Evaluating the effects of shadow on impervious surface estimation

Liu Fei

Master Program in Geoenvironmental Sciences

Introduction

Extraction of impervious surfaces is a challenge because of the complexity of urban and suburban landscapes and the limitation of remotely sensed data in spectral and spatial resolutions. Especially, when high spatial resolution data, such as IKONOS, are used for impervious surface mapping, shadows caused by tall buildings or large tree crowns may create a severe problem in effective extraction. Reduction of shadow information could potentially lead to misclassification or inaccurate derivation of biophysical variables from shadow pixel values. Total loss of such information means that shadowed areas of the image cannot be interpreted.

Motivation

The chief motivation of this field work is to identify the misclassification and misestimation of the urban impervious surface due to shadow and evaluate its effect.

Study Area and Datasets

In order to achieve this purpose, Ichinoya area of Tsukuba Campus is selected as the study area (Fig.1). Orthophotographs were used for extracting impervious surface and for identifying the shadow of the remotely sensed image. The color orthophotographs were provided by SIS, which was acquired in 2006 for the entire campus. The orthophotography has a spatial resolution of 0.32 m.

Methodology

First of all, deriving impervious surface by ArcGIS and mapping the impervious surface.

Secondly, shadow pixels in the Orthophotograph image were identified.

The next step is to check the land cover information of all the shadow plots. Measurements of field work were taken on 17 February 2017. There are three conditions of all the plots from the perspective of impervious surface: impervious surface, non-impervious surface, and mixed surface. For the mixed surface, the part of impervious surface was shaped and calculate their area by manual GPS receiver.

After that, all the shadowed area will be reclassified based on the land cover information derived from the field work.

Finally, the performance of the shadow identification in the remotely sensed image was inspected by visual analysis. Shadow images were compared visually with impervious surfaces map and with the original image to evaluate the effectiveness of shadow.

Results and Discussion

Shadow pixels in the remotely sensed image were identified by overlaying it with the reclassified shadow map containing two classes: shadows on grass (SOG) and shadows on impervious surfaces (SOI) (Figure1). Eighty-eight shadowed plots were shown in the study area, of which 50 were SOG plots, and 38 were SOI plots. 30 tracks were recorded by manual GPS receiver(Figure2). The calculated area was totally 6815.66 square meters. While the area of North Tsukuba Campus Area is 634026 square meters including impervious surface, grassland etc., the ratio is 1.07%; the area of the structure is 51256 square meters, the ratio is 13.3%. Compared impervious surface map with the color orthophotographs, more shadow areas were classified as soil, vegetation and grass and fewer areas were classified as impervious surfaces. Consider the limitation of time and data feature, SOI was detected more accurately and effective than SOG image when image conditions are identical, probably due to the less varied characteristics of the impervious surface. So I just calculate the impervious surface part of mixed shadow area. As a result, a significant proportion of high spatial resolution imagery in urban areas can be affected by shadows, this creates great difficulty in directly applying imagery data to analyze urban land use and land cover. Therefore, shadows had better be identified, and removal in remotely sensed images and the spectroradiometric responses are restored for shadowed areas before image classification and impervious surface extraction.

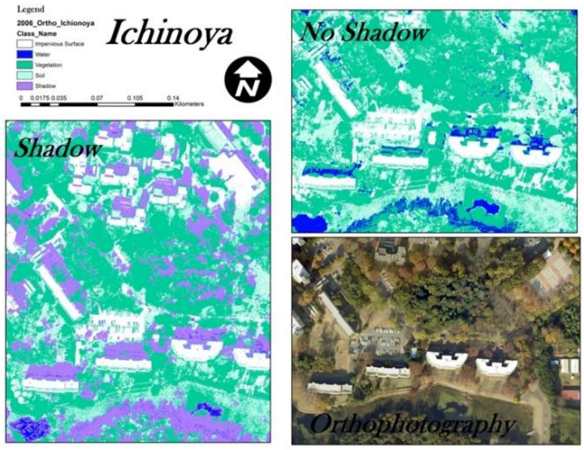

Figure 1. Impervious surface map and reclassified image

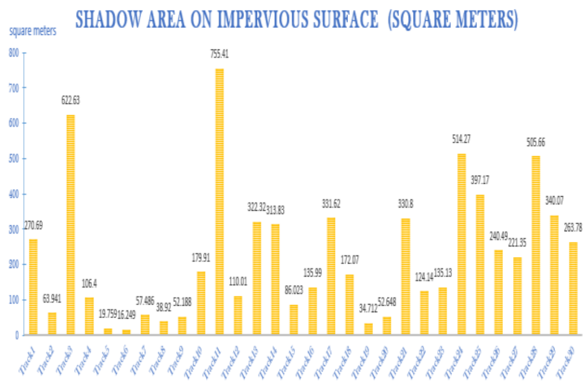

Figure 2. Field data (shadow area calculated by GPS