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Modelling coastal processes by means of innovative integration of remote sensing time series analysis

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Coastal marine and inland landforms are dynamic systems undergoing adjustments in form at different time and space scales in response to varying conditions external to the system. Coastal emerged and shallow submerged nearshore areas, affected by short-term perturbations, return to their pre-disturbance morphology and generally reach a dynamic equilibrium. Worldwide in the last century we have experienced in increased coastal inundation, erosion and ecosystem losses. However, erosion can result from a number of other factors, such as altered wind and current patterns, high-energy waves, and reduced fluvial sediment inputs. Direct impacts of human activities, including reclamation of coastal wetlands, deforestation, damming, channelization, diversions of coastal waterways, construction of seawalls and other structures, alter circulation patterns. Also indirect human impacts such as land-uses changes through time (from agricultural to industrial use) have affected coastal ecosystems.

The objective of this research is to propose innovative remote sensing applications for monitoring and/or combination of existing ones to monitor specific coastal processes in order to quantify and model their time evolution. In particular, it shows which properties are the best proxy for remote sensing characterisation of nearshore coastal areas both emerged and submerged environments by combining multi-sensor spaceborne remote sensing (SAR and OPTICAL) to a) produce deformation and spatiotemporal variations maps in coastal morphology with a special focus to point out the temporal subsidence evolution, b) integrate inter and intra-annual change detection maps into coastal morphology.

The basic strategy was to highlight the different components of the coastal system environment through: 1) deformation and spatio-temporal variations maps of coastal morphology, where the time-series from 1992 up today of SAR data (ERS-1/2 and ENVISAT-ASAR sensors) were used to produce deformation maps and to point out the temporal evolution and 2) to point out the temporal evolution via hyperspectral endmembers fractions map of coastal morphology. The objective was to locate and characterize important coastal indicators for different regions using multitemporal data from the multi-hyperspectral sensors, as well as topographic elevation, SAR phase/amplitude data. The identification of different indicators was based on land spectral properties, topography/landforms (low topography), disturbed areas (agricultural, construction), and vegetation distribution. Moreover, the "longevity" of the indicators was assessed at seasonal and interannual time scales over two temporal decades horizons starting from 1990 and 2000.

By combining SAR spatiotemporal dynamics and hyperspectral processing, the feedback in time and length scale of the different bio-geophysical parameters was highlighted. Surface changes analysis benefit the accurate collection of different ecological and morphological data. The research was applied in two dynamic and densely populated deltas and coastal areas (the Po and the Bangladesh delta) to understand how shallow water transitional environments respond to climate change and to enhance the management of future remote sensing mission by quantifying the estimation of uncertainties. In coastal landscape this question is still unknown.