Article ID: 100226819(2001)0120159204

Integration of GIS and TM Data to Extract Early Rice Area in Longyou County

Huang Jingfeng, Ahmad Yaghi, Wang Renchao
(*Institute of Agricultural Remote Sensing & Information Application, Zhejiang University, Hangzhou* 310029, *China*)

Abstract: This paper introduces the methodology of integrating GIS and TM data for estimating the early rice planted area. It overcomes static disadvantage of GIS and enhance the classification results of TM image. Land use map and town boundary map were digitized then transferred to raster format and opened in ENVI image analysis system. TM image, land use map and town boundaries map were registered to the same projection. Utilizing of mask utility, the study area, every land using type and every town TM images were established. Supervised and unsupervised image classification were applied to the study area TM image and to the paddy field TM image. And the early rice areas were calculated by each method. Using the proposed methodology improved the quantitative accuracy of early rice area estimated up to 93.98%, whereas it was 82.83% when image classification was used only. The extracted information from the classification is belonging to the early rice and not to any other vegetation. Since the GIS database is available, the method is easily applicable to any new RS images.

Key words: GIS; RS; early rice; area estimation
CLC number: S127 **Document code**: B

1 Back Ground

Rice is an important cereal crop and is cultivated in extensive areas in many countries[1]. It is one of the most important cereal crops in China. Estimation of cultivated area contributes directly in yield forecasting which may very helpful in decision2making on planting, marketing and transportation requirements.

Remote sensing techniques are extensively used for the identification of land usage and land cover over large area. Satellite based on remote sensing techniques could be effectively used in estimating the crop area and accurate assessment of the dynamic crop characteristic. By visually and digitally TM image analysis to estimate the rice cultivated area, the accuracy classification was over 90%[2]. The band combination of 1, 3, 4 and 5 was selected as an appropriate subset in the digital analysis for the estimation of the cultivated of rice area. Rice2cultivated area in the plain rice cultivation area was estimated by the comprehens2ive visual interpretation of TM image. The accur2acy of quatitative interpretation was 93.9%[3]. Stepwise classifier was applied to TM data to estimate the rice area cultivation in the plain region. The accuracy of 97.04% was obtained[4].

There is an increasing interest on introducing GIS and multi2temporal information into systems for agricultural evaluation purpose. Janssen et al[5] observed an improvement of more than 12% in overall classification accuracy of agricultural fields when integrating topographical data from GIS into landsat TM classification. Middelkoop and Janssen[6] included temporal and expert relationships in their expert classification system and observed an improvement over the traditional classification, mainly in areas where there were high spectral overlaps among classes.

This paper will introduce the alternative method that integrates GIS and TM data to increase the classification precision for accurate estimation of early rice planted area. The location of paddy field was defined by GIS. The temporal

Received date: 2000210227
Foundation item: Funds from the National Defense Scientific and Technological Committee of China (Y97# 142622)
Biography: Huang Jingfeng, male, associate professor.

information about the early rice in a specific time in this area was extracted by RS.

2 Materials and Methods

2.1 Study Area

Longyou County is selected as study area. It is geography located at 119°02′E to 119°20′E and from 28°44′N to 29°17′N with east west width of 29.37 km and north south width of 61.50 km. It covers about 1138.72 km^2. The regional terrain belongs to hill and basin region of middle Zhejiang, high land zone in the north and south, low land in the middle. The middle area along Qujiang River is the flat plain. The area is characterized by mid tropical climate with an annual average temperature of 17.3℃, and annual precipitation of 1631.7 mm.

2.2 Materials

RS Data: TM data for the study area was acquired on Jun 5, 1997 corresponding to the early rice planting season (booting stage).

GIS Data: Longyou 1∶50000 land use map in 1997 provided by Longyou County Land Use Bureau.

Statistical Data: Agriculture statistical report for the study area in 1997 was provided by Longyou Statistical Bureau.

2.3 Methodology

The land use map was digitized in four layers as land use, town boundaries, streams and road and their coverages were established in ArcöInfo 7.1.2 workstation version. Then land use coverage and the town coverage were polygrided into 30 m by 30 m pixel size using polygrid command. Using the function of GRIDIMAGE in ArcöInfo the landuse raster data were obtained.

At the ENVI image analysis system, registration of image versus land use map and town boundaries map was done and transformed to UTM (Universal Transverse Mercator) projection at 1∶50000 scale. The best three-band combination selected by using the Optimum Index Factor (OIF). The combination 1ö4ö5 (OIF = 45.590) was used to perform all the classification methods in this research. The raster land use map and town boundaries map were registered into the same projection like TM image. Utilizing from mask utility in ENVI. The mask of the study area was built. Then it was used to extract the TM study area image (called Longyou TM image). The mask of paddy field was also built. Combined with TM data, the TM image of paddy field (called paddy TM image) was created. IsoData Unsupervised and parallilepiped and maximum likelihood supervised classification were applied to Longyou TM image and the area of early rice was calculated. Then the paddy TM image was classified by parallelepiped. And maximum likelihood supervised classification and the early rice area was also extracted.

3 Result and Discussion

3.1 Area Estimation by TM Data

IsoData Unsupervised classification method applied to Longyou TM image. It just classified the land use type into four types as water bodies, forest, planted area and unplanted areas with 48.6351, 641.2833, 264.9744, 201.6387 km^2, consequently. Comparing with the area calculated from land use map, the water bodies and forest accuracies were 45.49% and 131.01%, consequently. This result indicates that the unsupervised classification is very poor method for crop area estimation.

Two supervised classification methods, parallelepiped and maximum likelihood, were used to classify Longyou TM image. They classified the land use type into seven classes as early rice, cropped area, forest, garden, unplanted area, urban and water bodies. Parallelepiped method was better than the maximum likelihood. The quantitative accuracy was 82.83% and 59.95%, consequently (Tab.1).

3.2 Area Estimation by Integration of GIS and TM Data

Although the quantitative results of the

parallelepiped classification (using Longyou TM data only) seemed good but it is difficult to guaratee that the results obtained is really belonging to the early rice and not to another vegetation type. To express the idea, the mask of early rice obtained from the classification was built. It used with masks of each town to calculate the area of early rice in each town. The results were compared with the statistical results. Results showed miss2classification in some towns and over2classification in some other towns. Towns located in the plain area were miss2classified (quatitative accuracy was 65.89%), where as towns located in the mountain area were over2classified (quatitative accuracy was 150.32%). For example, the extracted early rice area in Xiaonanhai town was miss2classified with error - 47.67%, whereas over2classified in Linshan town where the error was + 104.91%. This makes the results of this classification doubtful (Tab. 2).

Tab. 1　Quantitative results of parallelepiped and maximum likelihood classification of Longyou TM image

Land use type	Parallelepiped			Maximum likelihood		
	Pixels (30 m × 30 m)	Area (km^2)	Accuracy (%)	Pixels (30 m × 30 m)	Area (km^2)	Accuracy (%)
Early rice	145666	131.0994	82.85	105381	94.8429	59.94
Cropped area	19272	17.3448	—	160866	144.7794	—
Forest	673652	606.2868	123.86	547108	492.3972	100.60
Garden	146868	132.1812	187.42	304481	274.0329	388.56
Unplanted area	240246	216.2214	—	56496	50.8464	—
Urban	14210	12.7890	26.453	64707	58.2363	120.46
Water	45120	40.6080	183.54	45996	41.3964	187.10
Total	1285034	1156.5306	—	1285035	1156.5315	—

Tab. 2　Qualitative results of early rice area derived by parallelepiped classification in Longyou and paddy TM image

	Town name	Statistical data (km^2)	Longyou TM image (TM only)			Paddy TM image (GIS & TM)		
			Area (km^2)	Accuracy (%)	Error (%)	Area (km^2)	Accuracy (%)	Error (%)
Plain area	Longyou	14.9753	11.1528	74.47	- 25.53	12.8628	85.89	- 14.11
	Zhanjia	12.9793	10.5705	81.44	- 18.56	13.3758	103.05	+ 3.05
	Hengshan	12.6000	6.0129	47.72	- 52.28	11.9079	94.51	- 5.49
	Dashi	15.2273	11.1258	73.06	- 26.94	15.7923	103.71	+ 3.71
	Xiaonanhai	18.5760	9.7200	52.33	- 47.67	16.7472	90.16	- 9.84
	Huzhen	24.6160	16.0902	0.00	- 34.64	23.9085	97.13	- 2.87
	Zhesui	8.1600	6.6195	81.12	- 18.88	8.1162	99.46	- 0.54
	Mohuang	8.1460	5.3028	65.10	- 34.90	8.9559	109.94	+ 9.94
	Lantan	7.6820	4.3488	56.61	- 43.39	8.0289	104.52	+ 4.52
	Shiyuan	3.5333	2.4093	68.19	- 31.81	3.5847	101.45	+ 1.45
	Total plain area	126.4952	83.3526	65.89	- 34.11	123.2802	97.46	- 2.54
Mountain area	Xikou	0.7893	1.8387	232.95	+ 132.95	1.0755	136.26	+ 36.26
	Zhetang	4.3000	1.6542	38.47	- 61.53	3.7305	86.76	- 13.24
	Guantang	2.2300	6.8202	305.84	+ 205.84	2.7180	121.88	+ 21.88
	Loujia	3.6080	5.3055	147.05	+ 47.05	1.8945	52.51	- 47.49
	Shifu	7.1667	11.3769	158.75	+ 58.75	7.2531	101.21	+ 1.21
	Sheeyang	3.2140	5.3073	165.13	+ 65.13	1.7766	55.28	- 44.72
	Linshan	5.0107	10.2672	204.91	+ 104.91	4.7241	94.28	- 5.72
	Miaoxia	2.6407	2.3994	90.86	- 9.14	0.9279	35.14	- 64.86
	Muchen	2.3600	1.5021	63.65	- 36.35	0.7479	31.69	- 68.31
	Wucun	0.0840	0.5499	654.64	+ 554.64	0.2601	309.64	+ 209.64
	Dajia	0.3413	0.6966	204.10	+ 104.10	0.3186	93.35	- 6.65
	Total mountain area	31.7447	47.718	150.32	+ 50.32	25.4268	80.10	- 19.90
	Overall total	158.2399	131.0706	82.83	- 17.17	148.7070	93.98	- 6.02

Parallelepiped and maximum likelihood supervised classifications were applied to paddy TM image and the early rice area were extracted. The quantitative accuracy in this method was enhanced up to 93.98%. As well as the special accuracy were also enhanced. Since the early rice is planted in the paddy fields and the results in this method is extracted from paddy TM image, the

areas considered as early rice is really belonging to early rice and not to any other crop. The percentages of the quatitative accuracy in the plain area and in the mountain area were enhanced to 97. 46% and 80. 10%, consequently. The error percentage in Xiaonanhai town and Linshan town as example in the TM image classification method only became - 9. 84 and - 5. 72, consequently (Tab. 2).

4 Conclusions

The introduced methodology is promising method. It enhanced the quantitative accuracy from 82. 83% in the TM image classification method to 93. 98%. It insured that the early rice area results extracted is belonging to the early rice and not to the non2early rice and others. The quatitative accuracy results in the plain and mountain area are 97. 46% and 80. 10% consequently.

It overcomes the static weakness of GIS. GIS as very helpful tool to define the locations where early rice existed simplifies the extraction of early rice by remote sensing technique. It also overcomes the weakness of RS and enhances the accuracy of area estimation than to the accuracy obtained from RS only.

The methodology is applicable, repeatable and fast, since the GIS database is available. It can be used anytime with new TM data to estimate the planted area of other rice season.

Vegetation indices of early rice obtained from the extracted results by this method can be used in any crop2monitoring model or in yield estimation with very low possibility of error.

References

[1] Ortiz M J, Formaggio A R, Epiphanio C N. Classif2ication of croplands through integration of remote sensing, GIS and historical database. Int J Remote Sensing, 1997, 18 (1): 95～105.

[2] Tennakoon S B, Murty V V N, Eiumnoh A. Estim2ation of cropped area and grain yield of rice using remote sensing data. Int J of Remote Sensing, 1992, 13 (3): 427～439.

[3] Wang C F, Wang R C, Liang J S. Accuracy analysis of rice2field information interpretation from TM image. J of Zhejiang Agricultural University, 1993, 19 (Supplement): 55～59.

[4] Jiang H X, Wang R C. Study of drawing rice2field information from TM Data using stepwise classifier. J of Zhejiang Agricultural University, 1993, 19 (Supplement): 61～65.

[5] Janssen L F, Jaorsma M N, Van der Linden E T M. Integration topographic data with remote sensing for land2cover classification. Photogrammetric Engineering and Remote Sensing, 1990, 56: 1503～1506.

[6] Middelkoop H, Janssen L F. Implementation of temp2oral relationship in knowledge2based classification of satellite images. Photogrammetric Engineering and Remote Sensing, 1991, 57: 937～945.

利用 GIS 与 TM 资料集成技术估算龙游县早稻面积

黄敬峰, Ahmad Yaghi, 王人潮

(浙江大学农业遥感与信息技术应用研究所, 杭州 310029)

摘 要: 提出利用 GIS 与 TM 资料集成技术估算中国南方丘陵山地早稻种植面积的方法。该方法首先利用 ARC/INFO 对土地利用现状图进行数字化, 建立拓朴关系后将其转化为栅格, 然后进行投影变换, 使土地利用现状图、行政图、TM 数据具有相同的坐标, 最后利用土地现状图, 提取水田分布图, 对水田分布图进行分类估算早稻种植面积。不同方法比较结果表明: 非监督分类法不能用于提取丘陵山区的水稻种植面积; 只用 TM 资料估算龙游县早稻面积, 与统计数据相比, 平行六面体分类法、最大似然分类法精度分别达到 82. 83% 和 59. 95%; 而用 GIS 与 TM 资料集成技术对水田分布图进行分类估算早稻面积, 平行六面体分类法、最大似然分类法的估算精度分别达到 93. 98% 和 60. 65%, 所以利用平行六面体分类法对南方丘陵山地早稻种植面积估算是可行的。

关键词: 地理信息系统; 遥感; 早稻; 面积估算