

Censimento delle torbiere superficiali nella Provincia Ferrarese mediante tecniche di Remote Sensing.

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Lo scopo della ricerca è un censimento delle aree torbose superficiali presenti nella Provincia di Ferrara realizzato con tecniche tradizionali ed innovative di *Remote Sensing* applicate ad immagini radar ERS 1 Sar e Landsat ETM+.

Il censimento e l'ubicazione dei depositi torbosi avviene utilizzando dei rapporti di bande (*Band Ratios*) e la fusione dei dati (*Data Fusion*) tramite algoritmo IHS.

Le applicazioni di questo censimento sono inerenti e necessarie sia nelle fasi di sviluppo urbanistico per le "scarse proprietà geotecniche", che nel *wellness* ambientale per la capacità di indicare radioattività ambientale (Gaiodolfi, 1999).

Abstract

The main aim of this work is to take the first census of superficial / peat deposits in Ferrara Province (Italy), through conventional and innovative techniques of Remote Sensing applied to radar data ERS 1 SAR and Landsat ETM+. The peat census has been taken applying Band Ratios and fusion data with HIS algorithm. The application of census are useful for urban development about coarse geotechnical properties and for environmental wellness about environmental radioactivity (Gaiodolfi, 1999).

1. INTRODUCTION

1.1 General Introduction

This study, applying the Remote Sensing principles, takes the first census of peat areas and draws the limits of lateral discontinuities of the same deposits detected in Ferrara Province (Fig.1). Ferrara Territory has been largely studied by geological – structural, hydrogeological and geotechnical interpretations, to furnish a complete environmental monitoring. Considering geomorphological evolution, wetland origin is a result of tributary progradation of Po River during Delta evolution with cyclical inundations (BONDESAN, 1968), (VEGGI et al., 1968). The peat moss development is under right climatic conditions and with water stagnation condition for low permeability. The ground saturation decreases the oxygen quantity and, consequently, the bacteria entity within the organic matter in mineralogical components. In this way the Carbonium content contained in vegetable residuals is the same. The peat is fossil combustible with about 53/58 % of C, 5/6 % of H and 28/35 % of O₂. Knowing the geotechnical characteristic of peat sediments is fundamental for urbanization studies to prevent building and road tilting. Unstabilized peat has an inhomogeneous and anisotropic structure (different properties in different directions), which means that it is difficult to evaluate its properties. A peat deposit is very compressible; the relative compression may be up to 60%. It has a high permeability. When unstabilized peat is loaded its permeability quickly decreases. With 50%

compression, it is not unusual for only 1‰ of the original permeability to remain. An unstabilized fibrous peat often has strength parameters similar to non cohesive soils, while an unstabilized amorphous peat is more similar to quick clay.



Figure 1 - Studied area: Mezzano Valley, reclaimed land area.

The peat layers are needed like radioactivity indicators for radon content (GAIODOLFI et al.,1999). Radon is a radioactivity natural gas, odourless, colourless and tasteless. If this gas is inhaled, it produces internal irradiation and health consequence, especially for lung alveolus. Detection and classification of peat deposits on satellite images (ERS SAR and Landsat ETM + fusion image), could give radioactivity environmental informations if combined with physical and chemical parameters typical of the ground. To correlate the sedimentological information with the radioactivity detection it could be necessary create a risk map, not only for the growth of city planner, but also for citizen health to prevent the radon contamination.

1.2 Sensor System

Synthetic Aperture Radar (SAR) is a technique for creating high - resolution images of the Earth's Surface. Over the area of the surface being observed, these images represent the backscattered microwave energy, which depend on the properties of the surface, such as its slope, roughness, humidity, textural inhomogenities and dielectric constant. These dependencies allow SAR imagery to be used in conjunction with models of the scattering mechanism to measure various characteristics of the Earth's Surface. Radar (Radio Detection and Ranging) SAR (Synthetic Aperture Radar) is the most common active instrument of remote sensing able to create radiation at long wavelength and can detect the Earth surface, penetrating the atmosphere, in all weather, day or night moments. Especially, SAR sensor is used to generate microwave images with high spatial resolution. Each pixel (DN: digital number) in the radar image represents the radar backscatter for that area on the ground: - Darker areas in the image represent low backscatter with low energy reflected (i.e. quite water and smooth surface). Brighter areas represent high backscatter with strong radar energy reflected back to the radar (i.e. anthropic areas). Backscatter also depends on the use of different polarization. Some SAR satellite can transmit pulses in either horizontal (H) or vertical (V) polarization and receive in either H or V, with the resultant combinations of HH (Horizontal transmit, Horizontal receive), VV, HV, or VH. In this project radar images have been fused with multispectral image Landsat ETM+ . The differences existing between images taken over multispectral scanner system (Landsat ETM+) and with Synthetic

Aperture Radar (ERS 1 SAR) permit a several elaborations and consequent interpretations on lithology and land use (Rudant et al., 1994). Landsat ETM+ images give information about the absorption capacity of the visible and infrared part of the electromagnetic spectrum of the different surfaces (Sabins, 1987). With the right classification is possible to recognize the lithology with vegetation covers and with mineralogical composition.

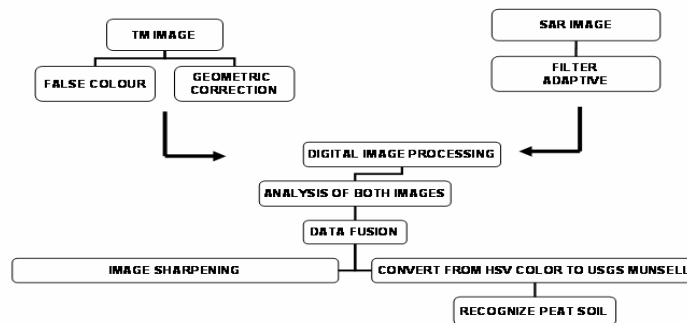


Figure 2 - Flow Chart

ERS SAR images give information about dielectric constant of the different materials united with the content of soil moisture (Sabins, 1987). Also, roughness surface depending on backscatter and texture of natural surface are able to characterize the lithology like sand, clay or gravel. Especially, the level between fine sand and clay has particle – size features that looks like peat or organic sediments. But during the detection on the image, the peat soil does not present clean contours, but a blur spatial distribution. It is possible to recognize peat soil to monitor organic matter content only in soil ground area and with sparse vegetation, because they are completely transparent to the radar waves and permit to observe the ground surface. The fusion data algorithm of Landsat ETM+ and ERS SAR images permit to combine information on vegetational covers and lithology and to extract the peat deposits.

2. METHODOLOGY

The methodology chosen is simple with direct results (Fig.2). First of all is needed to smooth the speckle effects due to noisy data having an intensity related to the scene and a multiplicative component typical of radar image. The filter application reduces the bad data and the opportunities to receive false information.

Generally, the most common adaptive filter applied to radar image is Lee Filters. It is based on a standard deviation and preserves image sharpness and details, deleting the noise (Lee et al., 1980).

Data fusion represents the last step between ERS SAR and Landsat ETM+ images with FCC combination (R: 4, G: 5, B: 7). After the co-registration of both images, it is necessary to perform HSV transform applying the Sharpening algorithm IHS. A sharpening image is the merge between a low-resolution colour image (Landsat ETM+ , Fig. 3) and a high - resolution grey – scale image (ERS SAR, Fig. 4).

Name	Wavelength range(μm)	Resolution
BAND 1	0.45 - 0.52	30 m
BAND 2	0.52 - 0.60	30 m
BAND 3	0.63 - 0.69	30 m
BAND 4	0.76 - 0.90	30 m
BAND 5	1.55 - 1.75	30 m
BAND 6	10.40 - 12.50	120 m
BAND 7	2.08 - 2.35	30 m

Figure 3 - Landsat ETM + image. Physical characteristics

To use Sharpening IHS algorithm it is necessary to transform RGB image to HSV colour space, replacing the value band with the high – resolution image, consequently resample the hue and saturation bands to the high resolution pixel size and can be used a nearest neighbour, bilinear or cubic convolution techniques and finally convert the image back to RGB colour space.

ERS 1 SAR PRI acquired 23 - AUGUST - 1992.
Orbit 05778
Frame 2709
Pixel size (range-across track) 12.5 m
Pixel size (azimuth-across track) 12.5 m
Scene area (range-across track) 100 km
Scene area (azimuth-along track) At least 102.5 km
Scene size (range-pixels) 8000 pixels per line
Scene size (azimuth-lines) At 8200 lines
Pixel depth 16 bits
Product location accuracy (range) 100 m
Product location accuracy (azimuth) 200 m

Figure 4 - ERS SAR General characteristics

2.1 Validation

The IHS algorithm uses three bands with low resolution datasets and transforms these data to IHS space. This IHS colour coordinate system is based on hypothetical colour sphere. The vertical axes represents intensity from 0 characterized in black to 255 in white. The circumference of the sphere corresponds to hue with the dominant colour wavelength, the saturation is the purity of the colour band. To prove the validation of this algorithm would be possible to compare with Brovey Transform based on colour normalized (Envi Ver. 3.5, 2000). Visual comparison of spectral and spatial features has been done applying to multispectral images like IRS 1 D pan and LISS III images fused with ERS SAR image to recognize and successively classify land use and anthropic buildings.

	VL1	VL2	VMA	TR	VMC	206	A1	VMAB
SI02	40.15	32.74	42.21	41.84	43.97	38.95	41.03	42.2
TI02	0.71	0.74	0.73	0.72	0.75	0.72	0.54	0.73
AL203	18.54	15.72	17.39	16.26	17.94	15.74	12.8	17.23
FE203	7.27	6.07	6.32	6.41	6.58	5.68	5.61	6.43
MNO	0.02	0.03	0.06	0.07	0.06	0.05	0.05	0.06
MGO	2.08	1.52	2.85	2.48	2.84	2.36	1.97	2.89
CA0	2.87	4.82	6.17	6.4	4.03	7.13	7.66	6.16
NA20	0.77	0.64	0.67	0.81	0.86	0.71	1.01	0.68
K2O	2.25	1.08	2.13	1.94	2.31	1.73	1.38	2.14
P205	0.17	0.22	0.27	0.28	0.27	0.17	0.26	0.27
LOI	25.18	36.43	21.2	22.8	20.41	26.75	27.69	21.2

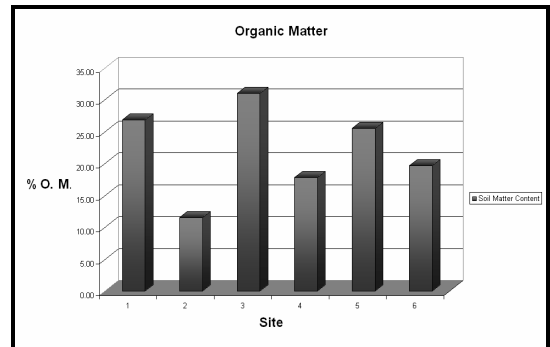


Figure 4 - Sampling. Mezzano Valley, Ferrara

3. RESULT – DISCUSSION

Creating the map with fused image and overlapping GIS anthropic data and topographic map it is possible to generate a risk map about peat deposits. The work is yet in progress, because the team is studying the choice of the best G.I.S database..

The fused image represents a lithological map of Mezzano area (Fig. 5), where sediment is combined with a colour: sand from yellow to red, clay green tones and peat blue colour to indicate the most water content respect other particle – size classes

The peat deposit appears without a geometrical representation, but basically shows itself with round and large stains. The principal peat area is located near the towns and this situation is visible observing building tilting and road embankment. A field sample was completed in Mezzano area to collect peat deposit in order to calculate organic matter content and chemical content (XRF analysis),(Fig. 6). In Ferrara Province peat deposits are associated with corn cultivations.

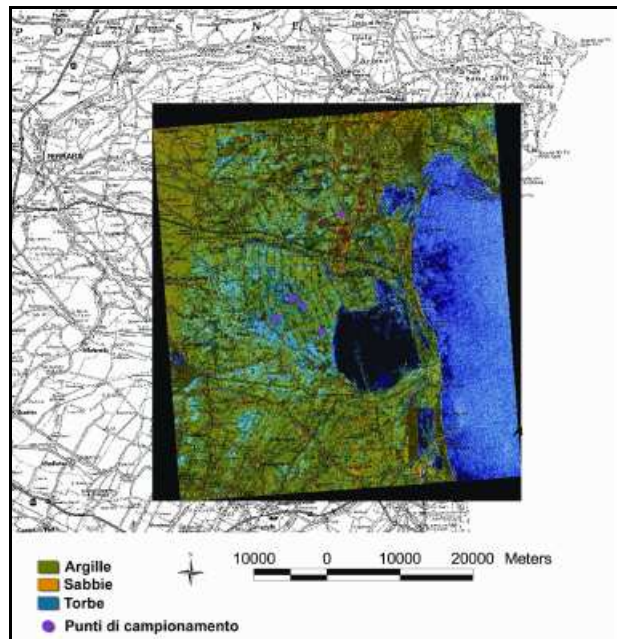


Figure 5. *Fusion image. IHS Sharpened.*

4. CONCLUSION

The importance to take a census of peat area regards not only the city urbanization plan but also the health care of people. In the last ten years the radon contamination has been the principal studied object in more Countries. In Emilia Romagna region, for example, a radon sample field has been done in cities with potential higher risk, but the final results have not graphically represented (risk maps) to have an immediate interpretation and localization

Recently scientists have discovered radon radioactivity relationship with geological units. In this study, applying the Remote Sensing techniques classifying the radar and multispectral images, it could be a simple and fast tool to obtain a first general observation (regional discrimination) to plan a direct action in the local areas.

5. REFERENCE

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