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Reduction of uncertainty in urban catchment by physically based distributed flood runoff model using geographical feature data

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Urbanization has been a universal phenomenon since the later half of the 20th century. With the progress of urbanization, the water retention capacity of the land has declined because of the increased amount of impervious surface areas and the extension of sewage system. As a result, the flood reach hour is significantly shortened and the flood peak discharge is drastically increased in urban catchments. Urban catchments are formed as very complicated artificial structures, such as buildings, houses, roads, parking lots, parks, waterways, underground sewer system and so on. Mainly grid based distributed models are used as rainfall-runoff models not only in mountainous and rural catchments, but also in urban catchments due to their simplicity and the limitation of available information of the catchments. Grid based models, however, are not appropriate for urban catchment modeling, because those models greatly average the land use property into each grid cell ignoring individual land structure property of the urban catchment. Recently, with the progress of GIS (Geographical Information System) technology and the development of the related geographical data, digital information on road network, grid based land use, sewer and drainage system has been rather easily available. GIS information on geographical feature, such as individual building, house, parking lot, park etc., for rainfall runoff modeling has also been prepared in the large cities. Physically based distributed flood runoff model using geographical feature data can exactly trace the rainfall runoff process in urban catchment. The physically based distributed model presented here takes advantage of GIS information of geographical feature data to take precisely into account of impervious and pervious areas as individual structure or segment of the urban catchment. The physically based runoff model is simulated by one-dimensional hyrodynamic modeling incorporating the interaction between the sewage system with manholes, the river system, the streets, and the areas flooded with stagnant water. The model uses two types analytical models: hydrological models which simulates surface runoff from rainfall, and hydraulic models which describe river flow, sewer pipe flow, and the flow of storage water on the surface of streets and residential blocks. The computation of the surface runoff from rainfall is carried out by a standard kinematic wave model. A surface runoff hydrograph is computed for each single area. Runoff hydrographs from each single area are then used as input for the hydrodynamic model, simulating flows in the pipe and street systems. The distributed runoff model is applied to a flood-prone urban catchment in Tokyo with actual rainfall event. It is found that the model can simulate both the physical rainfall-runoff process as well as inundation in the basin in a satisfactory way. Then, the reduction degree of uncertainty by this model, in this case taking runoff prediction error as its index, is investigated compared with a grid based model.