transport modeling the decision making system for controlling water pollution and stream community preservation was developed. Due to exposed hillside erosion prevention and settling pond system optimization the total decrease of sediment yield was up to 75 %.