Holocene Carbon Sequestration Budgets for the Fly River, PNG

R. Aalto[1], M. A. Goñi[2], J. W. Lauer[3], A. K. Aufdenkampe[4] and W. E. Dietrich[5]

[1]*Life and Environmental Sciences, University of Exeter, Exeter, UK Rolf.Aalto@exeter.ac.uk
[2]CEOAS, Oregon State University, Corvallis, OR, USA mgoni@coas.oregonstate.edu
[3]Civil and Environmental Engineering, Seattle University, Seattle, WA, USA lauerj@seattleu.edu
[4]Stroud Water Research Center, Avondale, PA, USA aufdenkampe@stroudcenter.org
[5]Dept. Earth and Planetary Sciences, UC Berkeley, Berkeley, CA, USA bill@eps.berkeley.edu

During post-glacial marine transgressions, sediment and carbon are deposited during the infilling of lowland fluvial systems. Quantifying the amounts, timing, and preservation of this material would provide insight into sequestration of carbon in fluvial systems in response to sea level rise.

We investigated the sedimentary and carbon dynamics of the Fly and Strickland Rivers, Papua New Guinea. Field data include: ^{14}C dated deep cores depicting base level evolution over the Holocene, sonar imaging of floodbasin stratigraphy, and the observations of blocked valley lakes and weathered erosional remnants. Measurements of carbon content of the deep cores are informed by our study of the biogeochemistry and morphodynamics of the modern river. These data provide insight into the potential biogeochemical storage & buffering provided by large tropical rivers during the Holocene.

We upscale our observations by modeling river system evolution, employing 1-D transport modelling to predict the longitudinal profile of the river bed during the LGM-Holocene transgression. We also use a GPU-based Landscape Evolution Model (GULEM) to predict the evolution and tropography of the entire LGM Fly River valley, thereby providing a novel means to estimate the accommodation space subsequently infilled during transgression. GULEM predicts river & tributary incision, non-linear diffusion, and hydraulic-geometry based estimates for channel morphology and deposition potential, all relatively simple ‘power laws’ that are commonly used. This reduced complexity model design allows the vectorized approach that GULEM employs to efficiently model coupled fluvial-landscape evolution for a complex system over large temporal and spatial scales.

Our combined approach affords estimates for the timing and budgets of sediment and carbon storage in Fly River floodplains in response to sea level rise, with the general observation that ~5 Pg of carbon were sequestered during the transgression from LGM to Holocene high-stand conditions.