Comparison of Topographic Correction Methods for Sentinel-2 Imagery

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Abstract: Recently, demand for satellite imagery has been rapidly increasing for forestry or agricultural. The Government of the Republic of Korea plans to launch the CAS500-4 (Compact Advanced Satellite 500-4) for observation of a wide range of forests and agricultural land. However, in South Korea, where mountainous terrain occupies more than 60% of the whole area, differences in illumination are commonly observed under the same amount of light due to terrain fluctuations. It is important to eliminate topographic effects because these variations cause quantitative problems in vegetation remote sensing.In this study, we compared effective topographic correction methods in the process of observing forests distributed over a wide range. For topographic correction method, we applied C correction and Minnaert methods based on the Non-Lambertian reflectivity model. We also applied Cosine, Sun-Canopy-Sensor (SCS) and SCS+C correction methods based on the Lambertian reflectivity model. The study area was selected as Jeollabuk-do with a mixture of forest and agricultural land. Sentinel-2 satellite imagery with similar spatial resolution, spectral bands, and swath width of CAS500-4 were used for the experiment. Since topographic correction is basically applied to the Sentinel-2 L2A images, the L1C images were downloaded, and atmospheric correction was performed using Sen2Cor. Slope and aspect were generated using the same 10m resolution DEM as the satellite image. Sun-sensor viewing geometry were obtained from metadata provided with satellite images. In order to quantitatively analyze effect of the correction, 300 pixels of the sunny slope and shady slope were acquired on the image. The results show that the corrected images of Cosine and SCS are visually overexposed, and the reflectance on the shady slope is over-corrected. On the other hand, the corrected images of minnaert based on the Non-Lambertian reflectivity model visually reduce the amplitude of the terrain fluctuations. In particular, minnaert correction effectively corrected the near-infrared band, which is useful for observing vegetation, and correlation coefficient of reflectance between the two slope types was -0.05.
Additionally, there was no significant quantitative and qualitative difference between the per-scene and per-pixel sun-sensor viewing angle in the results. In this study, various topographic correction methods were compared using sentinel-2 imagery. Cosine, SCS, and SCS+C correction methods are based on surface reflection as the Lambertian hypothesis, whereas the C and Minnaert correction methods are based on Non-Lambertian surface reflection. Since most of the Earth's surface generally corresponds to a Non-Lambertian reflective surface,

topographic correction based on the reflective model has a good effect. Among them, Minnaert correction method effectively corrected the shadow effect of the shady slope while preserving the reflectance of the sunny slope. In the future, it is necessary to study estimating coefficients that can effectively represent the Non-Lambertian reflectivity model.

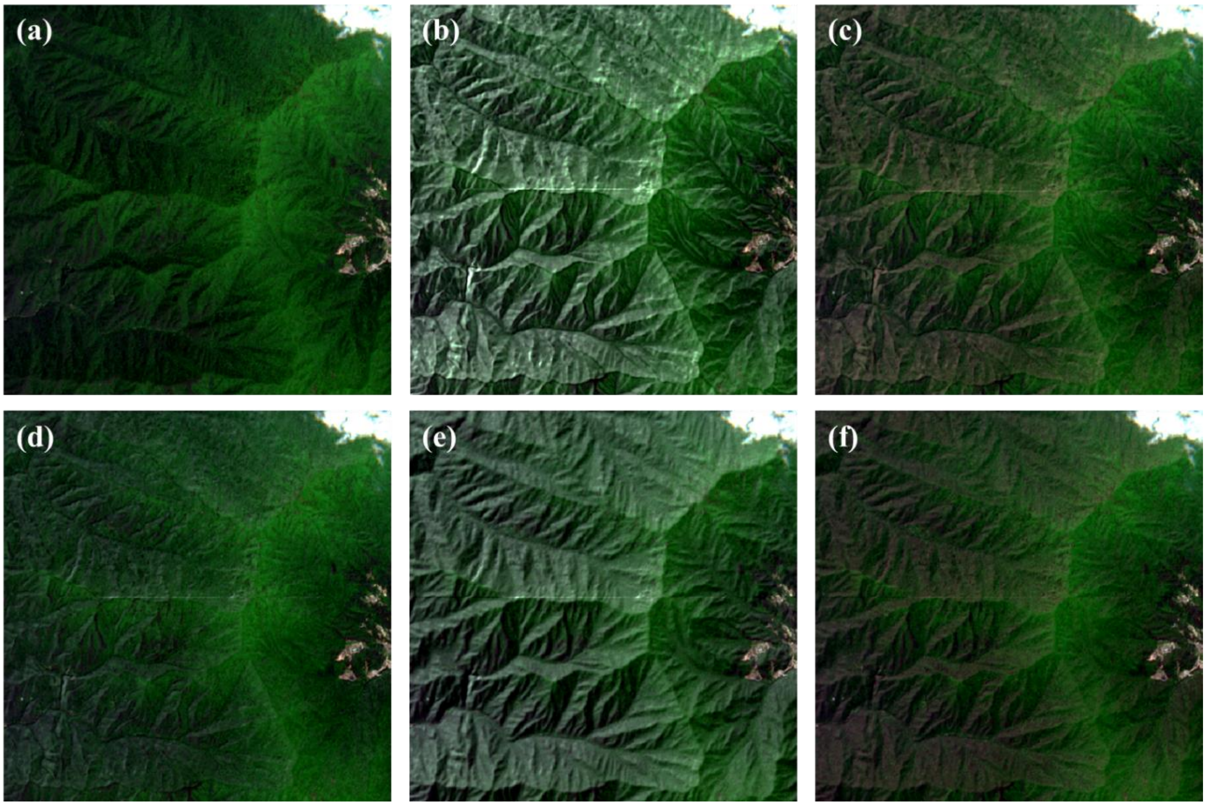

Figure 1. Sentinel-2 image in study area and 5 topographic correction results: (a) Uncorrected image, (b) Cosine correction, (c) C correction, (d) Minnaert correction, (e) SCS correction, (f) SCS+C correction

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