第 II 部門　　Assessment of land use change impact on the hydrology of the Kamo River Basin

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1. Introduction

The Kamo River Basin (KRB) is located in Kyoto city with a long history. It was frequently attacked and damaged by flood disasters during the past 1300 years. In recent decades, it has been concerned that climate change has a potential significant impact on watershed hydrology. The river basin hydrological cycle would be accelerated when the evaporation and precipitation rates are increased due to the increasing of surface temperature. Human activities are also contributing to the impact on climate change at a large scale and hydrological process at a river basin scale. In this study, we used the statistical method and the hydrological modeling method to assess the impact of land use change on the hydrology of the KRB.

2. Study area and data

The riverbank of the Kamo River is popular with tourists and residents for many activities such as sightseeing during Sakura blooms, fishing and walking. There are some pathways around this river, which are opened for picnic activity during dry season. During heavy rainfall season, many activities cannot be done because the pathways are flooding. In the upper stream of KRB, there is a Sajikigatake mountain area which is the boundary of Kumogahata village and Keihoku village in the northern ward of Kyoto. The length of the Kamo River is about 31 km. The area and highest elevation of KRB is around 210 km^2 and 896 m, respectively. The flood control activities at KRB was started from 824 AD when the officer position was set for the flood prevention. In this study, we collected spatial and hydrological information such as Digital Elevation Model (DEM), land use, soil type, channel network, observed discharge and AMeDAS data from Japan Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The 50-m resolution DEM data and 100-m mesh land use data are obtained from the National and Regional Planning Bureau of MLIT. The DEM map was re-sampled from 50 m to 100 m.

3. Methods

This study uses the Cell Distributed Rainfall Runoff Model Version 3 (CDRMV3), which is a physically-based hydrological model developed at Innovative Disaster Prevention Technology and Policy Research Laboratory, DPRI, Kyoto University. This model is based on the kinematic wave method. The model includes a stage-discharge, *q-h*, relationship for both surface and subsurface runoff processes:

$$q = \begin{cases} v_m * d_m * (\frac{h}{d_m})^{\theta} & 0 \le h \le d_m \\ v_m * d_m + v_a * (h - d_m) & d_m \le h \le d_a \\ v_m * d_m + v_a * (h - d_m) + \alpha * (h - d_a)^m & d_a \le h \end{cases} \quad (1)$$

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$$v_m = k_m i, v_a = k_a i, k_m = \frac{k_a}{\theta}, \alpha = \sqrt{i}/n$$

where q is the discharge per unit width, h is the water depth, i is the slope gradient, k_m is the saturated hydraulic conductivity of the capillary soil layer, k_a is the hydraulic conductivity of the non-capillary soil layer, d_m is the depth of the capillary soil layer, d_a is the depths of capillary and non-capillary soil layer, and n is the roughness coefficient based on the land cover classes. At first, Figure 1(a) shows the flow direction and flow accumulation raster maps based on the DEM. Constructing the Cell Distributed Rainfall Runoff Model (CDRM) in the KRB, we simulated flood runoff by using 1976 and 2006 land use conditions (Fig.1 (b), (c)). The statistical analysis of the observed discharge and rainfall has been done to compare with the hydrological modeling assessment.

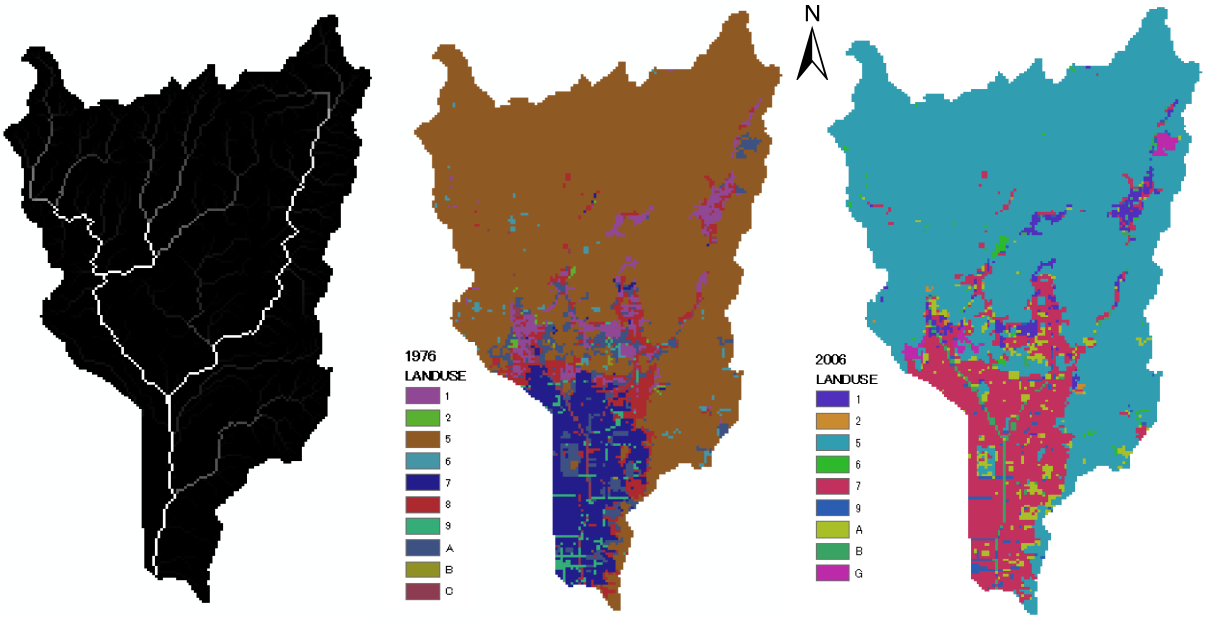

Figure 1: Spatial information for the Kamoriver Basin:
(a) Flow accumulation map, (b) Land use map in 1976, (c) Land use map in 2006

4. Concluding Remarks

The CDRM of KRB works very well in this study. Due to the increase of urban areas from 1976 to 2006, the river discharge was increased and the time of concentration was decreased because of the increased impermeable materials used for building houses and roads. The results of this study give a proof about the land use change ‘s effect on the hydrology of KRB.

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