Change Detection in the Semi-Arid Landscape Using Radiometric Rotation Applied to Remote Sensing Data

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Abstract

In Chile, the arid and semiarid regions affected by degradation processes exceed 60% of the national territory. The most important degradation is related to the loss of biodiversity and of land productivity. Consequently, there is an increase of human emigration associated to the reduction of life quality. In this frame a working group of University of Talca (UTALCA - Chile) and National Institute for Space Research (INPE - Brazil) was set up to develop a study on the semi-arid land. Its' main task is to apply at this biome, the multi-temporal change detection to the Radiometric Rotation Technique for the No-Change Axis (RCNA) using a TM/Landsat-7 images (data-take March 18th, 2004 – January 25th, 2008). So it was possible to evaluate the human changes suffered by the semi-arid landscape of Maule Region (Chile), which study area has a size of 1,579 km^2, located at (W 71º 50' to W 72º 07' and S 54º 51' to 54º 24'). The area understudy includes deciduous forest, sclerophyllous forest and thorny scrub *(matorral espinoso)* of the dry zone. These vegetation types are being substitutes by forest plantations (with *Pinus radiata*), resulting in only small fragments of native vegetation. Summarizing, the multispectral RCNA technique is a linear transform, which produces a rotation of the orthogonal axis from radiometric image attributes (in this case using the red and near infrared bands at different dates) in relation to the axis formed by the straight line of regression of those points labeled in the field survey as no-change areas. Initially a co-registration of TM images was made, with a RMS error below 1/3 pixel. Afterwards of a radiometric rotation was applied, which consists of a linear transformation operation, controlled by the regression equation of the DN at both points from the axis of no-change. So the rotation angle is found as a function of the

slope of regression line for each of these two points. In this both LANDSAT/TM data fusion, the rotation angles were calculated for red and near-infrared bands ($\boldsymbol{\theta}$ = 52° 19'12" and 40° 43' 34" respectively). The rotated images (intermediary images) were converted from an integer number to floating point and then we applied weights which increase or reduce the importance of information contribution for each of these images. Finally a linear complementary operation was done, in order to integrate two intermediary images to the sum and to apply the algorithm of transformation by stretching. At the last step the image in continuous mode was transformed to a thematic image, and so it became possible to calculate the thresholds among the classes and to label them in four classes of changes and no-changes. Those classes of change correspond to a high recovery, moderate recovery, high degradation and moderate degradation. In the timeframe 2004-2008, the detection image showed that 4.6 % of the investigated area presented degradation patterns, derived from the clear cut activity, followed by changes of land use, with the complete removal of the "*matorral"* type. In the study area, totally 17% of it is under recovery, including both natural and mainly planted forest. A field survey with geo-referenced points, allowed to estimate the performance of the thematic classification using *Kappa* statistics (value 0.74). A proportion of stable areas (with no change) in the land use dynamics is strongly influenced by implantation of Pinus stands, which grow slowly (age and the traditional irrigated agricultural activity of the Maule region. Concluding we found out that the application of multi-spectral RCNA technique in semi-arid landscape is robust and that the complex radiometric correction is not necessary, which simplifies the operational use of this technique. As a complement to the information generated at the map of change detection, we inform that presently the integration of some geomorphometric variables (slope and/or altimetry), derived from the modified DEM (Digital Elevation Model) with SRTM (Shuttle Radar Topographic Mission) is in preparation. This will allow the use of alternative data to understand the relation of the current land cover with the altitudinal distribution in this area, as well as to analyze the intensity and direction of flows from soil materials and sunshine which influence the eco-physiology of vegetation, for both the management or priorities for the conservation of remnants from the semi-arid domain.