SUBMARINE GEOMORPHOLOGY AND LINKS BETWEEN ONSHORE AND OFFSHORE EROSION IN THE IONIAN SEA, ITALY

Supervisors:
Dr N. Mitchell, Dr S. H. Brocklehurst (University of Manchester, UK)
Dr A. Argnani (CNR, Bologna, Italy)

Submarine continental slopes are landscapes characterised by large variety of relief from gullies and canyons, but how these features develop is still not well understood. Marine-geoscientists suspect that sediments delivered from the adjacent land might be the ultimate "driver" for these landscapes, for example, by supplying erosive sedimentary flows, but it is a difficult association to prove as along most coasts the shelf is too wide to allow us to assign individual canyons to rivers and we have poor idea of the sediment supply.

The coasts of NE Sicily and SW Calabria have narrow shelves and their uplift rates are well quantified. As the Sicilian coast landscape in particular is mature, the long term sediment flux can be assessed from the uplift rates and their drainage catchment areas. This has been carried out along the coasts by extracting drainage catchments from SRTM (Shuttle radar Topographic Mission) DEM. Published uplift rates are calculated from the Late Pleistocene terraces and Holocene tidal notches and they range from 0.7-1.5mm/yr and 1.5-2.5mm/yr respectively. The calculated long term sediment flux varies by a factor of 10 between the smallest and the largest drainage area. This sediment flux gives a rough estimate of the total mass transported to the sea.

A marine geophysical dataset was collected in 2006 aboard the Italian research ship Urania by my co-supervisor (Andrea Agnani), including multibeam echo-sounder, sediment profiler and seismic reflection data. The dataset reaches to within 100m water depth around the coast and represent areas that were exposed during the Last Glacial Maximum as, according to estimates, local relative sea level was depressed by 120m. This allows an assessment of sediment transport paths during glacial times. Near coasts, sediment delivered by rivers from the eroding landmass can create steep deposits that fail, disaggregate and form sedimentary flows, initiating erosion. Alternatively, the suspended sediment load in river waters may be so concentrated during flash floods that the river outflow is denser than seawater, leading to "hyperpycnal" currents, a type of turbidity current. The purpose of this project is to quantify and link via such mechanisms the offshore erosion/deposition within the Ionian Sea with the on-going erosion of Sicily and Calabria, characterized using various remote-sensing data and fieldwork.

There has been much attention given for over decade submarine erosion, such as how it is transported across the shoreline and shelf and then, how it is further eroded and/or deposited offshore. The links between onshore and offshore sedimentary processes have attracted much attention over the last decade as it has become realized that hyperpycnal river outflows can carry sediment from land to the deep sea. Some studies have addressed this with field measurements, especially in the Pacific coast of California, but they have tended to examine only single river outlets, not systems of many rivers as here.

The present data, in deeper water, show channels diverted oblique to the modern slope, allowing study of the response of the sedimentary system to regional tectonic tilting. Links between volcanism and submarine slope erosion can be assessed where the data encompass the eastern slopes of the Italian volcano Mt Etna. An estimation of the near shore sand flux by tidal currents in the Strait of Messina will be attempted from the available migrating velocity of these sand waves. This will also show locally the relative importance of tidal and river-supplied sand fluxes. The Straights of Messina

between Sicily and Calabria have been geographically important since Classical times, but it is unclear if the straights have been maintained by tectonics or by tidal scour, issues that can also be addressed within this PhD.

The onshore part of the study aims to observe how drainage systems in a Mediterranean climate respond to variations in sea level, bed rock erodibility and uplift rate. Published uplift rates suggest that the area is rapidly uplifting, and thus ideal to investigate how geological processes (rapid uplift) affect the channel morphology through different geomorphological processes (hillslope failure, channel incision and sediment aggradation, degradation and/or transportation), and the linkages between these processes. Channel profiles show general concave upward trends with some locally steep reaches (knickpoints). Field observation revealed that there is a major shear zone parallel to the coastline that causes brecciation of bedrock and promotes hillslope failure. The shear zone also causes more rapid accumulation of sediments on the channel bed. Unlike other coastal orogenic catchments, such as in California, where knickpoints reflect relative sea level fall, this study area shows a stronger effect of lithlogy and tectonically induced bedrock fracturing on knickpoint locations, making isolation of the different processes responsible for landscape evolution challenging. Earlier work on bedrock channel response to uplift suggests that channel steepness is influenced by the uplift rate, but here only a weak relation is observed. This might be due to the fact that the energy required to transport coarse fraction of the bed load is higher than the available energy of the channel to transport these sediments. Therefore, the coarse fraction of the bed load is not evacuated, meaning continuous aggradation of these sediments. Finer material is evacuated and fills the valleys downstream.

This Gill Harwood Fund will allow me to present a paper in the EGU (European Geosciences Union), 2009 in Vienna, Austria. The paper is based on the onshore findings of my present research and will be presented in the "Landscape Dynamics" session of the "Geomorphology" program group. Speaking at big conference like EGU would give me the opportunity to polish my presentation skills. There is a diverse selection of speakers in the session, so participation will allow me to interact with workers in the similar research areas. It is also helpful to see how different speakers provide insight to the similar issues. The most important part is the networking, an opportunity to make connections and exchange information.

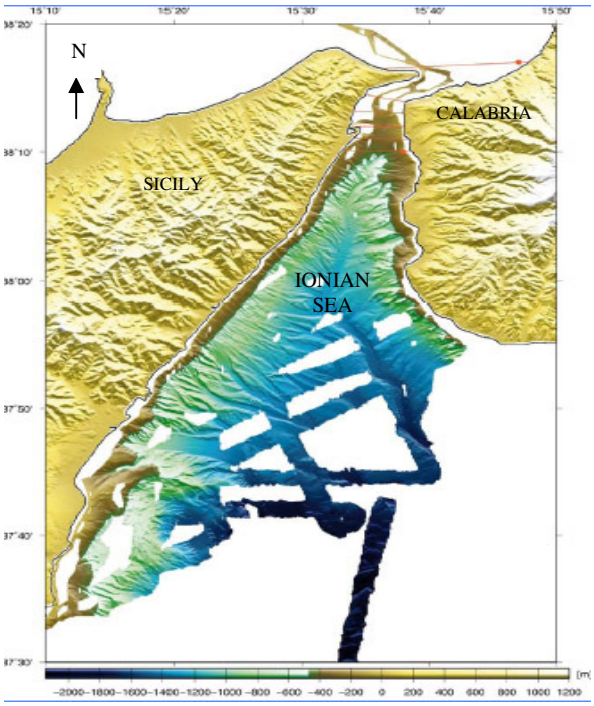

Figure: A gradient map prepared from the SRTM DEM of Sicily and Calabria and from the marine geophysical data of Ionian Sea.