Monitoring estuarine salt crusts using hyperspectral data (River Odiel, SW Spain)

**Buzzi, J.**; Riaza, A.**; García-Meléndez, E.**; del Moral, B.; Carrère, V.; Richter, R.

Abstract: Marshes are highly dynamic ecosystems based on the interaction between sea level, land elevation, vegetation cover and sediment accretion. In the current study case, the acid mine drainage-contaminated River Odiel water in the estuary interact with marine salt water resulting in complex geochemical processes developing salt crusts in intratidal planes. The use of imaging spectroscopy techniques with Hyperion imagery and field and laboratory spectral data permits the monitoring of the spectral trends of the salt crusts and perform a temporal monitoring of these efficiencies. Climate variability, geomorphology and tidal regime have been established as key factors in the salt crusts development. The results evidence that the marshes of the River Odiel are a suitable testbed with the upcoming spectroscopic sensors EnMAP (ESA) and HySpIRI (JPL). The good signal/noise ratio and the temporal resolution allow the acquisition of large sequences of images, adequate for real time data analysis.

**Keywords:** Imaging spectroscopy, coastal marsh geomorphology, mine waste contamination, real time Earth observation.

**RESULTS**

**CHANGES IN VEGETATION**

The hyper spectral capabilities of the Hyperion sensor allows the performance of highly detailed vegetation analysis. The analysis of temporal series of images reveals how the estuarine vegetation of marshes evolve throughout. Hyperion data analysis shows that the development of healthy vegetation in the marshes corresponds with humid and moderately warm climatic conditions.

**CHANGES RELATED TO TIDAL EFFECTS**

The analysis of hyperion data has permitted to record the variations in water flooding, wet intertidal surfaces and salt development over soil in areas of water withdrawal.

**SALT EFFLORESCENCES**

The salty areas of 27 August 2005 are flooded on 21 August 2006 at high tide. A wide area is covered by previously wet land that subsequently developed a salty soil, with these regions ribbed by narrow belts of salt with no evidence of salt. This outer ribbon represents the last endmember of the drying process according to the maps of 2005. Five days later, on 26 August 2006, the salty soils exhibit spectral features devoid of salt, and the salty areas are spared.

At the end of August during the comparatively wet year of 2007, salt development is restricted to small topographically elevated areas; the remaining topographically low areas are flooded, displaying a spectral response with a strong vegetation component. King tides are responsible for the wide flooding, since this Hyperion scene was recorded at low tide.

**ANALYSIS**

The Hyperion imagery was scheduled with funding from the Spanish National Research Program (CGL2007-60004/CLI), now public domain. The Hyperion processing routine was carried out following the Hyperion processing routine (HPR). The Hyperion pre-processing routine includes:

1. Atmospheric correction (Empirical Line)
2. Conversion of DN to reflectance values.
3. Cleaning of overlapping channels and faulty detectors.
4. Coregistration and masking of overlapping Hyperion and Quickbird images.
5. Workspace definition

**THE ESTUARINE ENVIRONMENT**

When the Odiel river reaches the Atlantic Ocean, it takes place a mixture of fresh acid water coming from the drainage of the northern relief, with saline marine water. Estuary environments are strongly influenced by tides, controlling the geomorphology of channels, the development of vegetation and the fauna. The evolution of salt marshes is controlled by the variations of the sea level, the land vegetation and the sediment accretion.

**NEW PERSPECTIVES**

One of the most promising trends in Earth Observation is the Real Time Monitoring. Future hyperspectral sensors onboard NASA's HySpIRI and ESA's EnMAP will provide an adequate temporal coverage of the Earth surface, offering standardized products for science and industry, in all the different disciplines of environmental, agriculture and Earth sciences.

**ACKNOWLEDGMENTS**

The Hyperion imagery was scheduled with funding from the Spanish National Research Program (GLO2007-60004/CLI), now public domain. The basis for the focus of this work was developed during the PhD work of Jorge Buzzi Marcos (BES-2008-003648, University of León, Spain, Dec. 2012).

**BIBLIOGRAPHY**


**DATA AND IMAGE PROCESSING**

**HYPERION PROCESSING ROUTINE**

Hyperion processing routine

- Hyperion pre-processing routine
  - Opening of overlapping channels and faulty detectors.
  - Conversion of DN to reflectance values.
  - Cleaning of overlapping channels and faulty detectors.
  - Coregistration and masking of overlapping Hyperion and Quickbird images.
  - Workspace definition

**SALTY AREAS**

- Hyperion pre-processing routine
  - Atmospheric correction (Empirical Line)
  - Conversion of DN to reflectance values.
  - Cleaning of overlapping channels and faulty detectors.
  - Coregistration and masking of overlapping Hyperion and Quickbird images.
  - Workspace definition

**ANALYSIS**

- Atmospheric correction (Empirical Line)
- Conversion of DN to reflectance values.
- Cleaning of overlapping channels and faulty detectors.
- Coregistration and masking of overlapping Hyperion and Quickbird images.
- Workspace definition

**THE ESTUARINE ENVIRONMENT**

- When the Odiel river reaches the Atlantic Ocean, it takes place a mixture of fresh acid water coming from the drainage of the northern relief, with saline marine water.
- Estuary environments are strongly influenced by tides, controlling the geomorphology of channels, the development of vegetation and the fauna.
- The evolution of salt marshes is controlled by the variations of the sea level, the land vegetation and the sediment accretion.

**NEW PERSPECTIVES**

- One of the most promising trends in Earth Observation is the Real Time Monitoring.
- Future hyperspectral sensors onboard NASA's HySpIRI and ESA's EnMAP will provide an adequate temporal coverage of the Earth surface, offering standardized products for science and industry, in all the different disciplines of environmental, agriculture and Earth sciences.