Beach change, cliff erosion, and flooding

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Accurate wave estimates at the coast are essential for understanding flooding, beach change, and cliff erosion. Flooding occurs when the total water level, or maximum runup, exceeds natural or engineered coastal protection levels. Runup depends on the incident wave conditions and nearshore bathymetry, and when these boundary conditions are well known, total water levels can be accurately estimated by phase-resolving, non-hydrostatic hydrodynamic models. However, these boundary conditions are often not well known, as surfzone bathymetry and incident long (infragravity) waves are particularly difficult to observe. Furthermore, morphological models that predict wave-driven nearshore sand level changes are highly parameterized and require extensive calibration. Total water levels control the landward and vertical extent of wave-impacts on the beach and cliff. Waves can erode the base of the cliff and create notches that cause it to become unstable, making it more likely to collapse when rain and groundwater flows exacerbate structural weaknesses. Cliff failures contribute sediment to the beach, which in turn helps shelter the cliff from wave impacts. Cliff stabilization to protect infrastructure atop crumbling coasts, and river damming for flood control, have reduced sediment supplies to the beach. Mechanical beach sand replenishment is a popular coastal management technique used to widen the recreational beach and protect coastal infrastructure, however the wave-driven redistribution of sand is not well understood. As coastal populations increase, sediment supplies dwindle and sea level rises, understanding wave-driven coastal processes will become increasingly important for effective adaptation solutions.