Analysis on Land Use and Land Cover Changes in the Jobaru River Basin

Saga University **Student Member** **Jeffry Swingly Frans SUMARAUW**
Saga University **Member** **Koichiro OHGUSHI**

1. Introduction

Land use change is one of the main boundary conditions which influence many hydrologic processes. The effect of land use changes on river flow is one of the most important environmental issues. Expanding cities due to economic growth, population growth or both often come at the expense of increased risk of flooding and decreased water quality and quantity. Since the 20th century, the frequency of global flood disaster has been higher than any time before. One of the main reasons is land use changes by human activities. Jobaru River Basin is one of the important river basins in Saga Prefecture. Due to the increasing of needs for residential area, it have been affected by change in the land use and land cover at Jobaru River Basin; especially the decreasing in paddy fields and the increasing in urban or built-up land. As recorded several cases, there has been major flooding which resulted in loss and damage in Jobaru River. It is believed that one of the major causes is the changes in land use. The purpose of this study is to observe land use and land cover changes on Jobaru Watershed and the results will be used as input for the flood analysis.

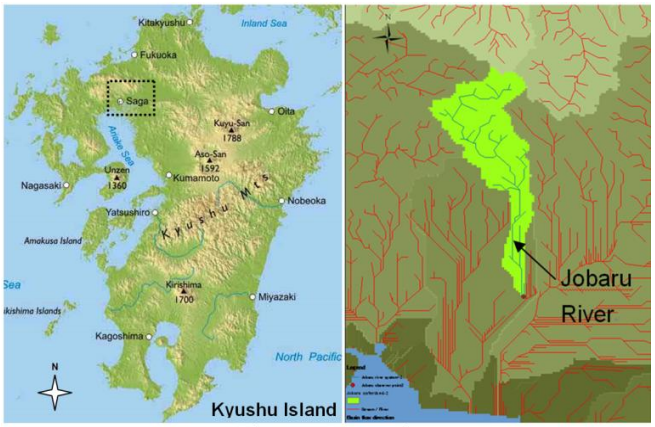

Figure 1 Research area

2. The Jobaru River Basin

Jobaru River Basin is located in one of the main islands of Japan called Kyushu. It is in Saga Prefecture (Figure 1). Jobaru River 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 geographical position is approximately between 129.9 to 131.0 degrees east and 33.08 to 33.58 degrees north. The area of the basin is 74.2 square kilometers and the length of the main channel is 31.9 kilometer.

The water resources of the basin are heavily developed for irrigation, fire protection, maintaining the environment and waterways. There are a number of irrigation schemes supplying water to paddy fields. Jobaru River Basin has a varied natural environment. In the middle and lower basins, it has a wide variety of plants and animals living there, upper part: flora and fauna, middle part: plant and animals, downstream: flora and fauna. Floods are normally experienced during the rainy season which has more intense rainfall than typhoons. The maximum discharge recorded from 1948 to 2005 was 690m^3/s which occurred in rainy season of 1953. Between 1948 and 2005, there were several floods in Jobaru River that caused damages[1]. The river discharge was recorded at Hideki Bridge point, from Hideki Bridge Observatory Station.

3. Analysis

The first step in this analysis is to delineate the Jobaru Watershed using the Hydrologic Engineering Center`s Geospatial Hydrologic Modeling System (HEC-GeoHMS). Data needed in this step is DEM data. The available DEM data is Japan Digital Map 50m Grid (Elevation), 1997. The next step is to define the Jobaru Watershed land use map by intersecting the Jobaru Watershed with the land use data. The available land use data is the Chikugo Watershed land use from Ryuki Shizen Kankyou Chousa Sagyou, for years 1948, 1975 and 2005. The original land use of Jobaru Watershed in 1948 is divided into 18 classes, whereas in 1975 and 2005 are divided into 20 classes (Figure 2). Category (1) (City, village, ground, etc.) in 1948 was divided into three categories in 1975 and 2005. For the purpose of flood analysis is necessary to reclassify the land use categories. Land uses such as urban, housing, public facilities, schools can be considered the same and can be grouped into one group, as well as rivers, lakes, ponds and swamps can be grouped into one. In this study; city, village, ground, urban area, place of residences, communal facilities, school, vacant lot, factory, oil tank place, power station, road and railway, and athletics facilities were classified into urban or built-up land. Whereas river, lake, swamp, pond, wetland, cloud, snow, and shadow were classified into water. The Jobaru Watershed is reclassified into 11 classes as shown in Table 1. Using ArcGIS tool a reclassification map for the Jobaru Watershed land use is defined (Figure 3). The land use change was analyzed between 1948, 1975 and 2005 by using ArcGIS tools. The changes of each land use and land cover area is shown in Table 2 and Figure 4.

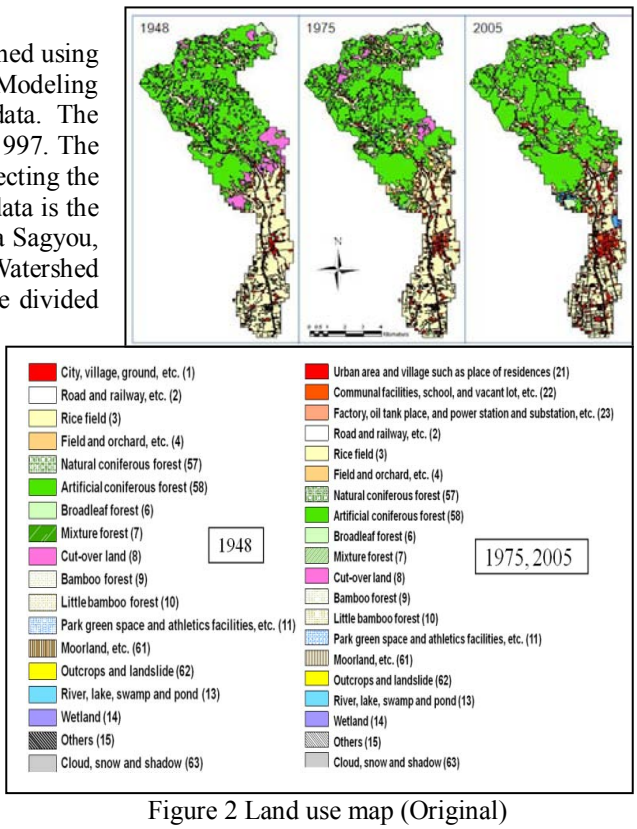

Figure 2 Land use map (Original)

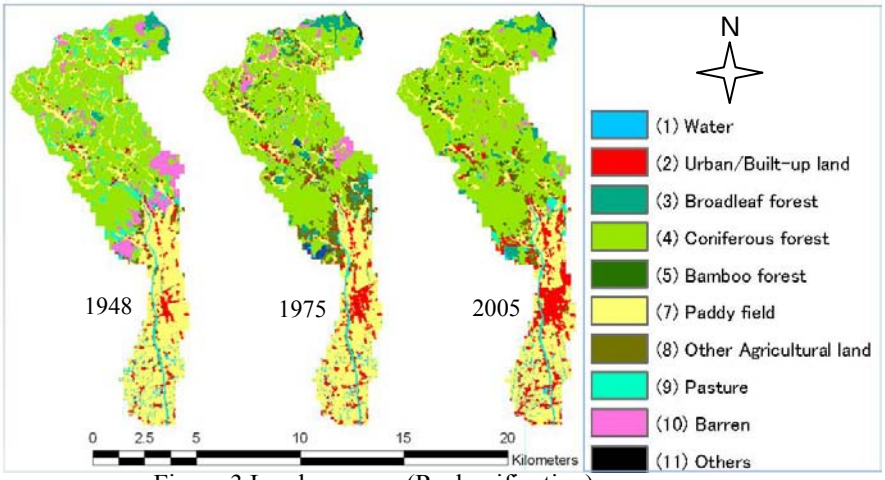

Figure 3 Land use map (Reclassification)

Table 1 Land use reclassification

Class code	Land use description
1	Water
2	Urban or built-up land
	Forest:
3	Broadleaf forest
4	Coniferous forest
5	Bamboo forest
6	Mixture forest
	Agricultural land:
7	Paddy field
8	Other Agricultural
9	Pasture
10	Barren
11	Others

4. Result and Discussion

According to the analysis, land use changes significantly in urban, forest, agricultural land and barren, while water and others relatively unchanged. The data of land use changes in 1948, 1975 and 2005 showed 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 data of land use changes in 1948, 1975 and 2005 showed that the paddy fields tend to turn into a built-up land. This is due to the increased demand for residential area. 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. The paddy field is chosen because this area is still relatively close to urban areas 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. The increasing forest dominantly caused by changes in barren into forest. Currently almost all of barren has turned into forest, so the possibility of increasing forest in the future is extremely small. On the other hand, the need for residential area will continue to increase, so the tendency of changes in paddy fields into residential area will be very substantial later. Changes in the paddy fields into residential resulted in a decreased land capability in reducing flooding. If these land use changes continue to happen, then the peak flow in the Jobaru River will also continue to increase.

Table 2 Land use change

Land use Description	Area (%), year		
	1948	1975	2005
Water (1)	1.59	1.36	1.59
Urban or Built-up land (2)	4.27	6.52	10.51
Broadleaf forest (3)	1.92	4.16	3.42
Coniferous forest (4)	46.06	44.61	53.26
Bamboo forest (5)	0.12	1.42	1.43
Mixture forest (6)	0.00	0.75	0.00
Paddy field (7)	32.34	28.34	23.05
Other agricultural (8)	1.58	7.35	3.60
Pasture (9)	5.45	2.01	2.16
Barren (10)	6.64	3.33	0.84
Others (11)	0.01	0.16	0.15

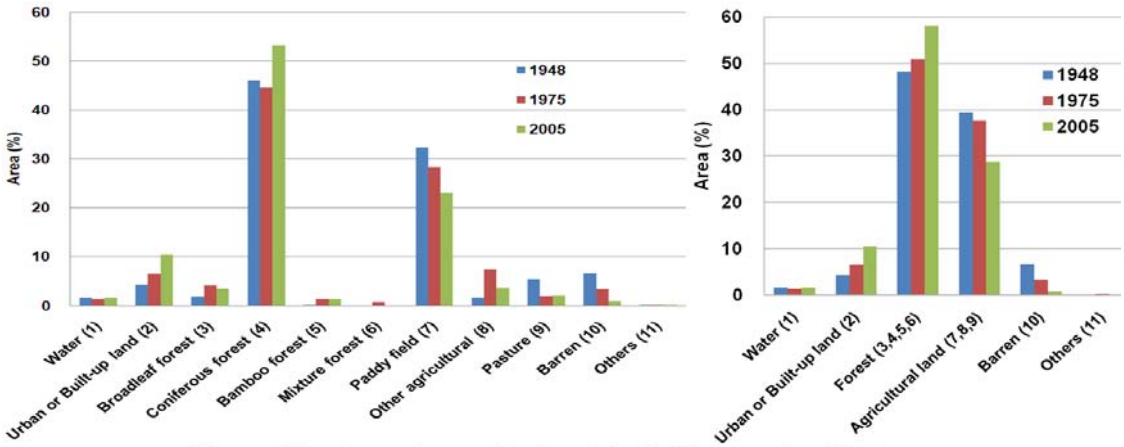

Figure 4 Land use change (Left; original, Right; reclassified)

5. Conclusions

(1) Land use changes in Jobaru watershed during 1948, 1975 and 2005 are: urban area increased by 6.23 %, forest increased by 10.01 %, agricultural land decreased by 10.56 %, barren decreased by 5.81 %, while water and others relatively unchanged.

(2) The increase in forest caused by changes from barren into forest, while the decreased agricultural land is due to the increased residential areas.

(3) The result of land use change can be further utilized for the Curve Number (CN) which can be finally analyzed against floods.

References

(1) M. Hiroshi (2008) : Study on Land use change in Jobaru watershed by using GIS, Saga University, Japan (in Japanese).
(2) ESRI (2009): Arc Hydro Geoprocessing Tools – Tutorial. Version 1.3, ESRI 380 New York, USA.
(3) US Army Corps of Engineers (2009) : HEC-GeoHMS Geospatial Hydrologic Modeling Extension. User`s Manual version 4.2, Davis, USA.