Abstract

This thesis presents a method and a set of tools to automatically obtain shorelines from Landsat imagery (5, 7 and 8) with an accuracy close to 5.5 m (RMSE). Three principal questions have been faced: (i) the definition of an algorithm for the automatic extraction of sub-pixel shorelines, (ii) the georeferencing of the successive images with sub-pixel accuracy, and (iii) its adaptation and application to different types of Landsat images.

The developed method is based on the analysis of the Near and Middle Infrared bands, where there are noticeable differences in terms of spectral response between water and soil. The definition of an initial threshold allows to obtain the coastline at pixel level. Around this line, the sub-pixel accuracy algorithm is applied. A function is adjusted by least squares method around each pixel on the preliminary line and the positions of maximum gradient are deduced from this mathematical function. The obtained points are preserved to finally obtain the average position and define the position of the coastline.

First, we evaluated the algorithm on QuickBird images (2.4 m/pixel) where the true position of the coastline has been drawn manually to serve as a reference. Subsequently, each image was resampled to pixel sizes similar to the Landsat images. We applied the proposed algorithm and evaluated it with respect to each reference coastline.

Secondly, we propose and evaluate a method based on cross-correlation to geometrically register images. In order to evaluate this method without the influence of the coastline detection method, a set of images of known translation was generated. By applying the proposed method and comparing the results with the known translation the errors were analyzed. The observed errors are close to 0.1 pixels. This means an expected error of 2 m when applied to images with resolution similar to Landsat TM/ETM+/OLI (30m/píxel).

Third, the shoreline extraction and the georeferencing processes were merged for the application on the infrared bands of Landsat TM/ETM+/OLI. For the validation, certain coastal areas that have remained unchanged along the time were taken as reference. It has been shown that the reflectance of the land areas surrounding the coast affects the position of the obtained coastlines. This behaviour has been described statistically. Thus, depending on the sensor and band used, the shoreline can be corrected to its definite position. Taking the whole set of analyzed coastlines a mean square error of 5.5 m is obtained.

Once the accuracy level is described we present two specific applications: (i) a study on the impact of a series of coastal storms on a large segment of sandy beaches (100 km) and the recovery process of those beaches, and (ii), a study of the medium-term trend (almost thirty years) of a coastal segment of about 14 km lenght. These two studies allowed us to show the usefulness of the coast lines obtained by the proposed method. The obtained coastlines provide a new source of information for studies of the dynamics of the beaches. Even with some limitations, the method faces and solves some others that are characteristic of standard data available for coastal dynamics studies.