GENERATION OF AN IMPERVIOUS MAP BY APPLYING TASSELED-CAP ENHANCEMENT USING KOMPSAT-2 IMAGE

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ABSTRACT ... The regulating and relaxing targets in the Land Use Regulation and Total Maximum Daily Loads are influenced by Land cover information. For the providing more accurate land information, this study attempted to generate an impervious surface map using KOMPSAT-2 image which a Korea manufactured high resolution satellite image. The classification progress of this study carried out by tasseled-cap spectral enhancement through each class extraction technique neither existing classification method. KOMPSAT-2 image of this study is enhanced by Soil Brightness Index(SBI), Green vegetation Index(GVI), None-Such wetness Index(NWI). Then ranges of extracted each index in enhanced image are determined. And then, Confidence Interval of classes was determined through the calculating Non-exceedance Probability. Spectral distributions of each class are changed according to changing of Control coefficient(α) at the calculated Non-exceedance Probability. Previously, Land cover classification map was generated based on established ranges of classes, and then, pervious and impervious surface was reclassified. Finally, impervious ratio of reclassified impervious surface map was calculated with blocks in the study area.

KEY WORDS: Impervious surface map, Tasseled-cap Transformation model, Enhancement technique, KOMPSAT-2

1. INTRODUCTION

Present, accurate partitioning of pervious and impervious surface in urban area is a necessary part, because it is deep associated with urban development. The generation of impervious surface map using mid-resolution such a Landsat-TM could not provide correct information to calculate impervious ratio of area. Supplying advanced high resolution satellite image helps to calculate impervious ratio more correctly. Therefore, the information of accurate impervious ratio of each block in area should be provided using high resolution image by correct classification technique.

However, the conventional image classification methods have shortcoming in estimating impervious surface. The DN(Digital number) value of the each pixel in imagery is mixed result of spectral character of various objects which exist in surface. But conventional image classification methods force each pixel to be allocated only one class(Cho. & Jeong, 2005).

Therefore, for the generation of impervious surface map using high resolution satellite image which has various spectral characteristics, this study attempted new classification method by applying a stepwise extraction technique using spectral enhancement.

2. METHOD OF STUDY

Study area is including various artificial features and nature fields.

Firstly, 1m spatial resolution image of study area is obtained through the Custom Subtractive resolution Merge. Basically, image fusion by existing fusion methods such as Principal Component Analysis, Multiplication, IHS, etc, were not provided good quality fused result because, KOMPSAT-2 has a defect of green sensor. The custom subtractive resolution merge uses a subtractive algorithm to pan sharpen multi-spectral(MS) images. The input consists of overlapping panchromatic and MS images. The output is an MS image that retains the colors of the MS image while maintaining the spatial detail of the pan image. This

This algorithm was designed specifically to provide a solution that was fast, yet produced quality results for the most common types of merges. Specifically, it was designed for Quickbird,

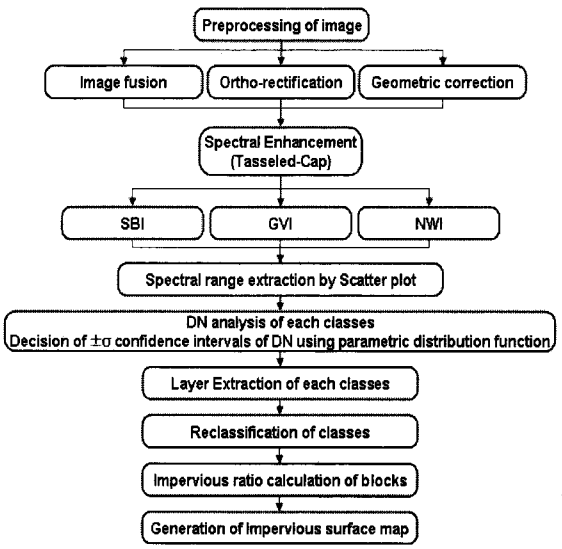

Figure 1. Progress of study

Ikonos and Formosat images that have simultaneous acquisition of the pan and MS, with all 4 MS bands present, and a ratio between the MS and pan image pixels sizes of approximately 4:1. Then, ortho-rectification was carried out by provided RPC(Rational Polynomial Coefficient) data from KOMPSAT-2 and then, Geometric correction also carried out by using 1:5,000 digital reference data. Result of geometric correction, X axial and Y axial and overall root mean squared error(RMSe) were indicated 1.48119 and 1.7218 and 2.2717, respectively. Therefore, this preprocess result of image was permitted to use to this study. In this study, secondly, spectral enhancement method was used for the generation of impervious surface map. Three changed indexes such as Soil Brightness Index(SBI), Green Vegetation Index(GVI), None-such Wetness Index(NWI) were constructed through the tasseled-cap transformation which a spectral enhancement methods. These are operated and converted by 4 bands of IKONOS on basis of 6 bands from the former Landsat-TM data(James H. Horne, 2003).

$$SBI = 0.326*B1+0.509*B2+0.560*B3+0.667*B4$$
$$GVI = -0.311*B1-0.366*B2-0.326*B3+0.819*B4$$
$$NWI = -0.612*B1-0.312*B2+0.722*B3-0.081*B4$$

In the above equations, B1, B2, B3, B4 refer to Blue, Green, Red, NIR band, respectively, from the image.

Transformed 3 indexes were created as a new image has peculiar DN value established three bands. Based on this new tasseled-cap transformed image, each class's DN values were extracted using region growing in scatter plot. Then, confidence intervals of extracted DN values are selected through statistic analysis of each class. And then, including DN values in calculated confidence intervals are spread to the each layer. Classified layers through this process are combined to the one image, and obtained image was reclassified with 7 classes. Finally, an impervious surface map was generated by separated blocks in area. Overall process of this study is shown as figure 1.

3. RESULTS OF STUDY

3.1 Comparison DN histogram and non-exceedance probability between original image and tasselled-cap indexes

The original study area image and the result of tasseled-cap transformed image are as figure 2, and the result of comparing characteristics between original image and Tasseled-cap transformed image is as fig 3. In case of original image, frequencies of each band in the histogram analysis are different, but DN values distribution characteristic of each band is overlaid with other bands. On the other hand, enhanced pixels of SBI by tasseled-cap transformation have very different pattern with GVI and NWI in case of distribution.

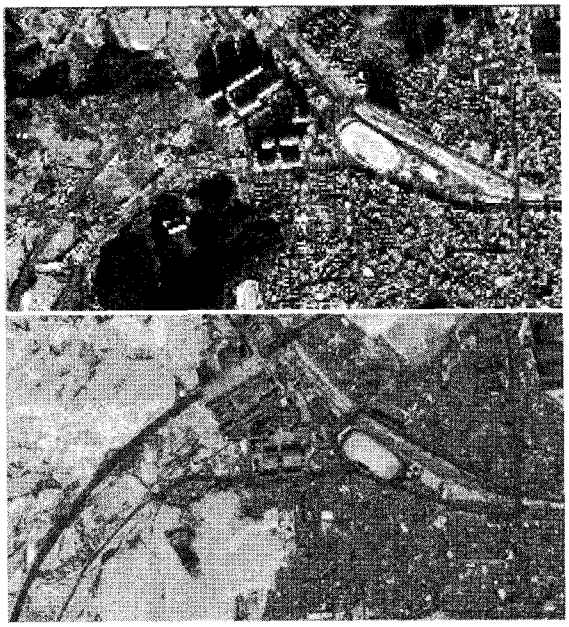

Figure 2. Original image(above) and Tasseled-cap transformed image(below)

Also, characteristics of each index in tasseled-cap transformed image in case of probability plot obviously indicated

3.2 Decision of each class's μ±σ confidence intervals

Suitable range of DN distribution is defined by changing control coefficient(α) of non-exceedance probability(Ha & Bae., 2007). Figure 3 shows an example of non-exceedance probability calculation.

DN Ranges of each class are as follows table 1. As a result of defined DN range, error was indicated the smallest when α is 1. So, DN values of each class were extracted by defined ranges through this process.

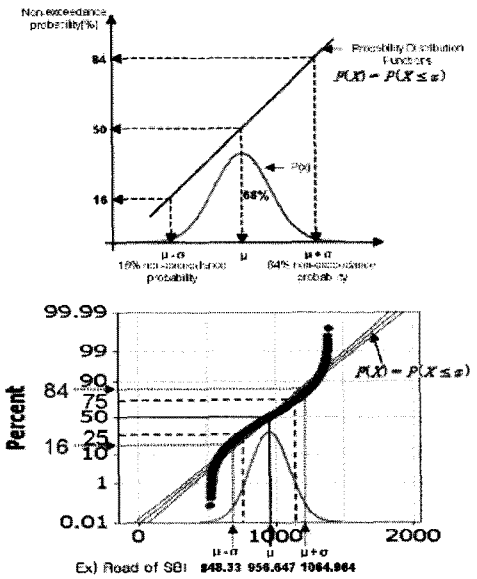

Figure 3. An example of non-exceedence probability calculation

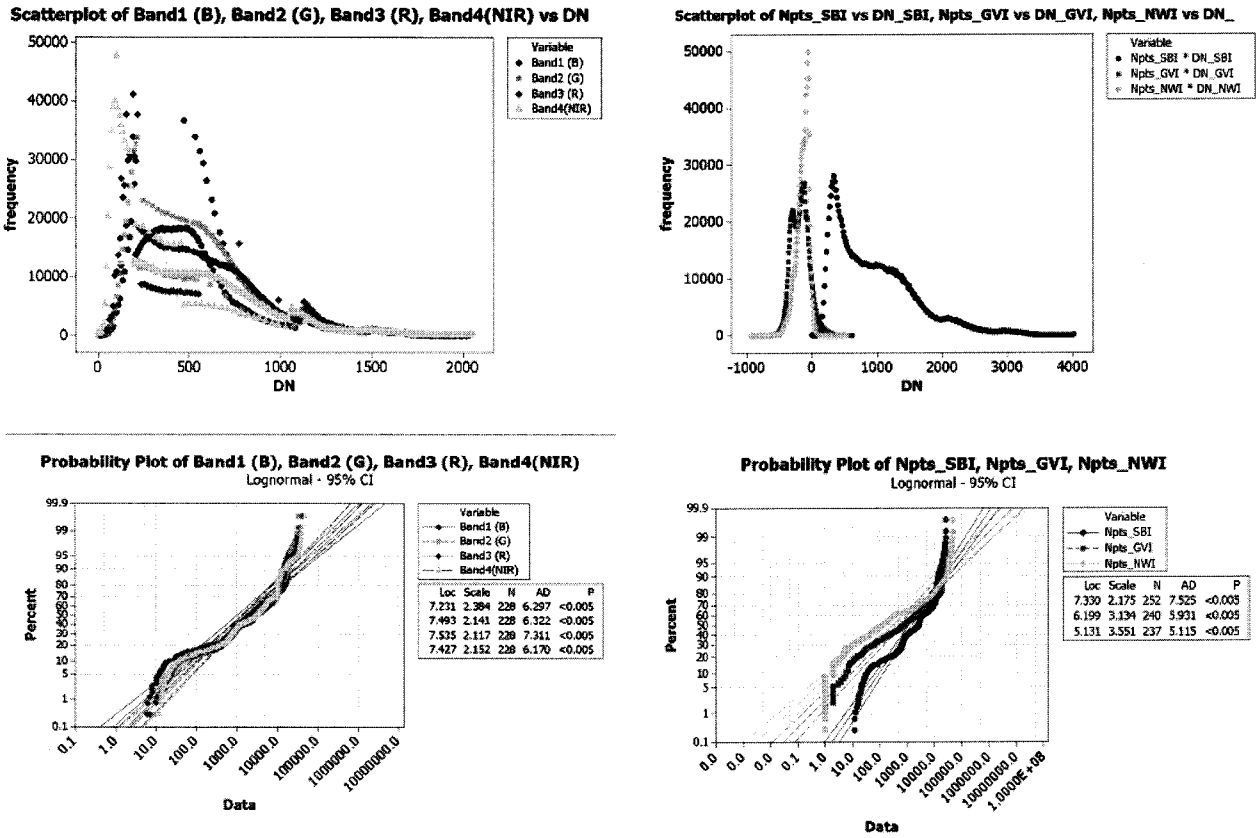

Figure 4. Comparing histograms(above) and probability plots(below) between original image bands(left) and tasseled-cap transformed image(right)

3.3 Generation of land-cover map and impervious surface map

Obtained 14 layers through above process were reclassified to 7 classes with grouping. Reclassified image is as follows fig 5, and area distribution of result is table 2. Especially, classified shadow was removed through visual classifying. Finally, Impervious map generated and impervious ratio calculated by block-size of area for the analyzing impervious surface distribution based on geometric information map of study area. A generated impervious map is as fig 6.

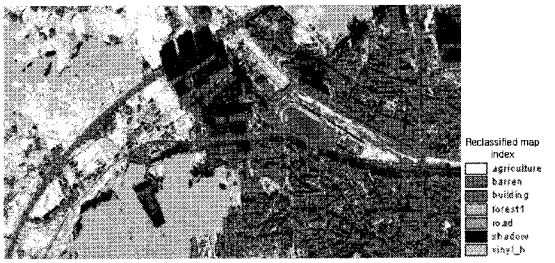

Figure 5. Reclassified land-cover map

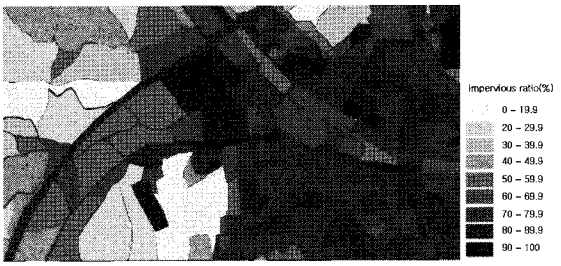

Figure 6. Impervious surface map of study area

4. CONCLUSION

This study attempted to generate an impervious surface map by applying a stepwise extraction technique through the tasseled-cap spectral enhancement methods to the KOMPSAT-2 image.

Three Indexes such as SBI, GVI, NWI are constructed by tasseled-cap transformation, and these indexes indicated different DN distribution.

In part of determining confidence intervals of each class's DN, control coefficient was decided α=1. DN values of each class are extracted by defined ranges based on this control coefficient.

Table 2. Area distribution of reclassified image

class	agricultural field	barren	building	forest	road	shadow	vinyl	total
area (m^2)	290,442	44,454	211,727	317,251	210,492	306,953	66,022	1,447,341

Table 1. $\mu \pm \alpha\sigma$ confidence intervals of each class

		min	max	mean	stdv	(μ-0.5σ)	(μ+0.5σ)	(μ-σ)	(μ+σ)	(μ-1.5σ)	(μ+1.5σ)
road	SBI	757	1118	956.647	108.317	902.4885	1010.806	848.33	1064.964	794.1715	1119.123
	GVI	-477	625	-260.446	111.549	-316.221	-204.672	-371.995	-148.897	-427.77	-93.1225
	NWI	-184	-59	-132.607	25.576	-145.395	-119.819	-158.183	-107.031	-170.971	-94.243
building	SBI	1828	4015	2683.66	488.296	2439.512	2927.808	2195.364	3171.956	1951.216	3416.104
	GVI	-799	276	-222.561	126.334	-285.728	-159.394	-348.895	-96.227	-412.062	-33.06
	NWI	-851	119	-368.033	123.447	-429.757	-306.31	-491.48	-244.586	-553.204	-182.863
barren	SBI	1922	2252	2072.193	74.227	2035.08	2109.307	1997.966	2146.42	1960.853	2183.534
	GVI	-279	156	-68.055	48.013	-92.0615	-44.0485	-116.068	-20.042	-140.075	3.9645
	NWI	-137	4	-75.412	31.444	-91.134	-59.69	-106.856	-43.968	-122.578	-28.246
slab roof	SBI	590	1843	1363.593	241.492	1242.847	1484.339	1122.101	1605.085	1001.355	1725.831
	GVI	-676	583	55.991	183.243	-35.6305	147.6125	-127.252	239.234	-218.874	330.8555
	NWI	-935	-468	-580.596	76.915	-619.054	-542.139	-657.511	-503.681	-695.969	-465.224
agriculture	SBI	1104	1622	1364.724	122.847	1303.301	1426.148	1241.877	1487.571	1180.454	1548.995
	GVI	-445	569	-96.092	103.329	-147.757	-44.4275	-199.421	7.237	-251.086	58.9015
	NWI	-137	4	-65.639	28.346	-79.812	-51.466	-93.985	-37.293	-108.158	-23.12
vinyl house	SBI	2033	2614	2279.102	133.511	2212.347	2345.858	2145.591	2412.613	2078.836	2479.369
	GVI	2506	220	-271.567	49.115	-296.125	-247.01	-320.682	-222.452	-345.24	-197.895
	NWI	-341	-200	-284.665	29.649	-299.49	-269.841	-314.314	-255.016	-329.139	-240.192
forest	SBI	175	489	358.119	76.55	319.844	396.394	281.569	434.669	243.294	472.944
	GVI	-275	361	-116.763	73.738	-153.632	-79.894	-190.501	-43.025	-227.37	-6.156
	NWI	-215	-27	-109.445	50.193	-134.542	-84.3485	-159.638	-59.252	-184.735	-34.1555
shadow	SBI	120	497	302.805	70.988	267.311	338.299	231.817	373.793	196.323	409.287
	GVI	-235	-34	-135	32.803	-151.402	-118.599	-167.803	-102.197	-184.205	-85.7955
	NWI	-244	-32	-109.113	38.937	-128.582	-89.6445	-148.05	-70.176	-167.519	-50.7075

Obtained 14 layers through above process are reclassified to 7 classes with grouping. And then Impervious map was generated and impervious ratio was calculated by block-size of area. Overall impervious ratio of study area was 50.38%.

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