Herrier J.-L., J. Mees, A. Salman, J. Seys, H. Van Nieuwenhuyse and I. Dobbelaere (Eds). 2005. p. 583-584
Proceedings 'Dunes and Estuaries 2005' – International Conference on Nature Restoration
Practices in European Coastal Habitats, Koksijde, Belgium, 19-23 September 2005
VLIZ Special Publication 19, xiv + 685 pp.

Sediment characterization in the 'IJzermonding' using empirical orthogonal functions: application to CASI

Stefanie Adam, Suhyb Salama and Jaak Monbaliu

Laboratory for Hydraulics, Department Civil Engineering, Katholieke Universiteit Leuven,
Kasteelpark Arenberg 40, B-3001 Heverlee, Belgium
E-mail: stefanie.adam@bwk.kuleuven.ac.be

Abstract

The erodability of mudflats is strongly determined by biophysical characteristics of sediments, such as silt, sand, benthic microalgae and water content. Mudflats are often large and inaccessible areas, leading to dangerous and time-consuming in situ measurement campaigns. Furthermore the collected point samples are unrepresentative for the spatial variability of these coastal systems. Airborne hyperspectral remote sensing is identified to be effective for the collection of a synoptic overview of biophysical characteristics of sediments in mudflats. An automated method for the classification of hyperspectral images acquired by the Compact Airborne Spectrographic Imager (CASI) is proposed. The method is based on a linear transformation of each spectrum in the hyperspectral cube. Comparable classification results are obtained using a standard classification method employed in hyperspectral image processing. The superiority of the proposed method lies in its robustness, computational requirements, repeatability, interpretability and objectiveness.

Keywords: Mudflats; Biophysical characteristics; Hyperspectral image classification; Linear transformation.

Introduction

The process of mudflat sediment entrainment, transport and deposition is dependent upon the biophysical characteristics of the sediment. Hyperspectral airborne images are promising for the study of intertidal zones because of the global coverage, the superior spectral and spatial resolution, and operational flexibility. Two classification methods will be applied to hyperspectral images of a Belgian mudflat acquired in 2001 and 2003.

Methodology

The principal component transformation (PCT) is a powerful technique to decorrelate the bands of hyperspectral images so that the largest amount of information can be explained in few bands. For the intertidal zone, the number of PCs did not exceed two to explain more than 99.2% of the data variation. The first two PCs explain the variability

in the near infrared (NIR) and the red reflectance. The most important classes present in an intertidal zone are vegetation (on the stabilized dunes), silt, sand and mixed sediment (mixture of sand and silt). These classes show distinct properties in the NIR reflectance and red absorption. The combination of the two PCs will enable us to separate these four classes. If more than four classes are present, a cluster of pixels consisting of more than one class will appear. The pixels of the mixed class are isolated, and the PCT followed by the classification is performed on these pixels.

The standard method of hyperspectral image classification consists of several steps: i) the minimum noise fraction transformation to reduce the dimensionality of the data; ii) the collection of the spectra of pure materials (endmembers); iii) the classification based on spectral angles between pixel spectra and endmembers.

Results and discussion

Both images were classified using the principal component transformation. The spectral characteristics of the classes and field knowledge are used as basis for the identification and labeling of the clusters of pixels.

The same classes were identified using the standard method, but large differences were observed in the classification results. An accuracy assessment of both methods could not be made due to lack of ground data.

However there are large differences in the procedures. The standard method is time-consuming and very subjective. It is mainly based on expert knowledge of the terrain and the image and on trial and error. The results are not reproducible. On the other hand, the classification method using PCT is objective and robust (no interference of image interpreter necessary) and it can be automated in a few steps. The procedure is fast and easy to perform. The results are physically interpretable.

Conclusion

A classification method for intertidal mudflats based on empirical orthogonal functions was developed. The proposed method is superior to the standard classification method of hyperspectral images with regard to user-friendliness, repeatability, ground truth requirements and physical interpretability.

Acknowledgement

We would like to thank the Natural Environment Research Council (NERC), UK, the Vlaamse Instelling voor Technologisch Onderzoek (VITO), and the Administratie Milieu-, Natuur-, Land- en Waterbeheer AMINAL. This work was supported by the Federale Diensten voor Wetenschappelijke, Technische en Culturele aangelegenheden (DWTC) in the framework of the PRODEX Experiment Arrangement between ESA and the Katholieke Universiteit Leuven, project C90164 “The IJzer Estuary”.