Hypothesis-test-based landcover change detection using multitemporal satellite images

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Land-cover change detection using remote sensing data and techniques has long been a common practice of remote sensing. It is particularly useful in Taiwan due to increasing residential development in hill-slope areas and frequent occurrences of natural disasters such as earthquakes, typhoons, and storm-induced debris flows. Many change detection techniques exist in literature including post-classification approach, composite analysis, image differencing, principal component analysis, change vector analysis, spectral mixture analysis, etc. All of these methods involve uncertainties in detecting changes. In general, a detection threshold is needed and is often determined empirically or by trial and error. In this study we developed a probabilistic approach based on statistical test of hypotheses to determine the threshold which corresponds to a desired confidence level of decision on landcover change detection. Firstly, we identified the sources of uncertainties by breaking down the total at-sensor radiances. Existence of these uncertainties necessitates a probabilistic model for radiance–digital number (DN) relationship. The probabilistic radiance–DN model provides basis for a bivariate distribution which characterizes the DN variation for multi-temporal no-change pixels with regard to individual landcover classes. After image-to-image registration, the proposed probabilistic approach is composed of five steps

(1) Eliminating the path radiance by the dark object subtraction (DOS) method.

(2) Selecting no-change training pixels for the three major landcover classes: vegetation, water and soil.

(3) Using NDVI values of the no-change training pixels to estimate distribution parameters of the bivariate normal distribution (i.e. f(NDVI1, NDVI2) for NDVI of pre- and post-images.

(4) Deriving the condition probability distribution for NDVI of the post-image given that NDVI of the pre-image is known.

(5) Determining the critical region for post-image NDVI with respect to the desired level of significance α, for example α=5% in this study. All pre- and post-image pixel pairs falling within the critical region were identified as changed pixels with a type I error α. Application of the proposed approach to a reservoir watershed in Central

Taiwan has shown very promising results with many correctly identified landcover changes.