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### 1. Introduction

The Curve Number (CN) is a hydrologic parameter used to describe the storm water runoff potential for drainage area, and it is a function of land use, soil type, and soil moisture. Therefore, the land use and land cover changes can be represented by this parameter.

Jobaru River basin is one of the important rivers in Saga Prefecture. Due to increase of the needs for residential area, it has been affected by the changes in the land use and land cover at Jobaru River basin during 1948 to 2005; especially the decrease in paddy fields and the increase in urban or built-up land. Jobaru River basin can be grouped into two sub-basins; Jobaru Mountainous and Plains sub-basin. Both parts have very different topography and land use. In mountainous sub-basin barren tended to turn into forest while paddy fields tended to turn into urban in the plains sub-basin. The changes in land use in both sub-basins would give a different effect. Changes from paddy fields to urban areas in the plains sub-basin will likely continue. It is feared that it will affect the flow in

Jobaru River.

### 2. The Jobaru River basin

Jobaru River basin is located in Kyushu Island in Saga Prefecture, Japan. It is one of the Chikugo River tributaries, originates in Sefuri Mountain and flowing to the south east to join the Chikugo River and pour to the Ariake Sea. The area of the basin is 74.2 square kilometers and the length of the main channel is 31.9 kilometer. An average annual precipitation of the Jobaru River basin is 2266 mm.



### Analysis 3.

The Jobaru River basin and sub-basin land use map is defined by intersecting the basins with the land use data. For the purpose of flood analysis it is necessary to reclassify the land use categories. Land use such as urban, housing, public facilities, schools can be considered the same and can be grouped into one group and classified into urban or built-up land, as well as rivers, lakes, ponds and swamps can be grouped into another, that is classified into water. The Jobaru River basin is reclassified into 11 classes. Using ArcGIS tools a reclassification map for the Jobaru River basin and sub-basin land use is defined (Fig. 1). The land use change is analyzed between 1948, 1975 and 2005 by using ArcGIS tools (Fig. 2).

The soil data from Geological map of Japan (AIST) was analyzed by using ArcGIS to obtain the Jobaru Soil map, and then it is compared with the soil map of Japan based on reclassification and also digital soil map of the world to obtain the soil types at Jobaru River basin. From this analysis, is obtained that there are three soil types: Fluvic soils, Brown Forest soils and Red-yellow soils (Fig.1).

The CN is estimated for a drainage basin using a combination of river basin, land use, and soil shape files. The information needed to determine a curve number is the hydrologic soil group (HSG), which indicates amount of infiltration the soil will allow.

MIKE 11-UHM tool is used for analyzing the Rainfall-Runoff.

### 4. **Result and Discussion**

# Land use change

In Jobaru River basin, land use changes

Fig. 2 Land use changes; (a) Basin, (b) Mountainous sub-basin, (c) Plain sub-basin significantly in Urban, Forest, Agricultural land and Barren, while Water and Others relatively unchanged. The result of land use changes in 1948, 1975 and 2005 show that the barren tend to turn into a forest. After World War II, Japan consumes a lot of wood to build houses, many trees were cut down to be used as construction materials, so that many forest areas turn into barren. This resulted in land use in 1948, forest area is relatively small and barren area is relatively large compared to the year 1975 and 2005. The land use in 1975 showed that barren area decreased, turning into forest. The results indicates that there is no longer booming demand for wood for construction materials at that time, even made reforestation in barren areas, so it turns barren areas into forest and the same thing happens also to land use in 2005. On the other hand, the paddy fields tend to turn into a built-up land. This is due to the increased demand of land for residential. Getting land in the urban areas becomes difficult and costly so that it causes the expansion into the countryside. One of the options is a paddy field. Paddy field is chosen because this area is still relatively close to urban area with flat terrain, and usually already have small group of housing.



Changes from Barren into Forest will lead to increase the land capability in reducing flooding.

In Mountainous sub-basin the land use significantly changed are forest, barren, agricultural land and urban, while water and others are relatively unchanged and dominantly barren areas turn into forest. In Plain sub-basin the land use change significantly in urban and

agricultural land, while water, forest, barren and others are relatively unchanged and dominantly the agricultural land turns into urban.

## **Curve number**

 Table 1 Average CN

 Average CN

 Basin/sub-basin
 Average CN

 1948
 1975
 2005

 Jobaru
 53.29
 53.54
 52.03

 Mountainous
 48.24
 48.43
 46.07

 Plain
 68.81
 69.04
 70.41



(Sept. 6-7, 2005)

From 1948 to 2005 the average CN of Jobaru River basin has decreased (Table 1). In this period, the main land use changes are increases of urban and forest, while agricultural land and barren decreased. The increasing in forest caused by changes from barren into forest, while the decreasing of agricultural land due to the increasing of the residential area. The increasing of urban and the decreasing of agricultural land cause the increasing of CN, on the other hand the increasing of forest and the decreasing of barren cause the decreasing of CN. It shows that in this period in the whole basin, the changes barren to forest is more dominant then the changes agricultural land to urban. The decreasing of CN indicates that the potential storm water runoff decreased while the increasing of CN means that the potential storm runoff increase, so in Jobaru River basin, the potential storm runoff decrease. In each sub-basin, the changes of average CN are different. In Mountainous sub-basin, the average CN decreased. It is caused that in the mountainous area the land use dominantly forest, and also most of the barren area are there. In this period almost all barren turn into forest, so it causes the CN in mountainous area decrease. It means the potential storm runoff in Mountainous sub-basin decrease. However in Plain sub-basin, the average CN increased. It is caused that in this area, the dominant land use are agricultural land especially paddy field and residential area. In this period, a lot of agricultural land changed into residential area, and cause the increasing of CN in plain area. In the Plain sub-basin, the potential runoff increases. From 1948 to 2005, the land use quality in whole basin changes better, but if we consider sub-basin, it shows that in the plain sub-basin, the land use quality changes worse. For anticipating the flood in Jobaru River due to the land use change we should consider in sub basin, especially the Plain sub-basin. We should control the land use change in the plain sub-basin. Currently, almost all barren have already changed to forest, so the tendency of increasing forest is limited but the need of residential becomes more and more, therefore the tendency of decreasing agricultural land and increasing urban becomes larger in the future. 100 0 50

## **River flow**

The rainfall-runoff processes during the period July 9, 2005 and September 6-7, 2005 under the land use in 1948,1975 and 2005 were simulated to analyze the response of flood to land use changes. With the same rainfall applied to the different land uses,



Fig. 4 Basin Rainfall-Runoff, different land uses. (a) Rainfall Sept. 6-7, 2005, (b) July 9, 2005

from 1948 to 2005 in the Jobaru basin and Mountainous sub-basin, the peak flow decreased (Fig. 4-5). It shows that the decreasing of CN caused the decreasing of peak flow. The CN method is good to analyze the rainfall-runoff in the mountain area, but not in the plain. The pattern of the discharge hydrograph in both Jobaru basin and Mountainous sub-basin are similar, it shows that in Jobaru River, the runoff dominantly influence by the runoff from the Mountainous sub-basin. The impact of the plain sub-basin to the runoff should be analyzed separately. It will be analyzed in the next step by using another method.

## 5. Conclusions

 Land use changes during 1948, 1975 and 2005 in Jobaru River basin; urban and forest increased, agricultural land and barren decreased, while water and others relatively unchanged. In Mountainous sub-basin; urban and forest increased, agricultural land and barren dec



agricultural land and barren decreased, water and others relatively unchanged. In Plain sub-basin; urban increased, agricultural land decreased, while water, forest, barren and others relatively unchanged.

- (2) In the whole Jobaru River basin the average CN decreased. It means that the potential runoff decreased. In the Mountainous sub-basin, the average CN also decreased but in the Plain sub-basin, the average CN increased it means that the potential storm runoff increased.
- (3) The result indicates that different land uses with different CN remarkably influenced peak flow in Jobaru River.
- (4) The result of the CN change can be finally utilized for flood analyzing.