Evaluation of long term variation in water balance and discharge of sediment and nitrogen in the urbanized catchment of Yamato River, using SWAT model

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Land-use changes, freshwater use, and the biochemical flow are important factors affecting the Earth's environmental threshold. In the research topics of Planetary Boundaries (PB), these factors have been defined as entering high-risk levels. One-third of the planet's freshwater resources come from groundwater, and now, in some countries and regions, it is also exposed to the risk of groundwater depletion. Large-scale urbanization brings economic development but also increases the possibility of urban waterlogging.

Yamato river is the highest-level river in Japan. It has a watershed area of 1067 square kilometers, covering almost half area of Nara prefecture. Yamato river catchment includes Nara basin which as an important agricultural base, Nara city and part of Sakai city. The water environment in the catchment is closely related to the healthy life of human beings. Especially in recent years, there are frequent flooding in the catchment. Therefore, the study of Yamato river is very necessary.

This thesis uses the SWAT (Soil and Water Assessment Tool) model and Geographic Information System (GIS) methodology. The SWAT model can not only simulate the water discharge and nutrient load but also find the essence of the change of water environment through the change of parameter sensitivity. Select Coefficient of determination (R2), Nash–Sutcliffe efficiency (NSE), and percentage of bias (PBIAS) as a factor of assessing results and obtained the experimental results with credibility.

It is found that the land use in the basin is mainly manifested in the change from farmland to urban land use type, which probably accounts for 1/3 of the total area of land use type changed. Over a period of 2009-2016, the average of water discharge from the total outlet in the main channel is 2.37 million m3/day while it's 2.06 million m3/day in 1971-1978. As a result of changes in land use, water yield from farmland decreased by 45% compared with the 1970s, while the yield from the city increased by 43%. Among them, Surface runoff generated increase by about 70%. In Sakai and its surrounding cities, surface runoff generated increased by 18% per 100 mm precipitation. Curb length density in the high-density urban area increased about one time. That means Sakai now, in the face of flooding caused by torrential rains, needs to take on higher risks.

Sediment yield reducing by more than 70% from 1988 to 2014. The change comes mainly from the management of the river channel. The non-point source load of nitrate increased from 1096 tons to 1534 tons, this is mainly due to the increase in precipitation and the increase in population. The growth of forests also has a certain impact. This is because the type of land used in farmland and forests, there has a large number of fertilizers on the surface of the soil from human agriculture activities or the decay of animal and plant debris. Under the driving effect of precipitation, it mainly transported by the lateral flow in farmland and forest area and the surface runoff in the urban area, a large part will enter the river channel.

Keywords: Land use change, Water balance, Nitrogen load, SWAT Model, Long term variation