LAND COVER CLASSIFICATION BY USING SAR COHERENCE IMAGES

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ABSTRACT:

This study presents the use of multi-temporal JERS-1 SAR images to the land cover classification. So far, land cover classified by high resolution aerial photo and field survey and so on. The study site was located in Non-san area. This study developed on multi-temporal land cover status monitoring and coherence information mapping can be processing by L band SAR image. From July, 1997 to October, 1998 JERS SAR images (9 scenes) coherence values are analyzed and then classified land cover. This technique which forms the basis of what is called SAR Interferometry or InSAR for short has also been employed in spaceborne systems. In such systems the separation of the antennas, called the baseline is obtained by utilizing a single antenna in a repeat pass

KEY WORDS: SAR, Classification, Multi-temporal, Coherence images.

1. INTRODUCTION

In these days the discussion on land cover areas and their monitoring has been brought up. Korea Land Spatialization Group has been performed variety programs for land cover fields since 2006. Multi-sensor image processing technique adapted for land cover in these days.

The possibility of having a global view of an land cover area with a good resolution make spaceborne remote sensing imagery a valid instrument for land cover area mapping and settlement analysis. Moreover, periodical acquisition of images over the same area allows regular and continuous monitoring of a specific area over a certain number of years.

Compared to optical sensors, SAR does not suffer from limitations due to cloud cover and darkness, therefore SAR imagery can be useful in land-oriented studies of any part of the Earth.

L-band SAR interferometry has been widely used for several Earth related studies (topography, volcanology, forestry etc.). Nevertheless, not much attention has been paid to coherence has been used for classification purposes only. In this study we focused on the meaning of coherence of an land cover area and performed several analysis in order to understand what causes baseline effects.

Concerning land cover areas, coherence has been shown to be a fundamental parameter for mapping purposes. However, the meaning of coherence of a land cover area has not been analyzed in depth; moreover, it has not been completely clarified what determines the decorrelation of man-made features.

A certain land cover areas(urban, man-made features, so on) are the only temporary stable land-cover; therefore, coherence, long-term acquisition interval basis, is generally high, equal to one in some cases. In this study we want to understand causes of coherence of land cover which parameters have influence and then we study the classification by using multi-temporal coherence images.

2. METHODS

2.1 Study Area and Data sets

This study focuses on land cover areas located in Non-san area. This area contained agricultural area, forest, ocean, urban area (Lat. N 36.1, Long E 127.1 for the center).

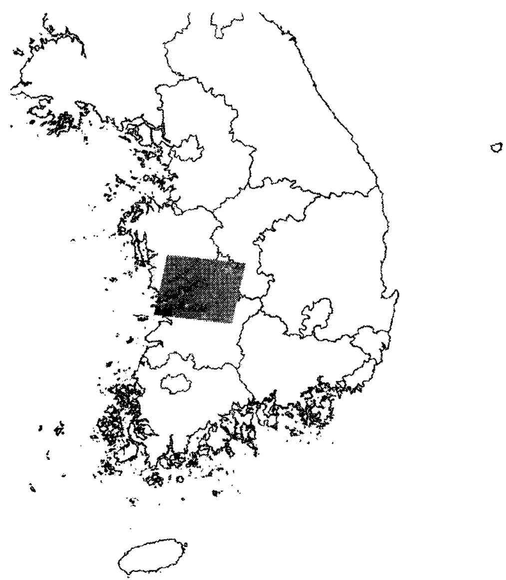

Figure 1. Study area

For this area we had a reasonable number of JERS-1 SAR images from July, 1997 to October, 1998 (9 scenes). All JERS-1 raw data are processed the Single look complex (SLC) image with pixel spacing is 8.8m in range direction and 4.5m azimuth. Image dimension is 52.1km in range and 79.2km in azimuth direction.

Orbital geometry of a satellite orbit may exhibit a small degree of drift such that the satellite does not return to the exact same location on subsequent orbit repeats. These repeats are generally parallel and separated by a distance (called the baseline) on the order of a few hundred metres. This baseline between passes provides the different viewing angles necessary for interferometry to work. Inaccuracy in the satellite orbit repeatability provides the ideal condition for interferometry. However, there are limits to the baseline. Typical values for maximum usable baseline separation are in the order of 1-2 km for JERS-1(Atlantis Scientific Inc., 2004).

Table 1. Data sets in study area

Master	Slave	Baseline [Perp.(m)]	Baseline [Para.(m)]	Coherence
9707	9709	1500.66	-43.05	High
9709	9710	1486.60	-2009.76	Mid
9802	9804	216.57	145.98	High
9802	9807	420.09	80.90	High
9802	9808	1474.79	-804.05	Mid
9802	9810	2228.69	-1323.97	Low
9804	9807	203.30	-63.87	High
9804	9808	1261.09	-945.86	Mid
9804	9810	2016.03	-1463.13	Low
9805	9807	-3210.56	-2713.99	Low
9805	9808	-2157.00	-1827.01	Low
9807	9808	1055.44	-885.00	High
9807	9810	1809.46	-1403.34	Mid
9808	9810	758.23	-512.75	High

2.2 Coregistration

The main purpose of the coregister processing step is to resample the slave SAR image to be coregistered with the master SAR image. After the master and slave interferometric image pairs are validated. And then calculate the predicted orbit/earth geometry based coregistration and interferometric parameters. To perform a coregistration refinement analysis, improving the coregistration bi-cubic polynomial parameters.

2.3 Interferogram and Coherence

InSAR uses phase information of SAR data. The change of distance between a sensor and the ground can be measured from phase difference of two observations using phase property of having information on slant-range length.

$$\phi=\phi_{orbit}+\phi_{topo}+\phi_{atm}+\phi_{def}+\phi_{noise} \quad (1)$$

ϕ_{orbit} is orbit fringe caused by baseline distance obtained by two observations, while ϕ_{topo} is topographic fringe with respect to terrain. These are described by the following (2) and (3) equations respectively.

$$\phi_{orbit}=\frac{4\pi B_{para}}{\lambda} \quad (2)$$

$$\phi_{topo}=\frac{4\pi h B_{perp}}{\lambda\rho\sin\alpha} \quad (3)$$

In these equations, B_{para} and B_{perp} represent parallel and perpendicular component of baseline distance. h, λ, ρ and α correspondently represent elevation, wavelength, slant-range length and incidence angle. ϕ_{atm} is a phase delay caused by reflection of microwave in water vapor layer, while ϕ_{noise} is error component caused by thermal noise, or temporal and spatial decorrelation associated with baseline distance or scattering characteristic change. ϕ_{def} represents the amount of surface deformation during the period between two observations.

The raw interferogram formed from the master image, and the conjugate of the slave image, after appropriate filtering, coregistration and flat Earth phase removal.

The degree of coherence of two SAR SLC images not only determines the quality of topography or deformation information derived by SAR interferometry, but also contains valuable information for land-use and land-cover classification (R.Touzi et al., 1999).

$$\gamma=\frac{E(g_1 g_2^*)}{\sqrt{E(g_1 g_1^*)E(g_2 g_2^*)}} \quad (4)$$

Where g is the coherence, g_1 and g_2 are the complex image values for the pair of SLC images, gi^* means the complex conjugate of gi, and E( ) means the expectation.

Using RGB color composite combinations of SAR and InSAR imagery, we could relate the level of coherence of a part of a land cover either to topography, InSAR system geometry and position of the targets or to image processing or to structural typologies.

3. RESULTS AND DISCUSSION

Each of master and slave image is performed to generate interferogram. Figure 2 is example of interferogram image (1998.07-08).

Generally interferogram image can be used to process the ground surface moving and so on. But in this study, we used to generate the coherence image by using interferogram image. Coherence was calculated by equation 4 according to the correlation coefficient definition and the coherence values were linearly scaled from 0 to 255 for display and further analysis (Atlantis Scientific Inc., 2004). Each pair coherence image can be generated. In case of image acquisition interval is long, coherence values are low. Its reason for vegetation, agricultural area changes by seasonally. Figure 3 shows coherence image. High coherence value show the bright and low value shows the dark. In particular, within urban areas, coherence remains high even between image pairs with long scale time (assuming that they have small perpendicular baselines). In contrast, naturally land surfaces are significantly influenced by temporal decorrelation and lose coherence within a few days (Grey and Luckmana, 2004).

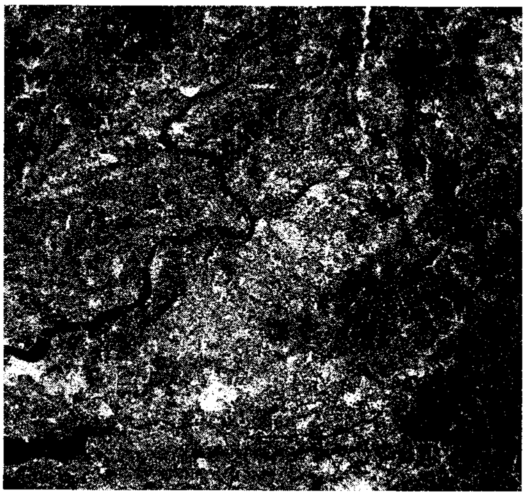

Figure 2. Coherence image (1998.07-08)

Study site consists of large agricultural area, forest area, a little urban area. From July to August in 1998, coherence value shows difference by land cover type. Coherence value of agricultural area and urban area shows higher than forest area. Water area shows lowest coherence value because water flow is not uniformly.

There is lower coherence value in forest area. It can be explained vegetation seasonal change by multi-temporal and so on.

Figure 4 shows the coherence in study area.

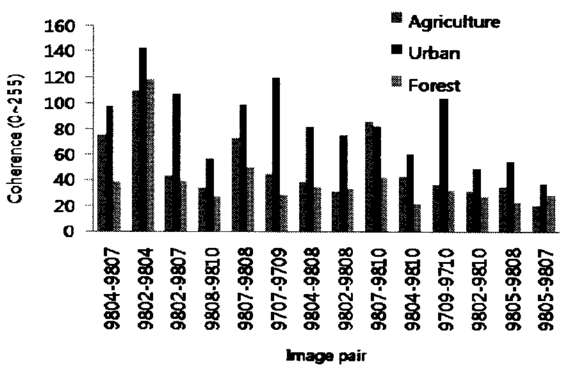

Figure 3. Coherence of image pairs

Coherence value of Figure 4 is averaged by class (agriculture, urban, forest). Image pair (direction from left to right) arranges to the baseline length from 213m to 4,204m. As baseline is shorter, coherence value is higher (except for urban area of 9709-9710, and so on). Winter and early spring season (9802-9804) image pair is highest coherence value. Winter season changes by forest volume and agricultural area less than other seasons. L band is more sensitive forest and rice stem. Almost urban area of image pair show highest coherence value. Coherence variation of urban features change less than other classes.

4. CONCLUSIONS

This study presents the use of multi-temporal JERS-1 SAR images to extract the land cover information and possibility.

There are many factors determine the coherence value and many error source. For example noise and speckle of SAR image. Compared to optical sensors, SAR does not suffer from limitations due to cloud cover and darkness, therefore SAR imagery can be useful in land-oriented studies of any part of the Earth and phase information can be used to centimeter scale in geo hazard mapping.

The degree of coherence of two images not only determines the quality of topography or deformation information derived by SAR interferometry, but also contains valuable information for land-use and land-cover classification. Non-san site are mostly consists large agricultural area and forest area. Coherence value shows difference by land cover type and error is depended on other source (wind, moisture status, and so on).

In this study, we choose the three coherence images and we perform the assign the RGB color composition(R: 9807-9808, G: 9802-9804, B: 9802-9807).

RGB color composites image of coherence shows similar with optical image. Green shows forest area, white and bright color shows urban area and artificial structure, red color appears agricultural area and water shed. Based on chosen the three coherence images, we classify the image.

Image Classification results are shown the Figure 5, Table 2, 3 and 4. Classification results of between coniferous and broadleaf areas can be discriminated because of exist by seasonally changing. Some case of agricultural area classified water body because of in this area composed of water for growing process.

This study is preliminary research for SAR image application development.

Future work will be classified for more precision classification by using optical and multi polarization SAR image.

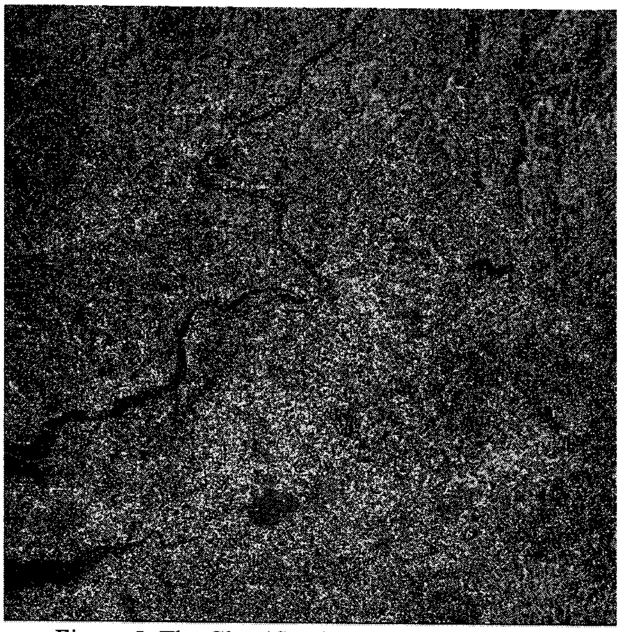

Figure 5. The Classification result of study area (Blue: Water, Yellow: Agricultural area, DarkGreen : Broadleaf area, Green: Coniferous area, Red: Urban)

Table 2. Classification results in study area

Class name	Count	Percent
Water body	1716756	12.05%
Agriculture	3409507	23.93%
Broadleaf area	4032030	28.29%
Coniferous area	3334277	23.40%
Urban	1757991	12.34%
Sum	14250561	100.00%

Table 3. Accuracy of Classification results

Class name	Producers Accuracy	Users accuracy
Water body	87.5%	87.5%
Agriculture	73.68%	93.33%
Broadleaf area	87.5%	50%
Coniferous area	63.64%	87.5%
Urban	100%	80%
Overall	78%	

Table 4. Kappa coefficient of classification results

Class Name	Kappa
Water body	0.8512
Agriculture	0.8925
Broadleaf area	0.4048
Coniferous area	0.8397
Urban	0.7826
Overall	0.7152

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