Mapping erosion and deposition rate changes along the Axios-Aliakmonas rivers Delta, North Greece based on Landsat TM imagery analysis

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1. INTRODUCTION & OBJECTIVES

Coastlines movement due to soil erosion and deposition can potentially cause significant hazards to human activities and settlements. **Remote sensing**, combined with **Geographical Information Systems (GIS)**, has shown a promise in detecting & monitoring coastlines movement (e.g. Wu, 2007; *Li & Damen, 2010; Cui & Li, 2010*).

Axios and ***Aliakmonas*** are two of the largest rivers of Greece, being recognised as extremely rich and fertile ecosystems. Their deltas is a wetland of international importance according to the Ramsar Convention. Their deltas, due to their highly dynamic nature also provide a very good case in evaluating the potential capability of a range of remote sensing algorithms for monitoring coastline changes as well as soil erosion & deposition due to changes in coastlines.

The objectives of our work had been to:

- *Evaluate a range of image processing techniques combined with Landsat TM imagery for mapping the coastline movement of the Axios and Aliakmonas river Deltas for the period 1984-2009.*
- *Appraise the use of different methods in estimating erosion and deposition rates taking place in the region for the studied period.*

2. STUDY SITES & DATASETS

1. Study site:

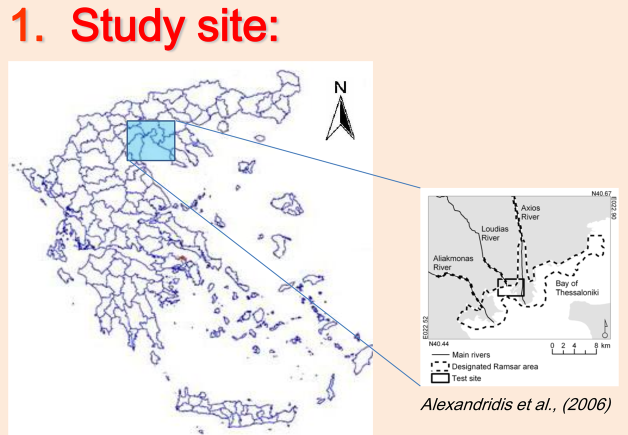
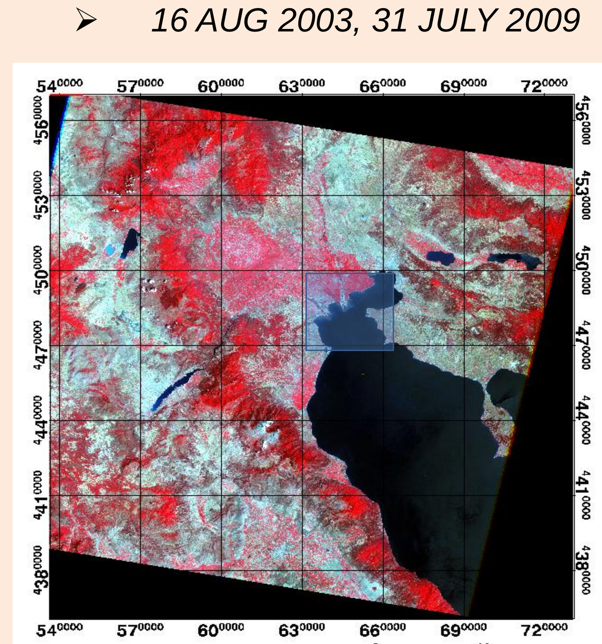


Fig. 1: *Study site location*

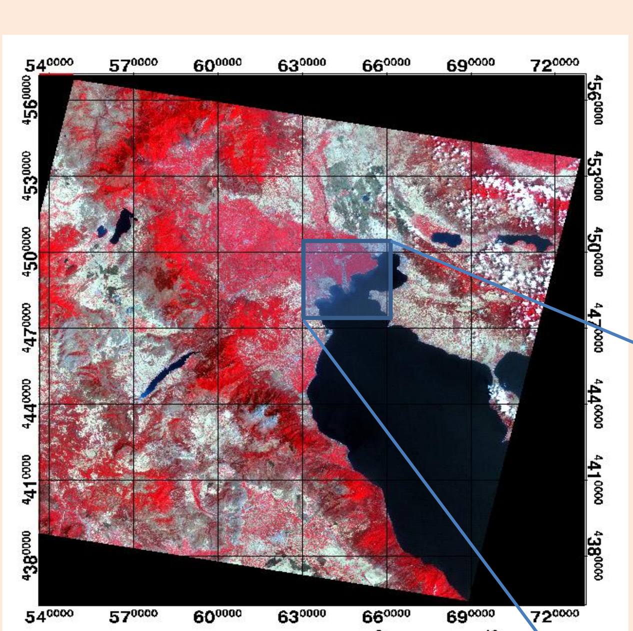
2. Datasets:

Landsat TM images:

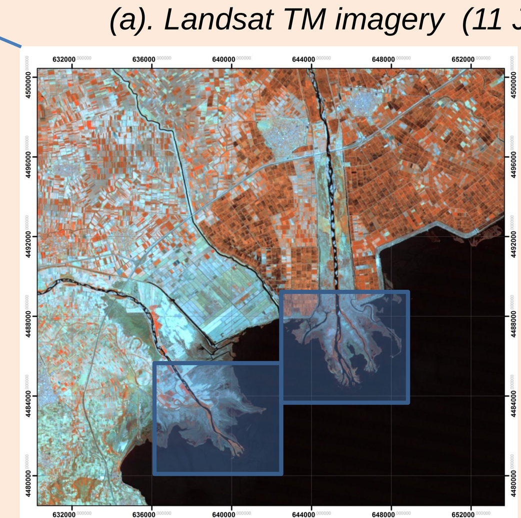
- 26 JULY 1984 , 11 JULY 1990
- 16 AUG 2003, 31 JULY 2009



(a). Landsat TM imagery (11 JULY 1990)



(b). Landsat M imagery (26 JULY 1984)



(c). Zoom to our study region

Fig. 2: *Examples of the acquired datasets*

3. METHODOLOGY

After standard pre-processing, coastlines from each TM image was extracted based on the following techniques:

1. *Direct digitisation (photo-interpretation –bands 4,5,7 – e.g. Li and Damen, 2010)*
2. *Band Ratio (TM2/TM5 – e.g Cui & Li, 2011)*
3. *ISODATA & K-MEANS unsupervised classification (Richards, 1999)*
4. *Support vector machines (SVMs) and maximum Likelihood (ML) supervised classification (Vapnik, 1998).*

Soil erosion and deposition rates in the Deltas were estimated based on the coastline surface area (m^2) changes.

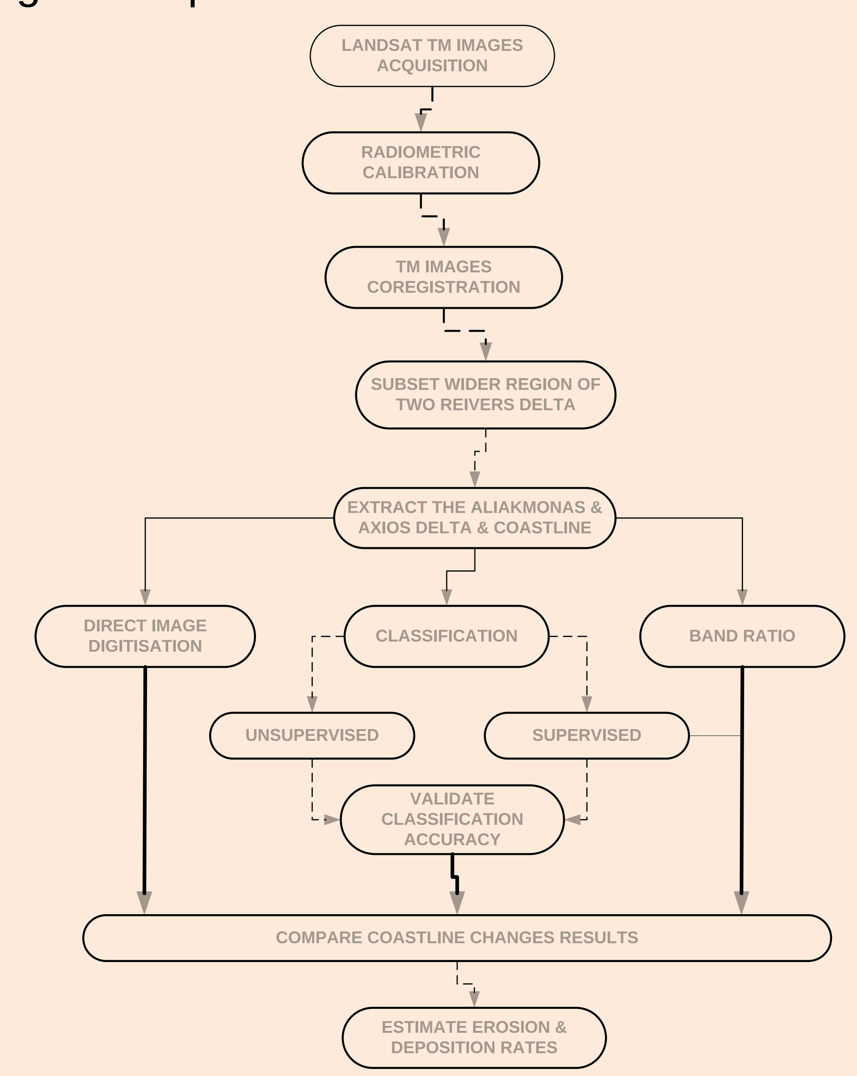


Fig. 3: *Overall methodology flowchart*

4. RESULTS: *differences in land/water detection*

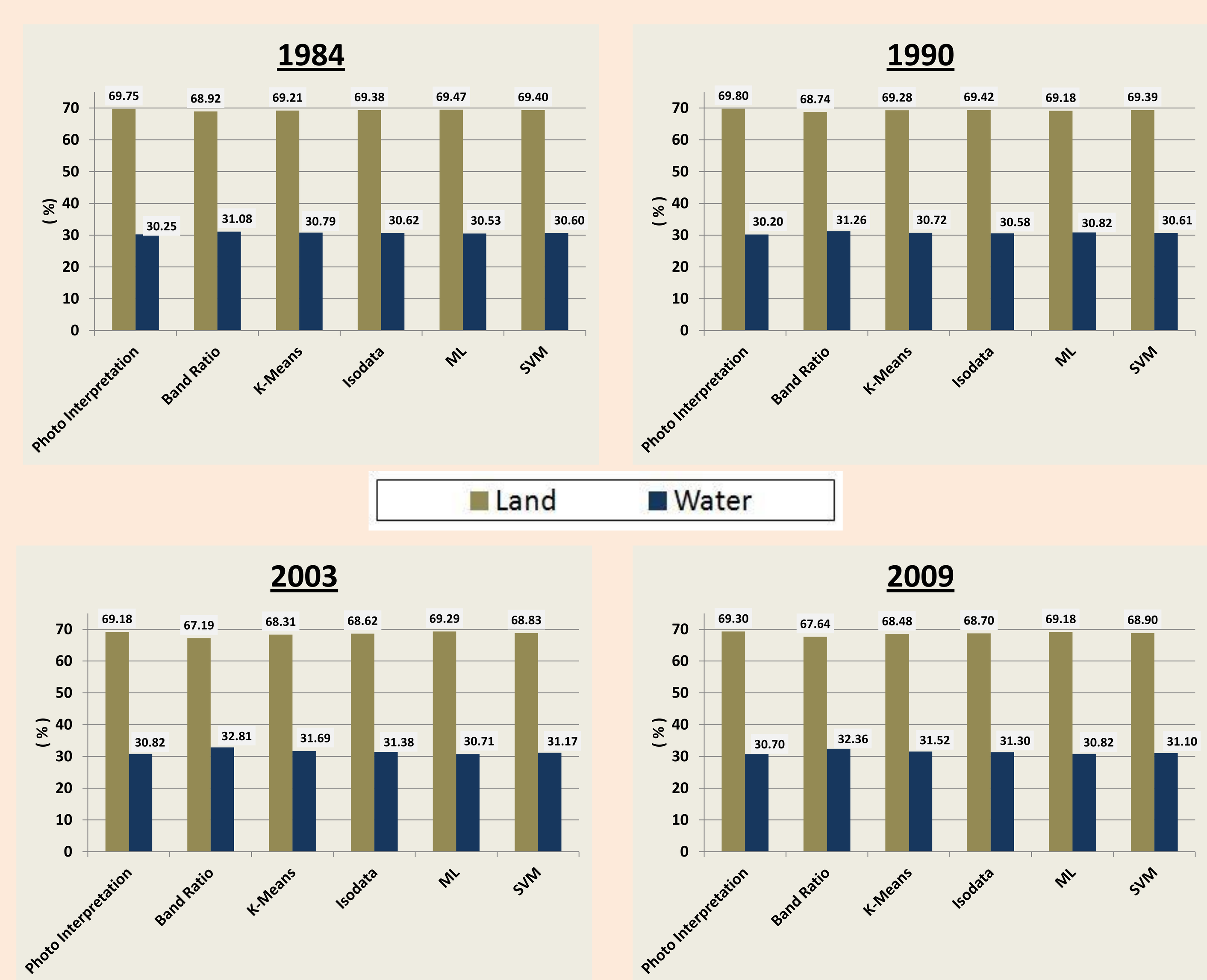


Fig. 4: *Changes in the land cover between water and land in the areas of the two river Deltas*

5. RESULTS: *soil erosion & deposition*

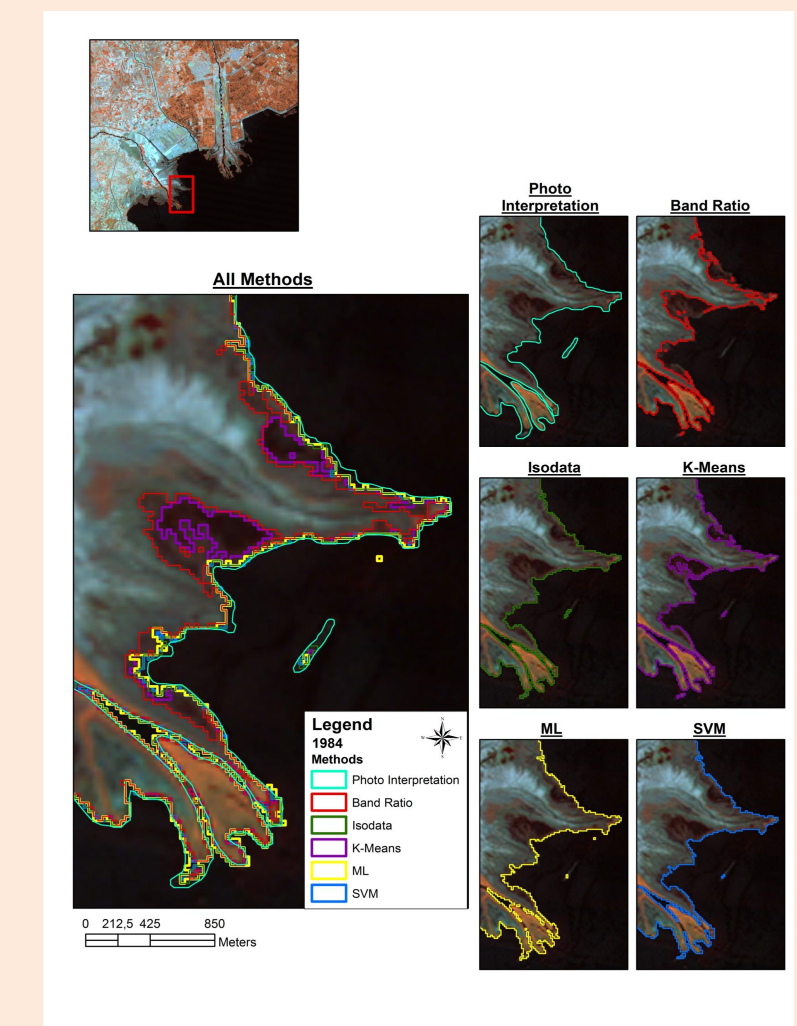


Fig. 5: *Example illustrating the differences in the coastline changes extracted from the different methods applied, here for Aliakmonas river delta.*

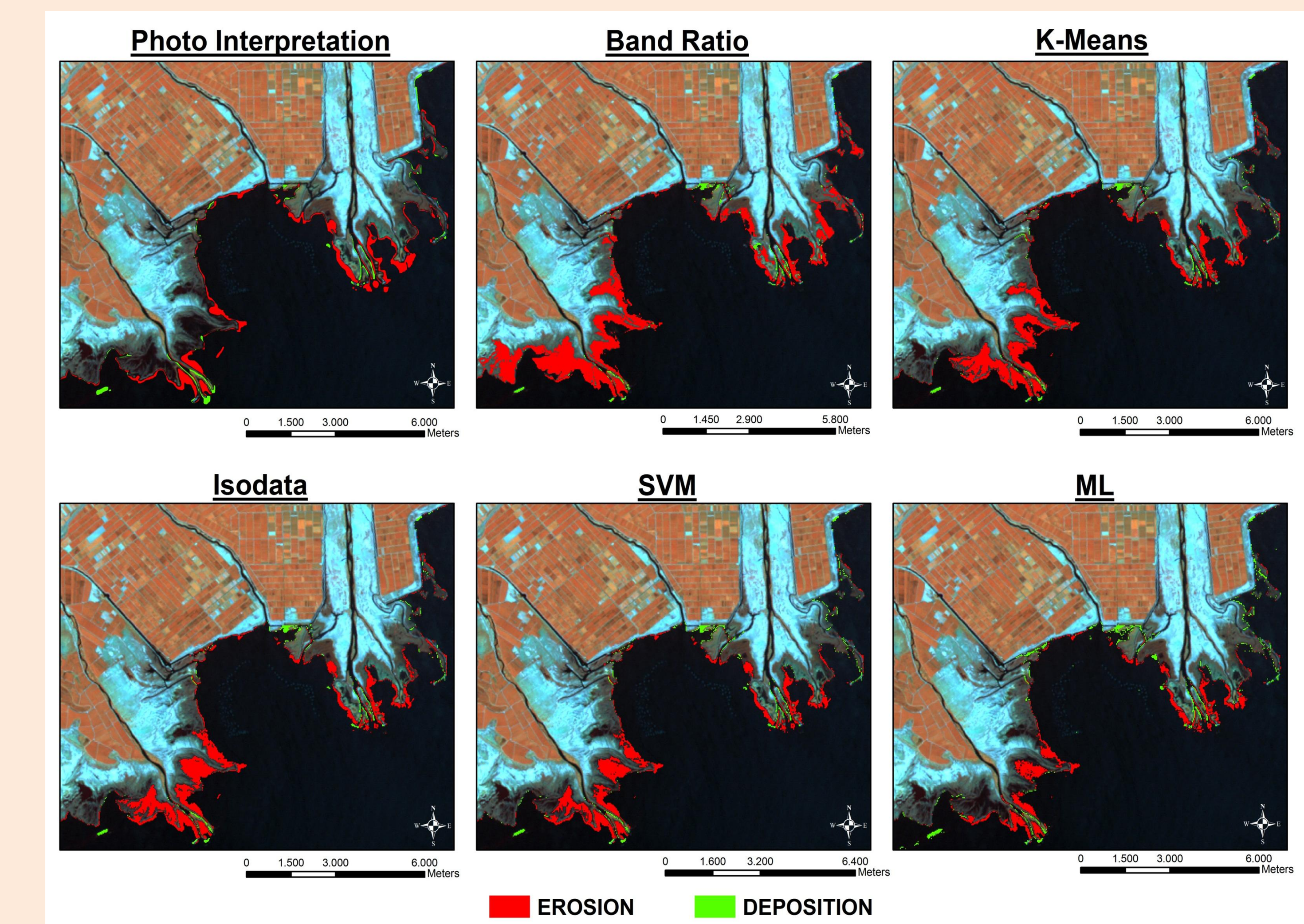


Fig. 6: *Overview of the total deposition/erosion for the 2 river deltas for the period 1985-2009.*

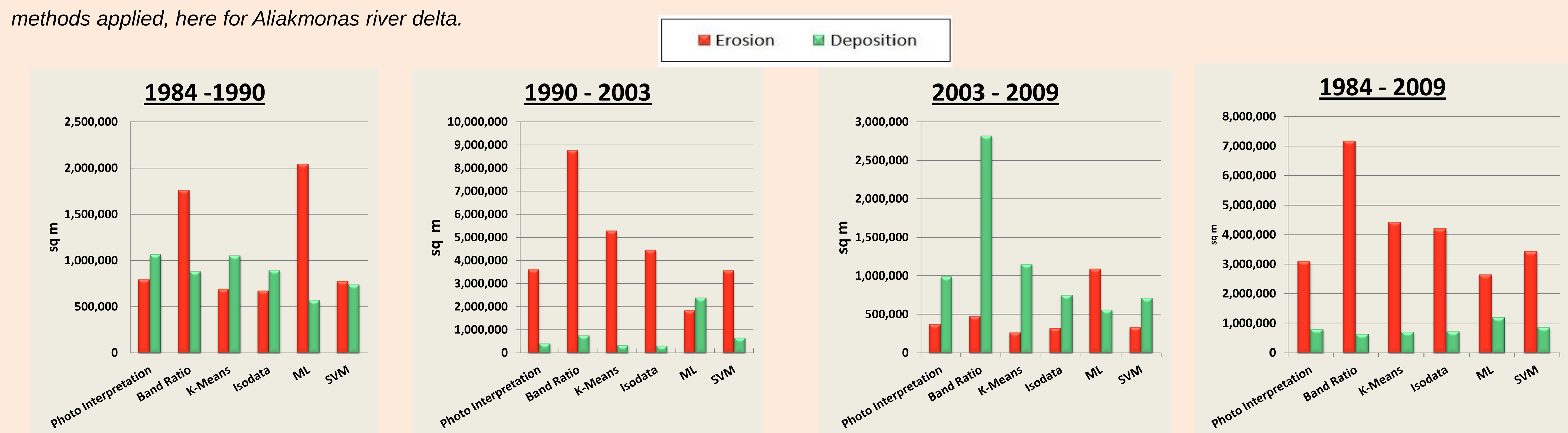


Fig. 7: *Comparisons of the total/erosion rates between the different methods for different time periods.*

6. CONCLUSIONS

Comparing the positions of the 2 rivers Deltas from a series of TM images allowed areas of coastline changes to be identified. Generally, patterns in the coastline transformation were commonly identified by all techniques, but to a different degree. Also, differences between the techniques were also reported in terms of erosion and deposition rates for both rivers deltas. Those were largely attributed to the ability of the different approaches in utilising the spectral information content of the TM data and the methods' operation assumptions. Supervised classifiers, particularly SVMs, showed generally the closest results to those of photo-interpretation, evidencing the potential of machine learning remote sensing –based algorithms in enhancing conventional field-based surveying for monitoring shoreline changes over long timescales in a cost-effective and rapid manner.

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