EVALUATION OF THE TURBIDITY DIFFUSION IN THE VENETIAN LAGOON BY THE USE OF LANDSAT DATA

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ABSTRACT

This work describes the results obtained from a multitemporal analysis of the turbidity diffusion, in different tide conditions, in the central basin of Venice lagoon through the use of Landsat images.
Utilizing an appropriate method for multitemporal calibration of these images, as basic procedure in data processing, a classification was made to distinguish turbidity diffusion and tidal inflow/outflow.
The analysis of the interaction between these phenomena has permitted to identify the lagoon areas usually affected by polluting discharges.

1. INTRODUCTION

The use of Landsat data for the study of turbidity diffusion in the Venice lagoon has found some contraints in the recognition of marine phenomena, in particular for the haze conditions and the complex environmental dynamics of the lagoon.
In fact, as it is known, an increasing haze has the following effects on MSS data:

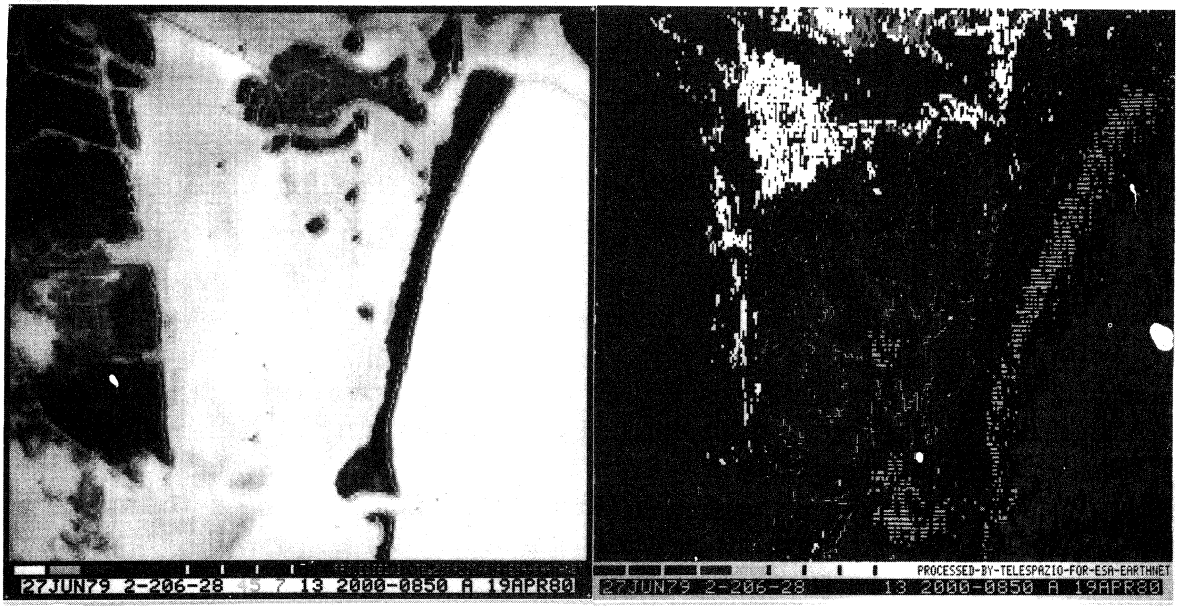
- a shifting of most signals towards brighter levels,
- a reduction in the available signal contrast.

On the other hand, the environmental dynamics imply sometimes that phenomena as industrial turbidity and sand movements due to the corrents, have the same spectral response.
These effects have been sufficiently removed, with improvements in the recognition, by means of a multitemporal calibration of Landsat signals, before their classification.

2. MATERIALS AND METHODS

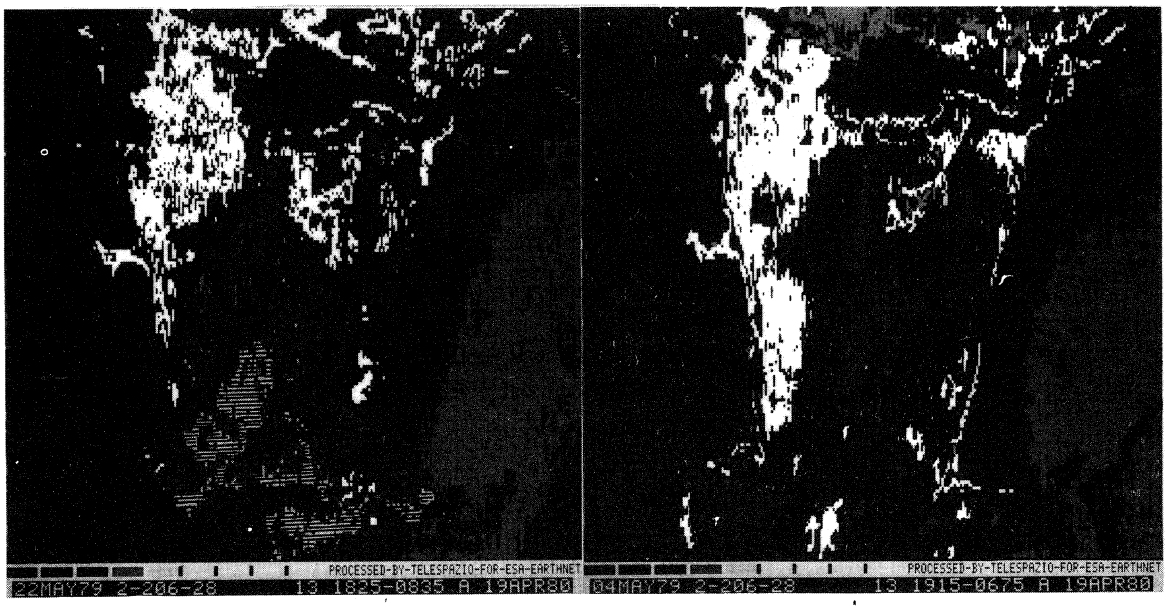
Landsat images used in the study refer to the time period from 1975 to 1979.
Figure 1 (point a.) shows the study area.
The selection criteria of the images has been:

- same season,
- representativeness of different tide dynamics,



a. Study area.

b. June 27, 1979.
Flood tide with high stream speed.



c. May 22,1979.
Ebb tide with low stream speed.

d. May 4, 1979.
Low tide with almost unexisting stream speed.

FIGURE 1 - Images recorded in 1979 under three different tide conditions. (Turbidities are represented in white, Tidal inflow/outflow in striped white).

- similar wind conditions,
- availability of useful data.

Late spring was selected as the most suitable season, because of the reduced atmospheric noise effect in the lagoon.
Concerning the tide conditions, a short and a long range period have been considered. The former corresponding to the year 1979, with three images recorded under different tide dynamics, to the aim of evaluating their interaction with turbidity diffusion. The latter represented by the years from 1975 to 1979 with five images recorded during the tidal inflow,for the analysis of clean water diffusion in the lagoon.
For both periods a multitemporal calibration method has been applied for the following channels MSS4, MSS5, MSS4+MSS5, MSS4/MSS5 (refer to Alberotanza and Zandonella, 1980 for their selection).
This method consists in a projection of work images into a common signals features space. This has been obtained by centering the images on their own gravity center. Details of the method can be found in Zandonella 1980.
Following this procedure, a classification method has been utilized to distinguish turbidity diffusion from tidal inflow/outflow.

3. RESULTS AND DISCUSSION

Figure 1 (points b. to d.) shows the classification results obtained from the images recorded in 1979.
On June 27th, the industrial turbidity surrounds the historical centre of the city during the tidal inflow with high stream speed. Flow waters are shown in the middle of the basin.
On May 22nd, at the beginning of ebb tide, the situation was very similar, even if a lower rate of turbidity diffusion was verified in the southern part of the lagoon.
On May 4th, the largest turbidity diffusion was detected during a low range ebb tide. The NNW wind helps to convey the waters from northern basin towards Venice and from the industrial zones towards the lower part of the lagoon.
A similar turbidity diffusion towards the historical centre was confirmed by the May 27th,1978, June 19th,1977, May 19th,1976 and April 28th,1975 images, recorded during tidal inflow phase. In all images the incoming clean water was gathering in a restricted areas around Malamocco and Lido entrances (Alberotanza and Zandonella, 1980).
The circulation patterns deduced from this analysis appear to be confirmed by the traditional oceanographic measurements (Nyffeler,1976).

5. CONCLUSIONS

From the results obtained, the following conclusions have been reached.
- The polluted waters are present between industrials zones and the historical centre of Venice under any tide conditions.
- The pollutants flow is continuous and involves the same areas with variations only in the spatial distribution.

- The clean water diffusion in the lagoon during flood tide remains limited to restricted areas around Malamocco and Lido inlets.

For the above considerations, taking into account also the sea-truth measurements, it can be deduced that turbidity concentration in well defined areas derives from both the short time interval between tidal inflow and outflow and the distance between the two lagoon entrances and the industrial zones.

REFERENCES

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