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Effectiveness of airborne multispectral thermal data for karst groundwater resources recognition in coastal areas

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Currently the detection, use and management of groundwater in karst regions can be considered one of the most significant procedures for solving water scarcity problems during periods of low rainfall this because groundwater resources from karst aquifers play a key role in the water supply in karst areas worldwide [1]. In many countries of the Mediterranean area, where karst is widespread, groundwater resources are still underexploited, while surface waters are generally preferred [2]. Furthermore, carbonate aquifers constitute a crucial thermal water resource outside of volcanic areas, even if there is no detailed and reliable global assessment of thermal water resources. The composite hydrogeological characteristics of karst, particularly directions and zones of groundwater distribution, are not up till now adequately explained [3].

In view of the abovementioned reasons the present study aims at analyzing the detection capability of high spatial resolution thermal remote sensing of karst water resources in coastal areas in order to get useful information on the karst springs flow and on different characteristics of these environments.

To this purpose MIVIS [4, 5] and TASI-600 [6] airborne multispectral thermal imagery (see sensors' characteristics in Table 1) acquired on two coastal areas of the Mediterranean area interested by karst activity, one located in Montenegro and one in Italy, were used. One study area is located in the Kotor Bay, a winding bay on the Adriatic Sea surrounded by high mountains in south-western Montenegro and characterized by many subaerial and submarine coastal springs related to deep karstic channels. The other study area is located in Santa Cesarea (Italy), encompassing coastal cold springs, the main local source of high quality water, and also a noticeable thermal groundwater outflow.

The proposed study shows the preliminary results of the two airborne deployments on these areas. The preprocessing of the multispectral thermal imagery and the retrieving of accurate sea surface temperatures (SST) allowed us to detect and identify thermal anomalies related to coastal and submarine karst springs. In particular, the preprocessing for both MIVIS and TASI-600 sensors was carried out as follows: (a) radiometric calibration of the raw data by using the RADCORR software provided by ITRES (Canada) and the application of a new correction tool for blinking pixel correction, developed by CNR (Italy); (b) atmospheric compensation of the TIR data by applying the ISAC (In-Scene Atmospheric Compensation) algorithm [7]; (c) calibration to temperature by separating temperature and emissivity according to the methods described by [8].

This study points out that considerable water resources are dispersed into the sea, through karst springs and such water resources could be effectively protected in artificial way against the salting sea water influence and exploited for human local uses. The obtained preliminary results are encouraging, even though suitable integration approaches also with the classical geophysical investigation techniques have to be improved for rapid and cost-effective karst groundwater resources detection and monitoring.

Table 1. Characteristics of sensors used for this study.

	Spectral Region	**Bands**	**Spectral Resolution**	**Spectral Range**	**IFOV**	**Spatial Resolution**
MIVIS	VNIR-SWIR LWIR	92 10	90-500 nm 340-540 nm	0.4÷12.7 μm 8.2÷12.7 μm	2.0 mrad	3 m
TASI	LWIR	32	100 nm	8.0÷11.5 μm	1.2 mrad	1 m

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