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Morphodynamics of Migration Surveyed at Large Spatial and Temporal Scales

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The controls on rivers migration are diverse and often complex. One way forwards is to select study rivers that meet certain simplifying conditions: near-pristine (no anthropogenic complications), large size and rapid mobility (resulting in significant change viewable in Landsat imagery), limited geological complexity (no bedrock), steady hydrology (relatively little variation in discharge and sediment load), and simplified base level control (no tides or other substantial perturbations). Such systems could then be measured at appropriate spatial and temporal scales to extract the reach-scale dynamics while averaging out the more stochastic behaviour of individual meander bends. Such an approach requires both special rivers and novel techniques, which we have investigated and present here.

The two explored examples are the near-pristine Beni River basin in northern Bolivia (800 km channel length) and the similarly natural Fly-Strickland River basin in Papua New Guinea (400 km channel length) – large, tropical sand-bedded rivers that meet the above criteria. First, we conducted a GIS analysis of migration using image collections that include 1950s military aerial reconnaissance – this allowed us to characterize mobility decades before the first Landsat satellite was launched. Following this approach, we characterized migration rate, sinuosity, and other parameters at the reach scale of 10km and the temporal scale of 50+ years, with clear patterns of rate and morphology emerging as a function of location within the systems.

We conducted extensive fieldwork to explore potential controls on these patterns, with the focus of this talk being the results from DGPS surveys of river and valley slope. The length scale of these rivers, the density of the forested floodplains, and the hostility of the environments precluded the use of standard RTK-DGPS methods. Instead, we employed three novel techniques for long baseline (100s of km) DGPS surveys: OmniStar HP/XP GLONASS kinematic RT-DGPS (sub-decimetre), filtered static RT-DGPS using OmniStar VBS (sub-metre), and post-processed DGPS using newly available Precise Point Positioning methods (sub-metre). We compare these novel DGPS techniques simultaneously (recent 2011 and 2010 surveys) and over time (our 2004, 2001, and 1999 surveys), presenting an assessment of their utility for long baseline surveys of large rivers. Additionally, we present a comparison to water surface profiles developed from the raw version of the 2001 SRTM DEM, with the water elevations determined from MINIMUM 1-arc-second values (not the average 3-arc-second values previously released) – this is the first evaluation of such 'minimum' data of which we are aware.

The field surveys ultimately produced quality elevation profiles that allow us to characterize and investigate the strong relationships of both reach-scale migration rate and sinuosity to water surface slope – empirical results realized over time and length scales that serve to average out stochastic noise at the bend scale.