Collaborative Research – Sediment Production and Alluvial Buffering in a Steepland River Basin: Waipaoa River Basin, New Zealand.

PROJECT SUMMARY – We propose to determine the extent to which alluvial storage has buffered basin sediment yield during the late Holocene from changes in the nature and intensity of the erosion processes that generate sediment in the headwaters of the Waipaoa River basin. Our research converges on a period (last 3.5 kyr, calendar years B.P.) in which high-resolution stratigraphic records show that perturbations to the landscape, caused by natural events (major volcanic eruptions) and human activity (deforestation), are the primary forcing factors. We seek funds to support an integrated research program that blends the skills and expertise of a diverse group of scientists from the U.S. Our research builds on a wealth of unusually detailed baseline data and existing research (including ongoing work being undertaken by our New Zealand colleagues), and involves field, analytical and modeling investigations.

Our approach will be to employ field surveys and coring, supported by Terrestrial Cosmogenic Nuclide (TCN) methods, to help constrain the essential components of late Holocene landscape evolution; specifically, the chronology of Holocene downcutting, and the rates and patterns of surface erosion. This knowledge, in conjunction with information about the late Holocene climate derived from cores from Lake Tutira (to be obtained and analyzed by our New Zealand colleagues), and conventional hydroclimatic and geomorphic data will be used to specify the boundary conditions for a numerical model (HYDROTREND) that creates synthetic river discharge and sediment load time series over long periods (thousands of years) as a function of climate trends and basin morphology. We shall calibrate the synthetic daily discharge hydrographs using observed meteorological data, and compare the modeled flood frequency, daily and annual sediment load variability to the modern gauging record, and the estimates of time-integrated rates of sediment generation derived from Nuclide activity. We shall also compare the synthetic data with modern gauging data from other, similar-sized, river basins in the East Cape region which have sediment transport regimes that either are unaffected by anthropogenic activity, or are known to be dominated by a specific suite of erosion processes. Alluvial storage on the Poverty Bay Flats and along the major tributaries to the Waipaoa River will be accounted for before trends in sediment yield are be compared with changes in the terrigenous mass flux to the ocean (as documented in core MD2122). We shall digitize existing soil maps, using a 0.5 DEM as a base, place them in a GIS environment, and use existing borehole and core data to extend previous work and increase the spatial scope and enhance the reliability of existing estimates of the volume of alluvial storage on the Poverty Bay Flats since the Waimihia tephra was deposited (3,470 calendar years B.P.).

Our proposed research has import because it will provide information about the effect alluvial buffering has on a small, high-yield steepland river system. Alluvial buffering is not usually thought to be a significant factor influencing sediment yields from this class of river, which collectively supply a disproportionate amount of sediment to Earth's oceans. Understanding long-term, background rates of sediment generation and discharge to the ocean is necessary to assess the effectiveness of sustainable land management strategies and for responsibly setting management criteria. Previous studies have provided information on long-term trends and patterns that are a response to climatic and anthropogenic change, but the inability to link process and response continues to limit our understanding of how fluvial systems respond to environmental change. By evaluating and testing direct links our research could help answer one of the fundamental questions in fluvial geomorphology and sediment transport; that is, how sensitive is the fluvial system to environmental change?

By fostering connections between our individual research groups we seek to transcend institutional and disciplinary boundaries and utilize this diversity to provide the students involved in the project with a cross disciplinary educational and research experience. There is a strong educational and mentoring component, including funding for two MS students. Research accomplished by the students will be an integral component of the project, and also contribute to their degrees. Each MS student will be in close contact with the other, and have the opportunity to work in other laboratories, including the Livermore Laboratory, where they will analyze samples on a one-of-a-kind instrument, the Livermore accelerator, and have the opportunity to undertake fieldwork in a spectacular natural laboratory.