MODELING OF WATER EROSION AND SEDIMENT TRANSPORT

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Contents

1. Introduction
2. Structure of the model
2.1. Modeling Rainfall Runoff Formation
2.2. Modeling Soil Erosion and Sediment Transport in the River Basin
3. Model application
4. Conclusion
Glossary
Bibliography
Biographical Sketch

Summary

A physically based description of the soil erosion and the sediment transport was included in a quasi three-dimensional rainfall runoff formation model. As a result, the model that describes spatial and temporal processes of water and sediment movement in the river basin (overland flow, unsaturated and saturated subsurface flow, water movement in river network, interaction between surface water and groundwater in the river channel and on the hillslope, erosion by raindrop impact and overland flow, sediment transport and deposition on hill slopes, sediment transport in the river network) has been developed. The erosion rate is determined as a function of rainfall, water flow and soil characteristics. The model has been tested against data from a small watershed, situated on the Zakarpatskaya water balance station (the Tissa River basin). The influence of the groundwater table changes on sediment discharges and sediment runoff was analyzed.

1. Introduction

Since the 1970s a number of the mathematical models describing soil water erosion processes have been developed: the FESHM model (Ross et al., 1980), the ANSWER model (Park et al., 1982), the SEM model (Nielsen et al., 1986) and the SHESED-UK model (Wicks et al., 1988, Wicks, Bathurst, 1996). Two last models are based on the SHE hydrological model.

The main objective of this study was the development a distributed physically-based soil erosion model on the basis of the hydrological modeling system of Water Problems

Institute of Russian Academy of Sciences (Kuchment, 1983; Demidov, 1989). The soil erosion model allows for simulating the temporal and spatial variations in erosion by raindrop impact and overland flow, sediment transport and deposition.

2. Structure of the Model

2.1. Modeling Rainfall Runoff Formation

A physically based model of rainfall runoff formation is based on using differential equations which describe the processes of overland, groundwater, subsurface, channel flow as well as vertical moisture transfer in soil. The catchment is represented in the horizontal plane by the rectangular grid squares. The main channel and the tributaries of different orders are represented by the boundaries of grid squares.

The model describes the following processes:

1) Vertical moisture transport in the unsaturated zone (the one-dimensional Richard's equation is used; the calculations is carried out for each grid square of hillslope);
2) Groundwater flow and the interaction of surface and groundwater on the hillslope and in the river channel (the two-dimensional Boussinesq equations are used);
3) Overland flow (the two dimensional kinematic wave equations are applied);
4) Unsteady flow in the river network (the one-dimensional kinematic wave equations are used).

The organization of the interaction between components of the hydrological modeling system allows us to take feedback into account. Coupling of the calculations of the vertical moisture transport with the overland and groundwater flow is accomplished by means of a special procedure (Demidov, 1989).

More detailed description of the hydrologic block of the quasi three dimensional model can be seen in (Demidov, 1989; Kuchment et al., 1990).

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Biographical Sketch

Victor N. Demidov is a Doctor of Science (Physics and Math), Principal Researcher of Water Problem Institute of the Russian Academy of Sciences. He is author about 50 publications. His field of scientific interests is mainly modeling of hydrological processes and water quality formation.