# Agricultural Land-use Survey by LANDSAT

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## 1. Introduction

The traditional agricultural land-use surveys in Japan have put a stress on the understanding of the evolution in farming systems under the circumstances of rapid economic growth. Therefore, the surveys have been relatively intensive and designed in close relation to the evaluation of land productivity as well as to the improvement of farm business.

Remote sensing itself never replaces that kind of intensive surveys, nor can it show its full capability by itself alone. Its large scope of observation with constant accuracy through each scene contributes to situate the results of intensive on-farm research in the regional framework. Especially its repeated observations at short intervals are effective for the cropping pattern analysis.

On the other hand, it is often mentioned that the resolution of LANDSAT MSS is not so high as to catch the clear image of patched land-use in Japan. Figure 1 serves as a test case for the evaluation of MSS imagery (Satoh, 1986). (a) shows the distribution of wet-rice fields identified by aerial photo, while (b) is generated through digital image processing of LANDSAT MSS data which was acquired one month after the aerial photo had been taken. Insofar as making a comparison between these two images, LANDSAT MSS imagery seems reliable enough to illustrate the general pattern of wet-rice field distribution, although it seems impossible to calculate the area under wet-rice cropping.

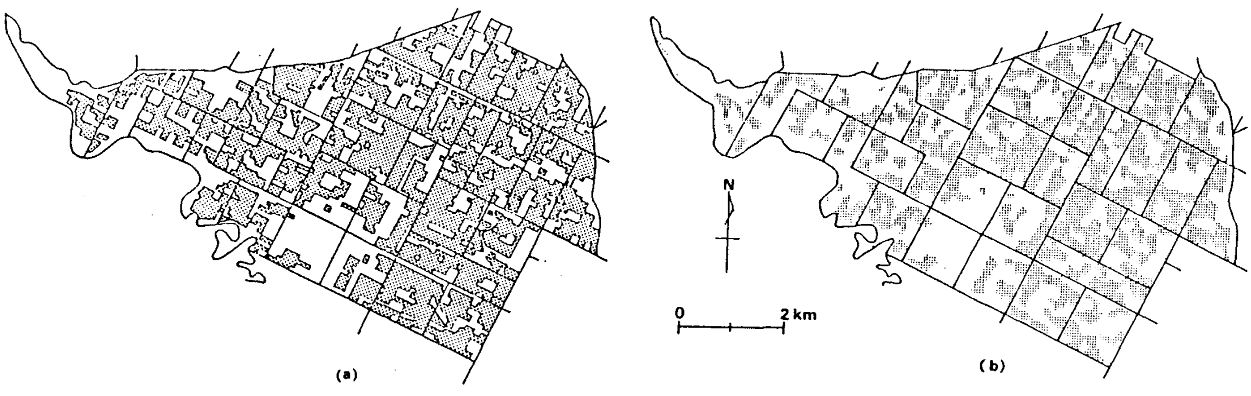


Fig. 1. Distribution of wet-rice fields in a test area of Naganuma (after Satoh, 1986). The distributions of wet-rice fields are identified by aerial photos (a) and LANDSAT MSS data (b).

This article presents a study on the distributions of wet-rice fields on a large scale. Due to the overproduction of rice, a considerable part of wet-rice fields in Japan has been diverted to dry field cultivation by government programs. The conditions of this wet-rice conversion are discussed with an application of LANDSAT MSS data analysis.

## 2. Land-use for wet-rice cultivation in Japan

The cultivated land in Japan is primarily classified into two categories. One is the bunded field (*Ta*), and the other is the unbunded field (*Hatake*). The bunded field is regarded as the field essentially prepared for wet-rice cultivation, no matter what crop may be grown there. All the wet-rice fields in Japan are bunded, and conversely, almost all the bunded fields had been utilized for wet-rice cultivation until 1970 when the government set up the program of reducing rice production.

The government policy of reducing rice production has experienced two stages. At the first stage from 1970 to 1975, only production quota was adopted, and the quota was almost equally shared among regions at the rate of about 20 percent reduction. At the second stage since 1978, land quota has been adopted as well as production quota, and thus the quota allocation system is dual at present.

The land quota is distributed to every village through the government administrative channel according to the past achievements of reduction and "regional indices" indicating suitability for rice cultivation. On the other hand, the production quota is applied only to the amount of rice sold to the government. Because the government rice is decreasing its share, the land quota is essential to the conversion of wet-rice fields.

The effect of the production adjustment policy on a local farming area is not always the same. It must be analyzed with a careful consideration on the application rules. Shogenji (1984) mentioned that production adjustment policies can lead the concentration in the more productive area, while Bowler (1986) suggested that "allotment programmes can fossilise patterns of production and obstruct the evolution of farming systems".

In the case of recent wet-rice conversion program, the wide range of yield variation within a municipal territory can promote the conversion because the incentive pay is calculated for every municipal unit on the basis of average wet-rice yield. It is often said that farmers' adherence to continuous single cropping of rice is still prevalent because it is the most efficient and convenient way of land-use for part-time farmers. Under such conditions, the conversion will be started beginning with the fields where yield is relatively low in a municipality, and on the contrary, the conversion quota will be accepted reluctantly in the municipality with uniformly high-yielding wet-rice fields.

## 3. Change of agricultural land-use in the lower Ishikari Valley

The study area is located in the lower part of the Ishikari Valley, including 15 municipalities (Fig. 2). The alluvial plain is one of the typical rice growing areas in Japan. The total paddy fields in the study area amount 66 thousand hectares and it is about a quarter of all paddy fields in Hokkaido as of 1985.

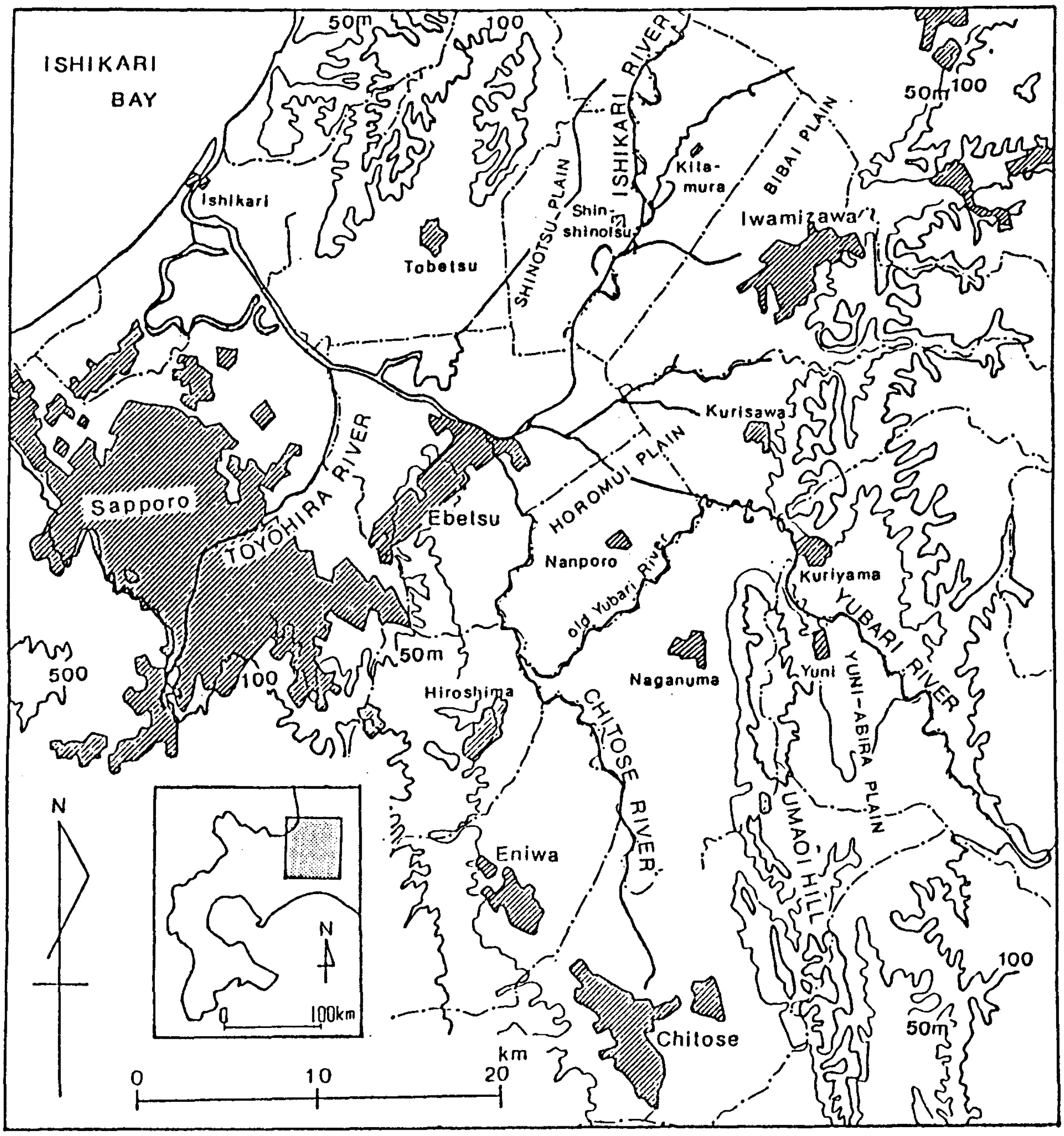


Fig. 2. Land configuration and municipalities in the studied area.

Hokkaido is regarded as unsuitable for rice cultivation. Although its productivity of rice in average year is not necessarily inferior to that of other parts of Japan, the yield is unstable due to the cool damages. Therefore, the reduction quota assigned to Hokkaido is relatively large so that the retreat of rice cultivation has been observed since 1970 (Okamoto, 1981).

Table 1 shows the land-use change in this area since 1960. With regard to the bunded fields, they were expanded by the reclamation from unbunded fields in the 1960's, but some of them have been diverted to dry field cultivation throughout the 1970's and the 1980's. In this study area, the percentage of area planted to wet-rice has decreased to 62 percent of total bunded fields.

Table 1 Land-use in the study area (in ha)

| | 1959/60 | 1964/65 | 1969/70 | 1974/75 | 1979/80 | 1984/85 |
|---|---|---|---|---|---|---|
| bunded field | 42,639 | 57,878 | 70,571 | 65,282 | 67,226 | 66,290 |
| area planted to wet-rice | 42,570 | 57,684 | 70,184 | 42,311 | 45,683 | 41,032 |
| (%) | 99.8 | 99.6 | 99.4 | 64.8 | 67.9 | 61.8 |
| unbunded field | 50,718 | 35,279 | 24,482 | 22,541 | 22,203 | 22,780 |
| DID* area | 5,920** | 8,420** | 14,170 | 18,290 | 22,960 | 24,900 |

source: Agicultural Census, Population Census
*DID: Densely Inhabited District (defined by Population Census)
**DID area in 1960 and 1965 excludes Chitose airfield

In order to verify the relation between yield and conversion of wet-rice fields, distributions of wet-rice fields and "high-yielding" wet-rice fields are identified through digital image processing of LANDSAT MSS data acquired on September 19 in 1980, and on June 24 in 1985. Both land-use classification and crop estimation are possible because the rice growing season in this area is standardized due to the restriction of climate, and also because the greater part of the converted fields are planted to wheat sown in the autumn.

The process of classification is shown in Figure 3. The class of "high-yielding" wet-rice fields is also defined with spectral signatures of LANDSAT MSS data, and its spectral characteristics are estimated with the samples of wet-rice fields located within the municipalities whose record of yield in 1980 is 4,000 kg or more per hectare in husked rice. The final output is prepared through smoothing process because the original image generated by pixel-by-pixel classification is too intricate to recognize its spatial pattern.

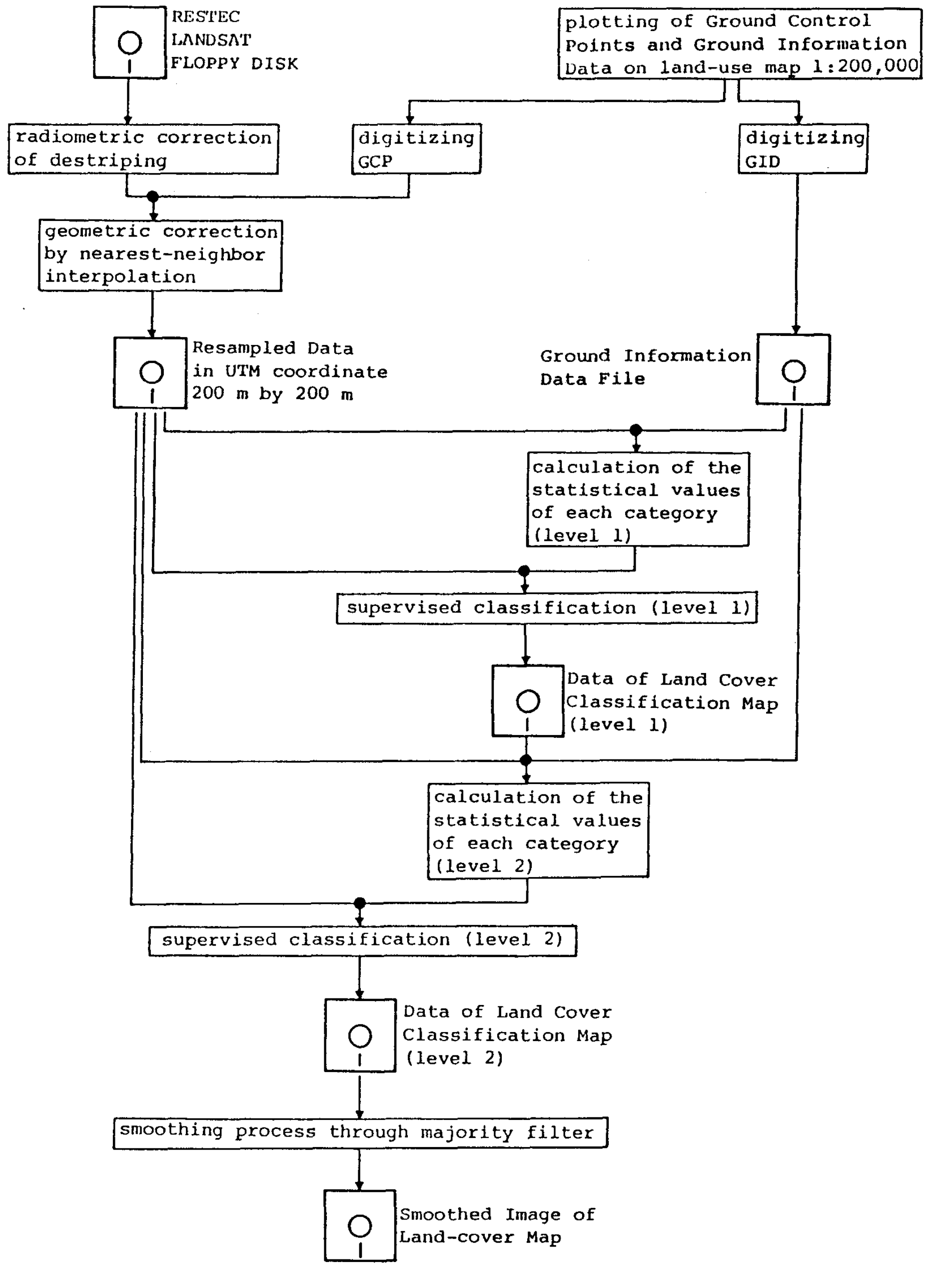


Fig. 3. Process of land-cover classification adopted in this study. The original data is provided by the Remote Sensing Technology Center, Japan, and processed with a micro-computer.

Figure 4 is compiled through overlaying the wet-rice distribution in 1980 on the land-use map in 1982 by the Geographical Survey Institute. And Figure 5 shows the conversion of wet-rice fields from 1980 to 1985.

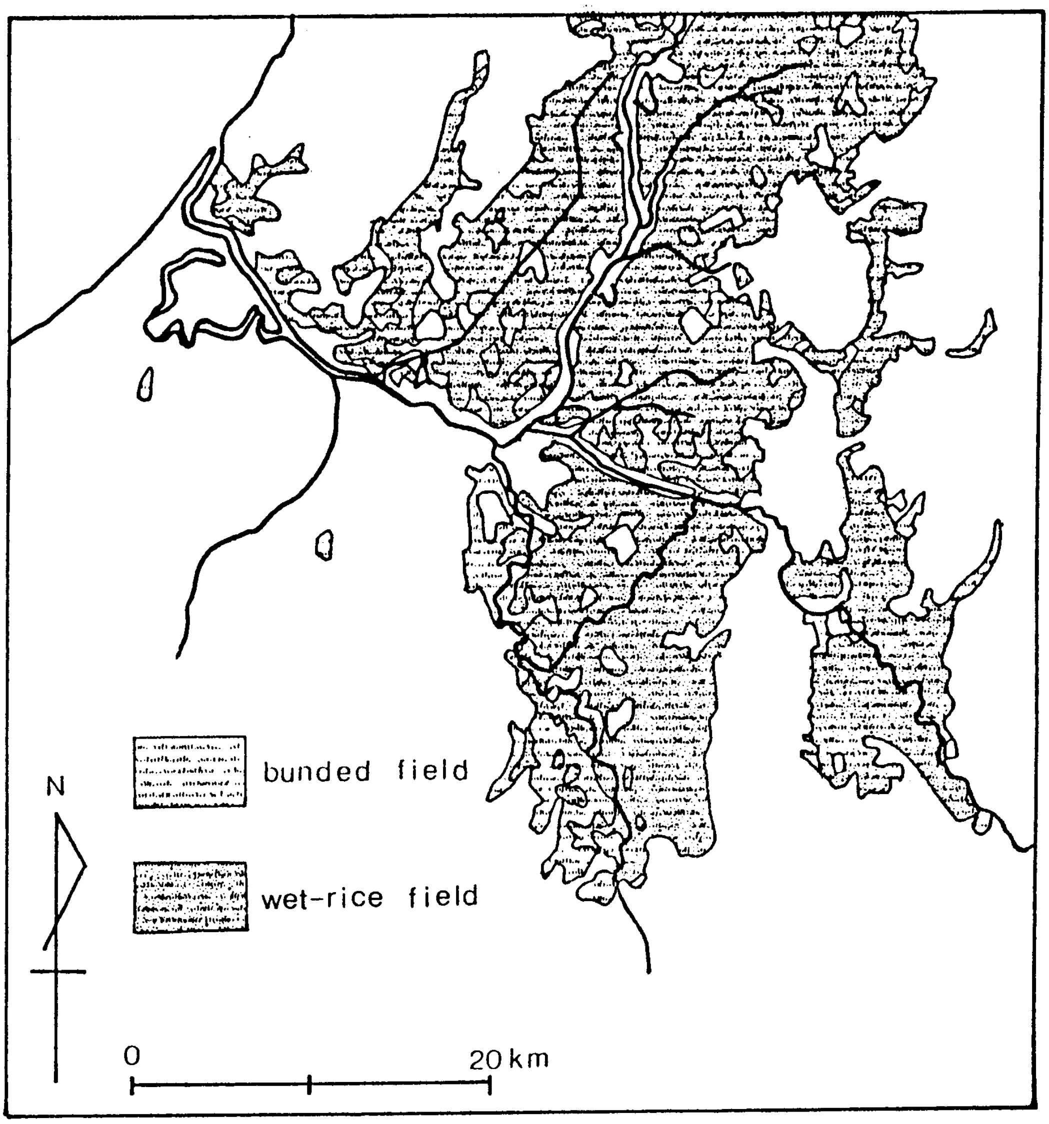


Fig. 4. Distribution of bunded fields and wet-rice fields in the study area in 1980. This map is compiled from land-use map by the Geographical Survey Institute and digital processed image of LANDSAT MSS data.

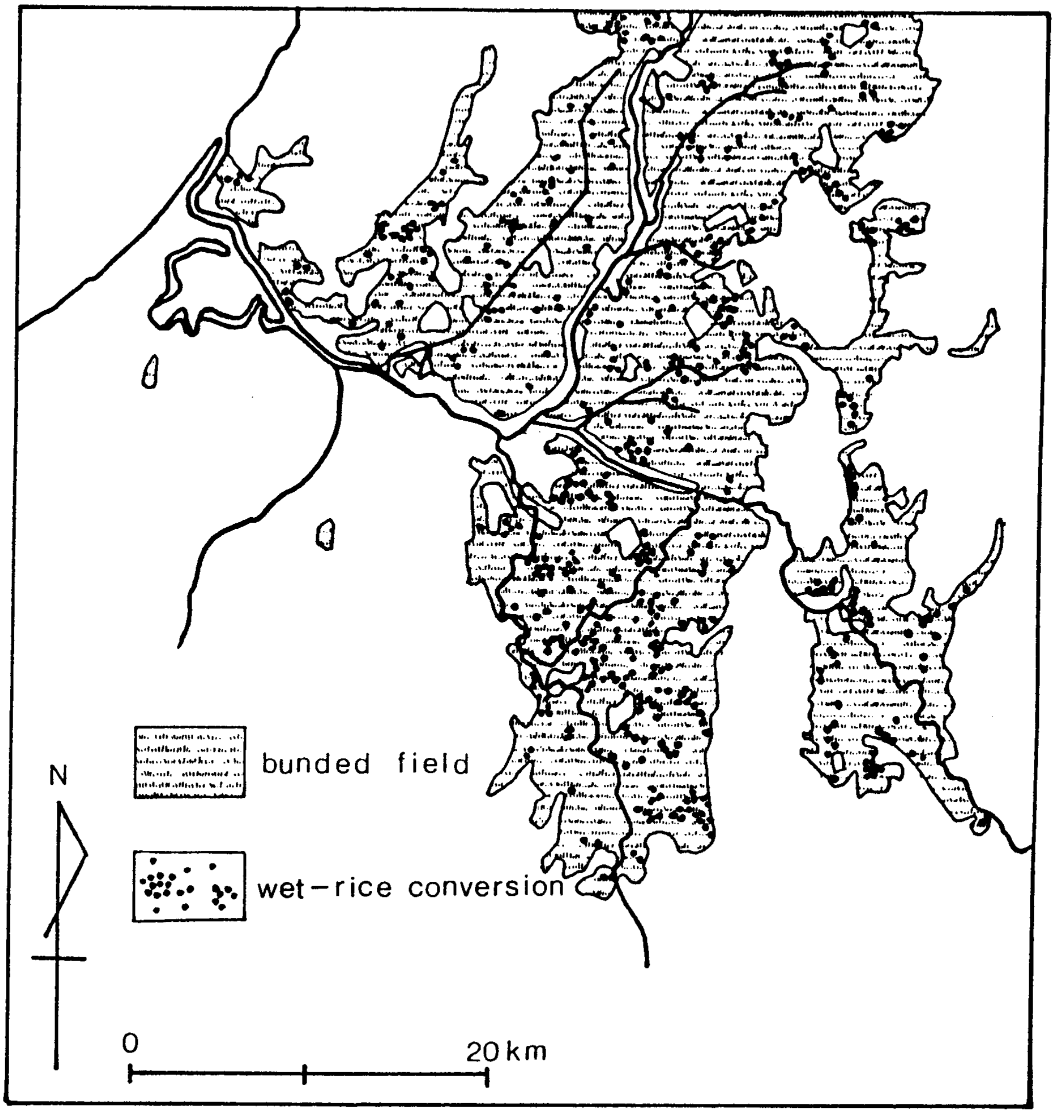


Fig. 5. Distribution of converted bunded fields from wet-rice between 1980 and 1985. This map is compiled from two images of wet-rice field distribution in 1980 and 1985 generated through digital image processing of LANDSAT MSS data.

According to the figures, the bunded fields converted into dry field cultivation at the early stage are mainly distributed on the western side of the Chitose River and around the junction of the three big rivers. Recent conversion of the wet-rice fields is in progress in the central part of the plains in Iwamizawa, Kuriyama, Yuni, and Naganuma. These areas are characterized by the gradual change of agricultural land-use. The northern part of the study area seems less responsive to the conversion program.

As shown in Figure 6, the "high-yielding" wet-rice fields are mainly located in the northern and the southwestern part of the study area. Only small part of this "high-yielding" wet-rice fields has been converted up to 1985. On the other hand, the central part of the study area around the Horomui Plain records poor yield in 1980, being seriously attacked by the cool damage. The strong southerly wind in the summer season flows through this area. The quick response to the conversion there reflects this unfavorable condition for wet-rice cultivation. In conclusion, the level and stability of wet-rice yield per hectare can be regarded as one of the important factors of conversion under the present production adjustment system.

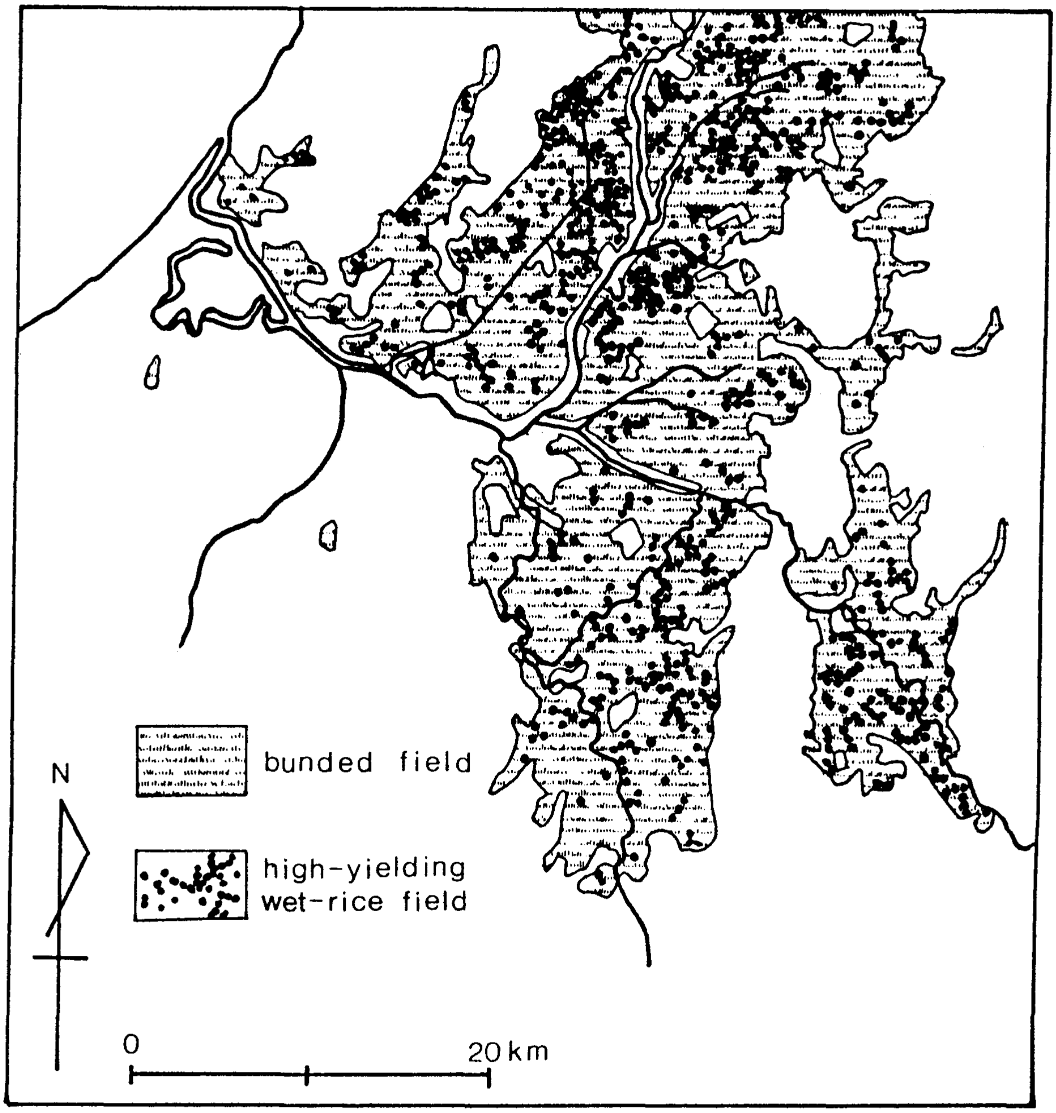


Fig. 6. Distribution of high-yielding wet-rice fields in 1980. Crop estimation here is based on the data of the Crop Statistics and LANDSAT MSS spectral signatures. The yield of wet-rice is poor in 1980 due to cool damage.

## 4. Prospects

Much more information on agricultural land-use is available than ever, owing to the development of new earth observation systems. LANDSAT TM produces images with extended spectral range and additional spectral bands including thermal infrared band. SPOT employs *high-resolution visible* system with off-nadir viewing function. And the increasing number of missions provides more opportunities of image acquisition.

The important thing for geography is not how to get a good quality image, but how to utilize the data in a regional framework. In this respect, LANDSAT MSS data is still helpful to inspire the idea of analysis though it looks out-of-date among the improved systems. It is equipped with basic function of satellite remote sensing, and its accumulation of data surpasses that of others.

With regard to land-use survey, it is necessary to revise the land-use classification system. A category of land-use is usually defined by a functional combination of land pieces. In the case of aerial photo interpretation, the identification of land-use depends on spatial patterns of land-cover, or ultimately pixels. The same method can hardly apply in the case of satellite remote sensing because of its poor resolution. Instead, the information on the multi-seasonal succession of land-cover in a area can serve an important attribute for the identification of land-use.

The information on local cropping patterns is essential to identify the fields and to interpret the features of land-use by remote sensing. From this viewpoints, the traditional intensive land-use surveys by geographers can certainly contribute to develop more realistic and fruitful applications of remote sensing to the field of farming systems research.

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