Macro-tidal rip currents: Circulation, dynamics and hazards

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Growing visitor pressures on beach resources means the role of beach safety management is becoming increasingly important along much of the macro-tidal, high-energy Atlantic coast of England, which experiences mean spring-tidal ranges of 4.1–7.4 m and average significant wave heights of 1.2 m and 2.7 m in summer and winter, respectively. Rip currents are responsible for 80% of all recorded incidents (2005–2007) along this coast which displays strong seasonality whereby extensive low-tide bar/rip systems develop through spring to a state of maximum development during the summer months. Analysis of seasonal morphological and hydrodynamic datasets coupled with detailed lifeguard incident data have established an 'optimum' combination of key drivers of recreational rip hazards within the region; 1) Small long-period swell-waves; 2) Well-developed, phase-offset low- and mid-tide bar/rip morphologies; and 3) Large (spring) tidal ranges.

To quantify rip current circulation and dynamics associated with these observations a field experiment was conducted on a macro-tidal, low-tide bar/rip system during spring tides and low-energy swell waves (H_s of 0.83–1.32 m). Measurements of flow velocity and water depth were collected using multiple in-situ sensor arrays, whilst the surf-zone circulation patterns were monitored with post-processed GPS drifter floats. In-situ results show that currents within the rip system were strongly tidally modulated with maximum mean offshore-directed rip-channel flow velocities, occurring around low-water, of -0.5 ms^{-1}. Lagrangian observations indicated extensive rotational surf-zone circulation patterns (peak velocities of >1 ms^{-1}) whose behavior modulated with local relative wave height (H_s/h) and through morphological constriction. Initial findings have initiated further research into macro-tidal rip hazard assessment and modeling.