Transport of Sediments and Strata Formation on the Adriatic Epicontinental Shelf

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LONG-TERM GOALS

The long-term goal of our research is to improve understanding of sediment transport and processes controlling fate of associated nutrients and contaminants in coastal water. Specifically, we hope to improve our ability to model sediment erosion, transport, and deposition on a regional-scale (over a few 10s of kilometers) with a predictive capability over time scales of decades. Such models would be useful for a wide range of engineering, environmental, and Naval applications. Field observations and measurements of sedimentary processes are a key component of our research, because quantitative data are needed to improve parameterizations of sedimentary processes and to test existing models. Measurement of near-bottom velocities, shear stresses, suspended-sediment concentrations and size distributions, bottom sediment characteristics, and bottom topography are crucial for developing new algorithms for transport models and for critical evaluation of existing models.

OBJECTIVES

The objectives of EuroSTRATAFORM are to measure and model the oceanic and geologic processes that erode, transport, and deposit sediment on continental margins, with particular focus on those events that form and destroy beds over time scales ranging from weeks to years. EuroSTRATAFORM hopes to transfer knowledge accumulated in the ONR STRATAFORM program, incorporate the expertise and insight of European investigators, and test our developing understanding of depositional marine systems in a different environmental context.

The science plan outlines immediate objectives for the Adriatic component of EuroSTRATAFORM, comprised of the following field programs.

- Po Delta Studies – Examine dispersal of sediment in the Po Delta region using long-term moorings, and seasonal and post-flood sampling of the seabed and water-column.

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14. ABSTRACT

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- Po and Apennine Survey – Regional reconnaissance survey of seabed and water-column properties following winter discharge season (Spring 2002) along the Adriatic shelf between the Po Delta and the Gargano Peninsula.

- Apennine Region Field Study – Conduct process studies on cross-shelf transects with tripods, moorings, and water column measurements during fall and winter runoff periods (November 2002 – April 2003) to observe transport and deposition of material from Apennine River plumes. The measurement program will combine resources of several investigators and institutions, deploy instrumentation at ~5 or 6 sites extending from the mud/shelf transition region on the inner shelf (~5 – 8 m) to the region of maximum deposition on the foreset beds (~45- 55 m), and measure dynamics of the river plumes, bottom boundary layer processes, sediment resuspension and transport, and evolution of bed properties.

The objectives of USGS studies are as follows:

- Participate in the Apennine field study, measuring key processes in the benthic boundary layer and the response of bottom sediments and bottom morphology to sediment input and oceanographic forcing during winter months at two sites in the Apennine study area.

- Develop a regional model of sediment transport and compare model results with measurements, with particular emphasis on the relationship between suspended-sediments and bottom sediments

- Develop and test new methods of estimating bottom sediment size.

APPROACH

We propose to contribute to three areas of EuroSTRATAFORM research. Each of these is discussed below.

Apennine Field Study – Tripod Measurements

The USGS will participate in collaborative measurements of oceanographic and geologic processes on the Apennine coast. Overall, the measurements are intended to measure water column, benthic boundary layer, and bed sediment properties on cross-shelf transects beginning near the sand/mud transition and extending seaward region of maximum cross-shelf transport on the topset beds. These measurements will be made in the Fall 2002 – Winter 2003 season when sediment delivery by the Po and Apennine rivers and resuspension and transport by Bora winds is likely to occur. In conjunction with tripods and moorings to be deployed by other investigators, the array will provide measurements of alongshore changes in the rate and character of sediment flux as the relative influences of the Po and Apennine Rivers change towards the south.

We are planning to deploy three instrumented tripods off the Chienti River. The USGS tripod measurements will provide measurements of waves, currents, temperature, salinity, shear stresses, turbidity, suspended-sediment concentrations, bottom micro topography, and bottom grain size at a shallow inner shelf location (~12 m) and deeper midshelf location (~20 m). Two tripods will be deployed at the inner shelf location, in collaboration with researchers Hill and Milligan (from Dalhousie Univ. and Bedford Institute of Oceanography, respectively). One of the inner shelf tripods

will be designed to record flow conditions, and will be instrumented with a pair of Sontek acoustic Doppler velocimeters to estimate near-bottom stress, a downward-looking Sontek pulse-coherent acoustic Doppler profiler for measuring current-velocity profiles in the bottom meter, and an acoustic backscatter sensor for estimating suspended-sediment profiles. This tripod will support as few instruments as possible to reduce flow disturbance. Other instruments will be deployed on a nearby tripod to measure bottom sediments and suspended particles. Devices to be deployed on the particle tripod include laser-illumination and video system for imaging flocs, a LISST-100 laser particle sizer, a dual sonar for profiling and imaging, and a new instrument to optically record changes in bottom-sediment size.

The tripod at the deeper site will provide continuous profiles of currents and suspended-sediments over most of the bottom ~1 m, allowing us to make relatively detailed flux estimates, and propose to monitor bedforms with a scanning sonar. Although our current profiler will not be able to measure in the wave-boundary layer, both tripods will be capable of estimating suspended sediment concentrations within a few cm. of the bottom.

Modeling – Community Sediment-Transport Model Test Site

The USGS proposes to establish a regional sediment-transport model for the Apennine study regions in the Western Adriatic. This model will complement the proposed efforts of Signell and Harris, but will rely on different model code, and is intended as one of the first test cases of the community coastal sediment-transport model being advanced by the USGS. The model will incorporate detailed measurements from the Apennine study area to provide parameterization and validation of small-scale processes and will attempt to scale up these processes to predict sediment motions on a regional scale. Mass-balance budgets based on observed suspended-sediment loads and the observed movement of mud/sand interfaces will be reconciled with modeled tidal, wind-driven, and residual currents. Parameterization of bbl processes including bed stress, bedform transport, sediment-induced stratification, and gravitational influences will be derived from the tripod and mooring observations. The model will likely use hydrodynamic code from either the developing Regional Ocean Model (ROMS) or Delft3D, a model recently adopted by ONR for nearshore and coastal use.

Instrument Development – Grain-size Camera Measurements

The USGS recently developed an underwater digital video microscope (UDVM) that can be placed in contact with the sea bed to illuminate and photograph bottom sediment. UDVM images of well-sorted sand can be digitally processed to determine grain diameter, and we are working to extend the technique to poorly-sorted and finer sediment (coarse silt). The UDVM is suitable for vessel deployments, but we have developed a prototype for EuroSTRATAFORM that is capable of remote autonomous tripod deployment. The lens is mounted on a retractable probe, and programmed to image bed sediments on a regular (daily) basis at the inner-shelf location. The resulting estimates of bed size distribution will complement water-column measurements of suspended sediment made with LISST with multifrequency acoustic backscatter sensors. Combined, these measurements will aid tremendously in quantifying resuspension processes and provide data for comparison with model.

WORK COMPLETED

Work in FY 2002 has involved planning and preparation for the Winter 2002-2003 deployment. USGS scientists attended planning meetings in Seattle, Washington and Winchester, UK. We have prepared our tripods and instruments for deployment in Italy and have shipped them to Bologna, where construction of the tripods will occur in mid-October. and have prepped instruments and shipped them to Bologna, Italy.

Using USGS funds, we have developed and built a UDVM suitable for autonmous deployment on a tripod, and plan to deploy it at the inner-shelf location.

RESULTS

None yet.

IMPACT/APPLICATIONS

None yet.

TRANSITIONS

None.

RELATED PROJECTS

One of the instruments to be deployed on the Chienti transect is a dual sonar and datalogger system developed with ONR funding (award number: N00014-01-F-0263).