THE WETLAND DISTRIBUTIONS OF THE KIYA RIVER USING REMOTE SENSING

MUROOKA M.[1], HARUYAMA S.[2], YAMAGATA K.[3] AND KUWAHARA Y.[1]
[1]*Hokkaido Abashiri Fisheries Experiment Station, Japan*
[2]*Mie University, Japan*
[3]*Joetsu University of Education, Japan*

ABSTRACT

The wetlands on the floodplain of the Kiya River basin produced big volume of Fe. The underground water in the open well in this river floodplain contained NO_2 and NO_3, and it was probably induced by the agricultural fertilizer. Because the heaps of *Calex* spp. were tall and the dead shell of the river were found, much water often flows the wetland on the lower terrace of the alluvial fan of the middle reach of the Khor River. In the view of geomorphology, the base rocks are usually found on the wetland landscape of the floodplain of the Kiya River, and the peat layer of surface was very thin. After analyzing precipitations and floodplain morphology of the Kiya river, the wetland areas enlarge using remote sensing data, however, there were sometimes large wetlands on the terrace.

I OBJECTIVE

The Kiya River is one of the important branch rivers of the Ussuri River in Russia. There is wetland along the Kiya River floodplain and wetlands in this flood plain are considered to be playing important role of producing dissolved iron flowed into the Amur River. The authors conducted a basic research of the area of the Kiya River and to identify 1) the wetland morphology, 2) wetland vegetation, and 3) seasonal changes of wetland.

II KIYA RIVER

The Kiya River is on the middle reach of the Amur River (Fig. 1). The length of the Kiya River is 173 km, the basin area is 1290 km^2 and the discharge is 11.2 m^3/s. The length of the Khor River is 453 km, the the basin area is 24700 km^2 and the discharge is 386 m^3/s.

The Kiya River is located on 30 km above the point of the river junction of the Amur River and the Ussuri River. The Khor River whose width is larger than Kiya is near Kiya River. The flora was mapped out by Soviet Academy of Sciences. The lower reach of the Kiya River was the bush of *Betula* and other kind of low trees, or the glassland containing *Salix*, or the forest of oaks and cedars and other trees. The area between the Kiya River and the Khor River in the lower reaches consisted of the forest of the cedars and other kind of tall trees and low trees. The area of the lower reach of the Khor River consists of glassland, pond of wetland, and the forest with *Salix*, *Betula*. The middle reach of the Kiya River consists of the peat wetland of *Larix kaempferi* and sphagnum, mixed area of glass, bryophyte, pond and bush on the slightly high land, the forest of the cedars and other kinds of tall and low trees

(Soviet Academy of Sciences, 1968). Density of population is not high around the Kiya River. There are some small towns or the villages such as Marcino Town, Georgiyevka Village, Ekaterinovka Village. The land cover is almost natural in this area except for some crop lands and pasture lands. The Khor area is famous for lumber sawing and many people had been immigrated contrarily (Slapanov, 1966)

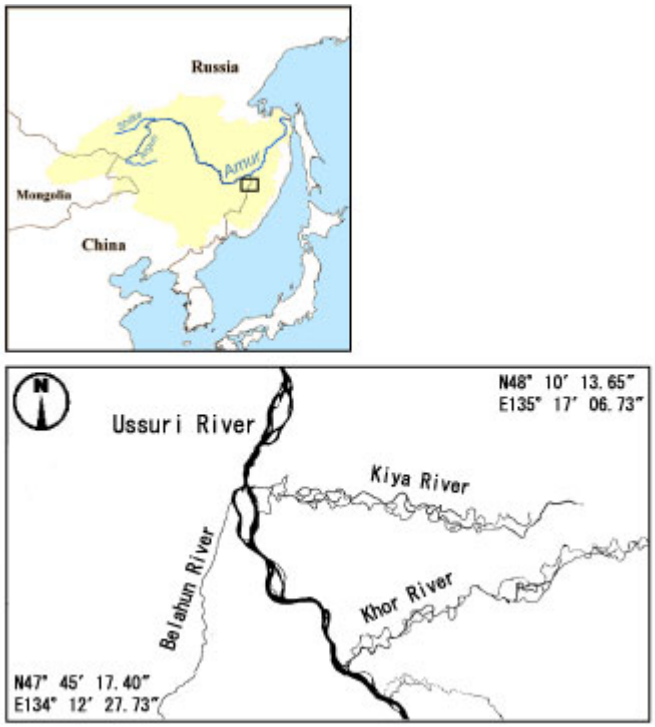

Fig. 1. The Study area.

III DATA AND METHOD

1. Identify Landform of the Kiya River flood plain

The landform map was made using JERS-1/SAR data and SRTM data. SRTM (Shuttle Radar Topography Mission) were 100m mesh elevations from the home page (http://www2.jpl.nasa.gov/srtm/). JERS-1 was launched by NASDA from 1992 to 1998. SAR (Synthetic Aperture Radar) can observe when the weather is rainy, JERS-1/SAR used L-band, which was most capable of observing soil water.

2. Analysis of Submerged Area using remote sensing

The Kiya River is often suffered from floods. In this study, the submerged area map was described and compared with landform and flood pattern. The altitude map was identified as the bowl and the water was assumed to be poured, the submerged area map was made when the 33 – 40 m of altitude was submerged.

3. Fe analysis of the Wetland

Some points around the Kiya River were picked up for researching wetlands. The points were representative for some kinds of landforms in the middle and lower part of the Kiya River. The lowest reach of the Kiya River was inaccessible and army closed the road

gate because it was the border region. The upper reach of the Kiya River was inaccessible either owing to bad road condition in the mountainous district.

In the wetlands, the authors recorded vegetation. The heights of slightly elevated areas were measured with a hand level (Nobel K50-1560).

4. Examination of Water Quality Analysis

The water examination was conducted at some points of the Kiya River, the Khor River and water well. The water quality was examined by Digital Pack Test（Kyoritsu Chemical-Check Lab., Corp. DPM-MT）. The amount of Fe, Fe^{2+}, NO_2^-N (NO_2), NO_3^-N (NO_3) were measured. Measuring range of Fe was from 0.05 to 10 mg/L, that of Fe^{2+} was from 0.1 to 10 mg/L, that of NO_3 was from 0.2 to 10 mg/L and that of NO_2 was from 0.005 to 0.5 mg/L.

5. Wetland Distribution and Seasonal Change analysis

The wetland distribution was drawn by JERS-1/SAR. The method of Murooka *et al.* (2007) was used for drawing wetlands. NRCS (normalized radar cross-section) on each pixel of the JERS-1/SAR data were obtained. NRCS was used to make the SAR digital recordings independently of the equipment used. The linear transformation used was: NRCS [dB] = $10log_{10}(I^2)$ - CF, where I is the digital SAR value and CF is the conservation coefficient. Because SAR data in this study were processed after 2000, CF = 85.15 (Shimada, 2002). The available JERS-1/SAR data were 8 sheets, but the data of snow season were not used because covering snow decrease the reliability of the NRCS of JERS-1/SAR data. The wetland of mountainous area were not calculated either because the NRCS are not reliable on the slope area.

IV RESULTS

1. Landform Map and elevation pattern analysis

Fig. 2 shows the elevation map made by SRTM. Fig. 3 shows the landform map. The alluvial plain is the main landform in the study area. The Kiya River is flowing on the alluvial fan and the terrace. The slope was bigger in the Kiya River basin than in the Khor River basin. The floodplains were large in both Kiya River and Khor River basins. There were lower and upper terrace between the Kiya River and the Khor River. The several former river courses were traced on floodplain of the Kiya River. In the view of sediment of flood plain, there are alluvial fans along the Khor River and the out skirts of alluvial fan was dissected by the main Ussuri River. The main river course of the Khor and Kiya Rivers are showing braided river courses. Natural levees were developed in the Ussuri River.

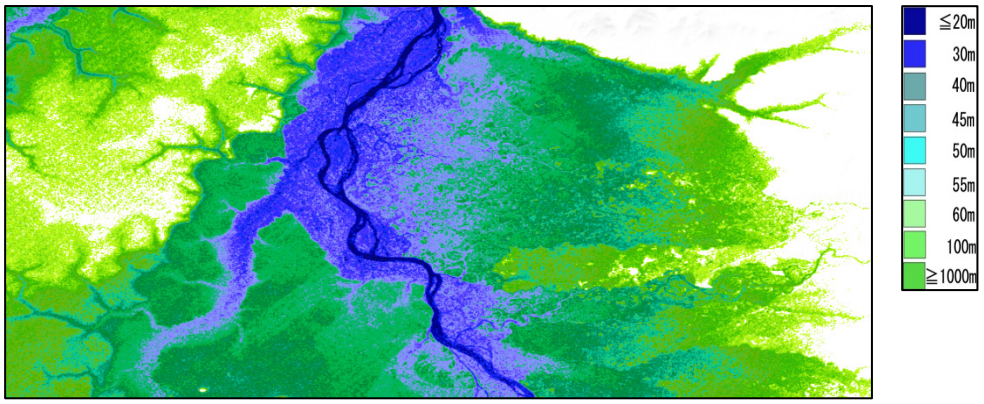

Fig. 2. Elevation Map made by SRTM data.

2. Submerged Area Map

The submerged area map was shown in Fig. 4. When the precipitation was small, the submerged area was distributed around the Ussuri River. The higher the water level grew up, the distribution of the water was expanded to the lower part of the Kiya River, Khor River and Belahun River in China. For example, higher water level +40m, the flood plain along the Ussuri River and the out skirt of alluvial fan formed by Kiya River are suffered by stagnation.

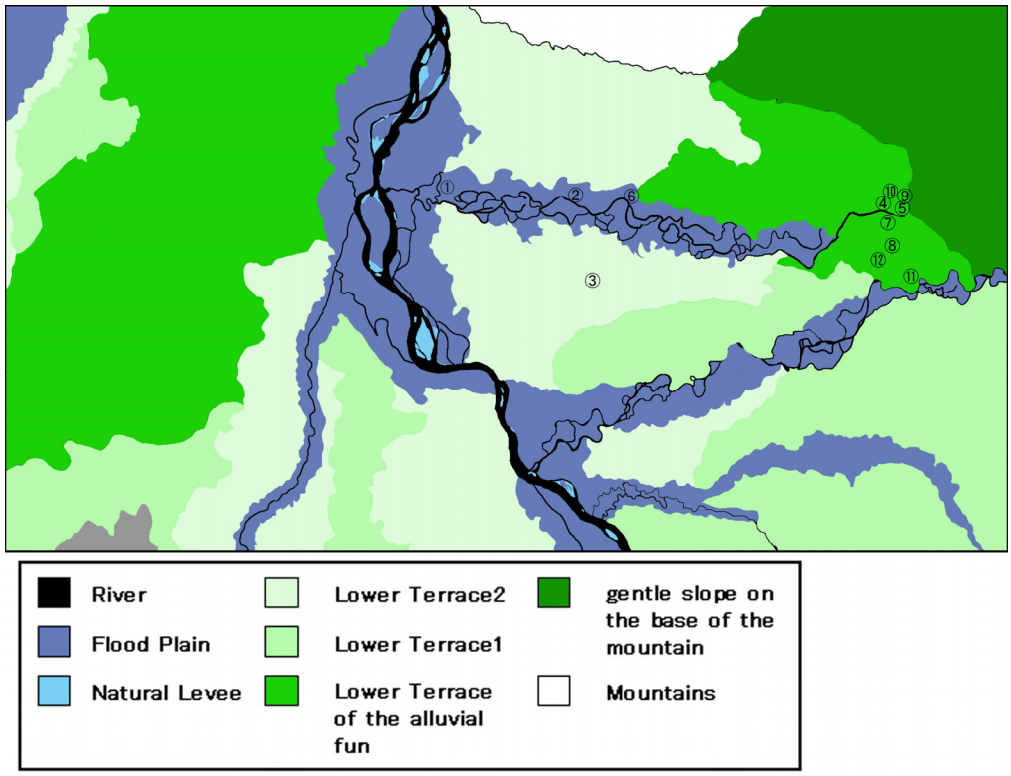

Fig. 3. Landform Map made by the SRTM data and the JERS-1/SAR data (the numbers in the circles are the research points of the wetlands which accord with those of Figure5 and the water examinations which accord with those of Table 1.).

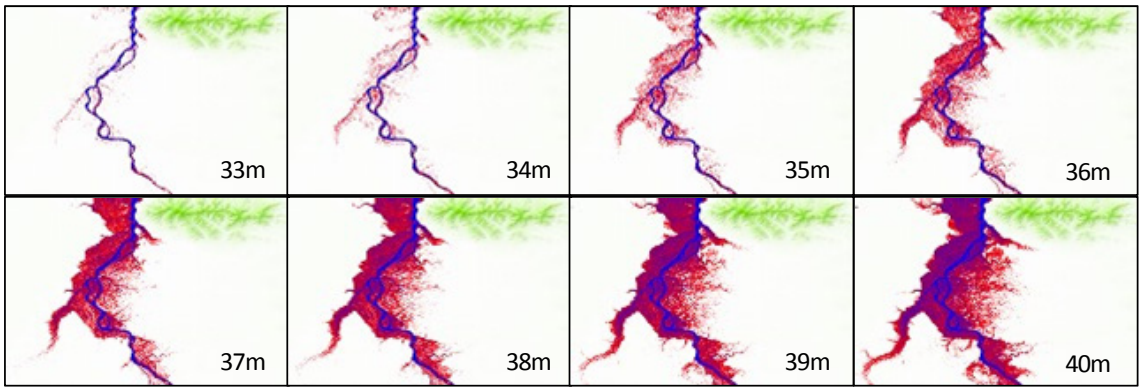

Fig.4. Submerged area map made by the SRTM data (the numerical characters located in the lower right shows the water- covered altitude.).

3. The Field Research in the Wetland

The details of the wetlands were shown in Fig. 5. On the wetland on the floodplain of the lowest part of the Kiya River, only *Phragmites* spp. were found (No. 1 in the circle). On the wetland on the floodplain of lower part of the Kiya River, not only *Phragmites* spp. but also *Artemisia* spp. were found and on the slightly high area, *Quercus crispula* were found (No. 2 in the circle). On the wetland on the lower terrace between the Kiya River and Khor River, *Calex* spp. were found among *Phragmites* spp. On the slightly high area, *Quercus Crispula* were found (No. 3 in the circle). On the wetland on the lower terrace of the alluvial fan of the middle reach of the Kiya River, some kinds of flora such as *Carex* spp.,

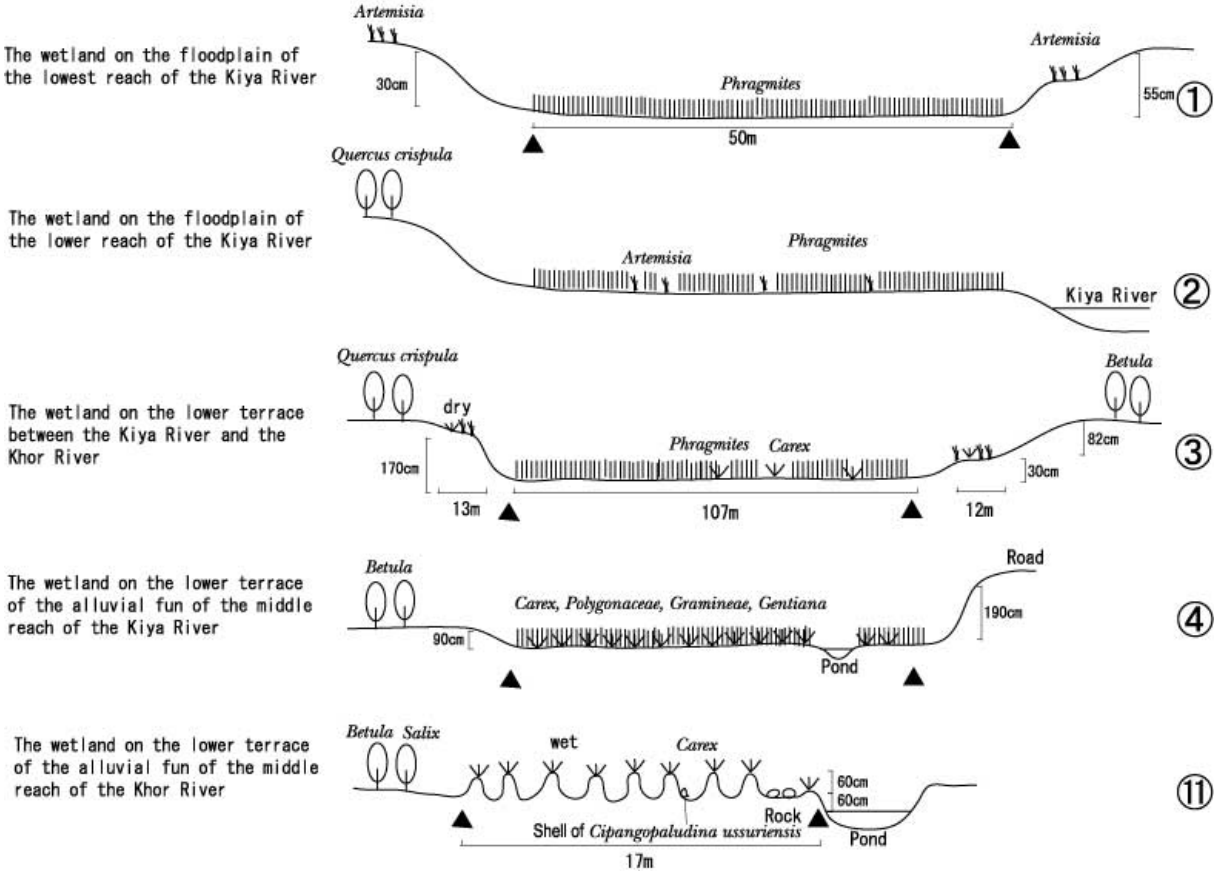

Fig.5. Cross-sections of wetlands on the selected research points. The numbers in the circles are the locations which accord with those of Figure 3. Wetlands are between the sets of two triangles.

Plygonaceae spp., *Gramineae* spp. and *Gentiana* sp. were found. On the slightly high area, Betura sp. were found (No.4 in the circle). On the wetland on the lower terrace of the alluvial fan of the middle reach of the Khor River, there were many small heaps of *Carex* spp. On the slightly high area, *Betula* sp. and *Salix* sp. were found. There was a shell of *Cipangopaludina ussriensis*. among the heaps of *Carex* spp. and big rocks near the pond (No. 11 in the circle).

4. Water quality Examination

The results of the water quality examination are shown in Table 1. The water derived from the wetlands of floodplains sometimes contained Fe and Fe^{2+}. The river water close to the wetland was contained Fe, but Fe was not detected in the river water not close to the wetland. Fe was detected in the wetland on the terrace. NO_2 and NO_3 were detected in the wells in Marusino Town and Vasil'evka Village.

5. Wetland Distribution and Seasonal Change

Fig. 6 shows the wetland distribution. The wetlands distribute along the Kiya River and the Ussuri River. In May 1995 when the precipitation was 55.9 mm/month the wetland was small. In the Aug. 1997 when the precipitation was 232.8 mm/month, the wetlands were large on the floodplain of the Ussuri River, the Kiya River, the Khor River and the Belahun River. Comparing between the Sep. 1992 and Sep. 1996, the precipitations are 120.9 mm/month and 147.9 mm/month respectively, the wetlands on the floodplains were larger in Sep. 1992, but the wetlands on the terraces were larger in Sep. 1996.

Table.1. The results of the water examinations. The numbers on the left side are the locations which accord with those of Figure 3.

No. in the map	Location	Latitude	Longitude	Depth (m)	Fe (mg/l)	Fe2+ (mg/l)	NO2 (mg/l)	NO3 (mg/l)	Detail
2	Kiya River	47° 59′ 52.34″	134° 47′ 20.42″		under	under	under	under	Not close to wetland
2	Kiya River	47° 59′ 51.57″	134° 47′ 24.44″		0.13	0.14	under	under	Close to wetland
3	Wetland	47° 56′ 00.52″	134° 52′ 02.92″		0.41	0.31	under	under	Wetland on the terrace between the Kiya River and the Khor River
4	Kiya River	47° 58′ 41.97″	135° 25′ 33.13″		under	under	under	under	Not close to wetland
5	Kiya River	47° 58′ 23.28″	135° 27′ 14.25″		0.10	0.15	under	under	Close to wetland in Marusino
6	Kiya River	47° 58′ 18.33″	135° 04′ 55.55″		0.06	under	under	under	Neighboring to wetland in Georgiyevka Village
7	Wetland	47° 58′ 16.10″	135° 25′ 51.27″		0.28	0.18	under	under	Old river course of the Kiya River
8	Blushka River	47° 54′ 21.72″	135° 27′ 28.08″		under	under	under	under	Old river course of the Khor River
9	Well	47° 58′ 20.11″	135° 27′ 28.54″	5～6	under	under	1.64	0.017	Marusino Town
10	Kiya River	47° 57′ 22.27″	135° 07′ 30.97″		under	under	under	under	Ekaterinovka Village
11	Khor River	47° 51′ 33.48″	135° 30′ 30.31″		under	under	under	under	
11	Wetland	47° 51′ 22.04″	135° 30′ 29.61″		under	under	under	under	Near the Khor River
12	Well	47° 53′ 26.34″	135° 27′ 53.80″	2.8	under	under	2.05	0.012	Vasil'evka Village

V CONCLUSION

The wetlands on the floodplain of the Kiya River produced Fe.

The water in the well contained NO_2 and NO_3, it was probably by the agricultural chemicals (Table 1).

Because the heaps of *Carex* spp. were tall and the dead shell of the river were found, much water often flows the wetland on the lower terrace of the alluvial fan of the middle reach of the Khor River. Because the rocks were found on the same wetland, the peat layer of surface

was thin (Fig. 5).
When the precipitations increase, the wetland areas enlarge from the floodplain theoretically (Fig. 4). But actually, there were sometimes large wetlands on the terrace (Fig. 6).

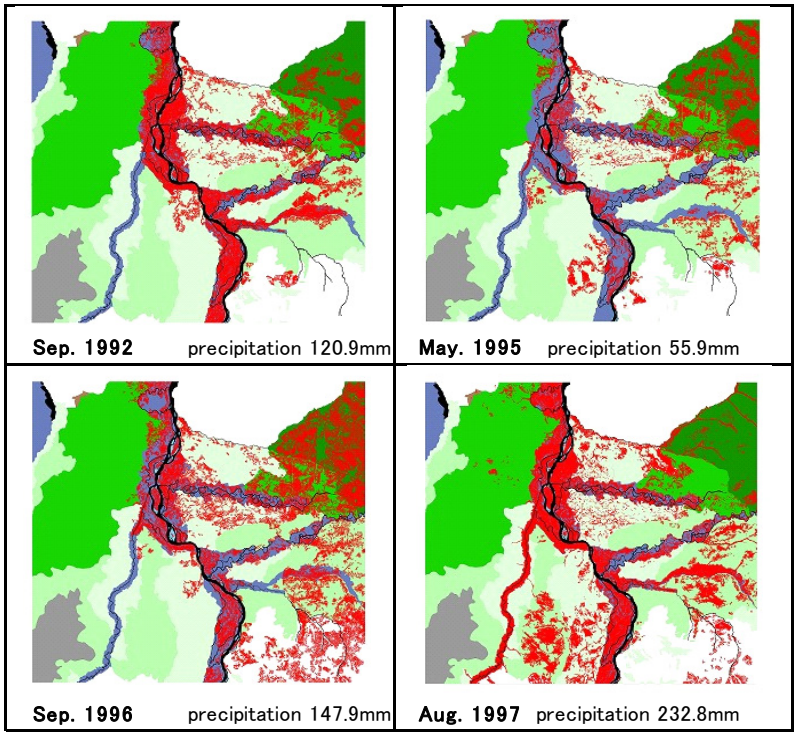

Fig.6. The map of the wetlands distributions. The precipitation is monthly.

In the Fig. 6, There was little wetland in the Chinese region, especially the area in the west of the Belahun River. It was because the wetland in China had been cultivated. The wetlands on the floodplain increased and decreased very much but there were always wetlands on the lower terrace between the Kiya River and the Khor River. The results of the sediment research, the clay covered all over alluvial plain in this study area. It was thought the layer of clay blocks the surface water into the underground. Though the higher the rain fell, the larger the wetland distributed, wetlands did not spread throughout the floodplains when the precipitation was very high, like Aug. 1997, in the Kiya River and Khor River area. It was thought that because the Kiya River and the Khor River were on the alluvial fan, the area has a steep slope and the wetland water easily flowed down to the lower reach of the rivers.

REFERENCES

Slapanov (1966): Khabarovsky City, Progress publishing company, Moscow.
Soviet Academy of Sciences (1968): The Vegetation Map of Amur River Basin.
Murooka, M., Haruyama, S., Masuda, Y., Yamagata K., Kondoh, A (2007): Land Cover Change Detected by Satellite Data in the Agricultural Development Area of the Sanjiang Plain, China, Journal of Rural Planning, Vol.26, 197-202.