GRASS GIS processing to detect thermal anomalies with TABI sensor

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Abstract

In this study, we report the adopted methodology used in GRASS, a free open-source GIS software, which has allowed us to map surface water thermal anomalies and, consequently, to identify and locate coastal inflows in the Mar Piccolo sea (Taranto) part of the National Priority List site identified by the National Program of Environmental Remediation and Restoration. An ongoing work, where to apply the same procedure, is being carried out on Bari province coast and effimeral streams.

Keywords

GRASS GIS, thermal anomalies, coastal, effimeral streams

1 Introduction

With the advent of increasingly powerful airborne thermal sensors, it is becoming easier to obtain synoptic information on areas otherwise difficult to monitor or areas that until now have been monitored only with medium/low spatial resolution as Landsat maps. Through the use of these maps, since several years, remote sensing techniques allow to identify (big) thermal anomalies on water cloves, providing useful information to detect, for example, oil spill evolution on sea (Hua, 1991) and to characterize and quantify spatial dynamics of currents in water (Hedger et al., 2007; Matarrese et al, 2004).

The Water Research Institute of the Italian National Research Council (IRSA-CNR), in 2013 and 2014, has been involved in an activity about identification of surface thermal anomalies related to legal or illegal Mar Piccolo inflows and to submarine springs (in Italian Citri). Successively, a similar activity has started on the coast of Bari province, in a scientific agreement that aims to detect all the illegal discharges in coastal waters.

Nowadays, there are only few cases in which these data have been used to support the action of local Authorities that, usually, base their considerations on image visual interpretation, a very time-consuming, subjective and expensive technique (considering also the cost of specialized software). Furthermore, the big amount of data storage that this images require is usually seen as a limit in their use. Open-source and free softwares can represent one possible solution of all the listed difficulties.
In this paper, we report the partial results obtained using the free and open-source GIS software GRASS v.6.4, applied to the thermal images from TABI-320 sensor providing, as output data, a map with high degree of accuracy of surface water thermal anomalies that, consequently, leading to the identification and location of the inflows, as well as manmade or natural watershed drains or submarine springs. Furthermore, according to the results obtained, it will be possible for Authority to assess which maps can be useful for the most varied purposes.

2 Materials and methods

2.1 Study area
Two study areas have been considered. The first one, were the analysis has been already performed, is Mar Piccolo sea of Taranto (200km²). The second study area is the whole coast (84 km x 900m) and the effimeral streams of the province of Bari (~350km x 900m). Both areas are in the Apulia region, South of Italy.

2.2 Data description
In order to have the most accurate thematic map of thermal anomalies, images from ITRES TABI-320 have been processed. The TABI-320 (Thermal Airborne Broadband Imager) is an airborne thermal mapping sensor. Its specifications are described in http://formosatrend.com/Brochure/TABI-320.pdf. For the 2 cases study, two main campaigns of acquisition were performed: 13 images were collected between March and April 2013 to cover the whole area of Mar Piccolo with 1m² of spatial resolution; 29 images of the Bari coast were acquired in November 2014 with pixels of 1.30mx1.30m. The total amount of data was of about 10 Gb.

2.3 Data processing
The following procedure, used for this study, has been developed by the mean of the GRASS GIS (Geographic Resources Analysis Support System), (http://grass.osgeo.org/).
In order to locate thermal anomalies by the airborne images collected, TABI data have been first geo-referenced using the i.ortho.photo module (Rocchini et al, 2012). Then the i.image.mosaic module allowed to create the mosaic of the whole zone.
In order to find thermal anomalies along the coast and into the open sea, the whole TABI-320 mosaic image was ‘clumped’. It means that the image was recategorized in a raster map by grouping cells that form physically discrete areas into unique categories (Neteler and Mitasova, 2008). This step was necessary to simplify the calculations in order to perform processing focused on small groups of values rather than on the entire original raster map. This was applied only to TABI-320 thermal images.
As second step, the raster data just obtained was transformed into an isolines vector data. This contour method, often used to identify temperature and elevation, was able to determine the minimum and the maximum isoline values and the interval (step parameter) for the given raster map: in such application...
we used 16°C as minimum value, 28°C as maximum value, and 0.25°C as interval. Finally, isolines were simplified and smoothed by a generalization. The simplification process reduces the complexity of vector features decreasing the number of vertices for each line. The smoothing is a process applied to produce a smoother approximate line than the original. The algorithm used is the Chaikin’s one (Chaikin, 1974). This algorithm approximates the given line very well for the purpose of this study because of Chaikin’s curve has been shown to be equivalent to a quadratic B-spline curve and is a useful to the analytical definition of B-splines and provides a simple, elegant curve drawing mechanism (Kennet, 1999).

3 Partial results
As result obtained for the Mar Piccolo sea, we produced a map of thermal anomalies around the coast surprisingly coincident with the inflows detected during a survey carried out in situ to validate the product (Fig. 1).

![Figure 1: Example of Taranto sea thermal anomalies found by GRASS.](image)

4 Preliminary conclusions
GRASS - GIS allowed to identify most of the thermal anomalies in the Mar Piccolo Sea. Its skills demonstrated that it is possible to perform complex and big data processing with a step by step procedure, considered before an exclusive prerogative of expensive licensed software. The advantage in using open-source software is due to the possibility for the user to create its own subroutines in order to manage huge amount of data. A non-expert user, since the community that uses this particular software is very active, can easily find help or subroutines already written to satisfy his needs.
Furthermore, the gratuity of GRASS-GIS, is another important added benefit. Working with public administrations, it is relevant to emphasize all the possible advantages deriving from the combination of remote sensed data and open-source softwares, in order to better combine research and common needs.

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**References**


