

Process Model for Terrace Formation and Shoreline Evolution

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Shorelines change on seasonal and decadal time scales in response to variations in littoral sediment supply and wave climate. Over millennial time scales, variations in sea level add to the mix of factors inducing coastal change. A model is presented (Fig. 1) that solves for shelf and shore response to

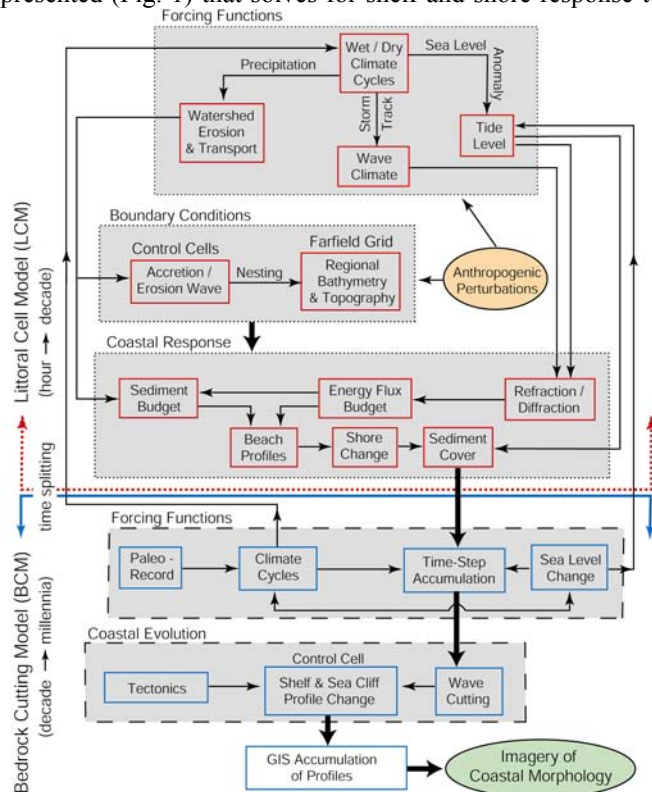


Fig. 1. Architecture of the Coastal Evolution Model consisting of the Littoral Cell Model (above) and the Bedrock Cutting Model (below). Modules (shaded areas) are formed of coupled primitive process models, after [1].

variable sea level, sediment supply, and wave climate over long periods of time. The model domain is set by the natural boundaries of a littoral cell. The model treats the cell as a two-phase medium containing 1) a mobile sediment cover having equilibrium and disequilibrium beach profiles governed by the laws of thermodynamics and continuity, and 2) a bedrock layer that may be periodically and/or episodically exposed by loss of sediment cover, thereby becoming available to cutting by wave abrasion. The beach

profiles of the sediment cover are computed by a set of modules grouped above the red line in the model architecture shown in Fig. 1. These upper modules are collectively referred to as the Littoral Cell Model (LCM). Once the LCM computes exposure of the bedrock, the model shifts to a set of calculations for bedrock abrasion and notching treated by the modules labeled Bedrock Cutting Model (BCM) found below the blue line in Fig. 1.

The model presently uses continuous 20-year long wave records and 45-year long river sediment flux records to resolve decadal variability of sediment supply and wave climate. The wave record was taken from a multi-decadal wet climate period in the Oceanside Littoral Cell that was frequented by clusters of strong El Niño storms. The cutting of the bedrock computed from this wave forcing proceeded as step-wise incremental retreats in the position of the bedrock interface with mean sea level. Most of the bedrock recession forced by the 20-year wave record was produced by a handful of the most powerful storms that had sufficient energy to both remove the sediment cover and abrade and notch the bedrock.

The multi-decadal forcing records are looped 50 to several hundred times over millennial time scales. This looping process results in about 80 m of bedrock cutting in 1000 years of constant sea level for bedrock material having an erosivity comparable to sandstone. When these bedrock cutting dynamics are applied to millennial scale changes in sea level, the model computes a wave-cut terrace as shown in Fig. 2. Here a transgression with 1000-year intervening

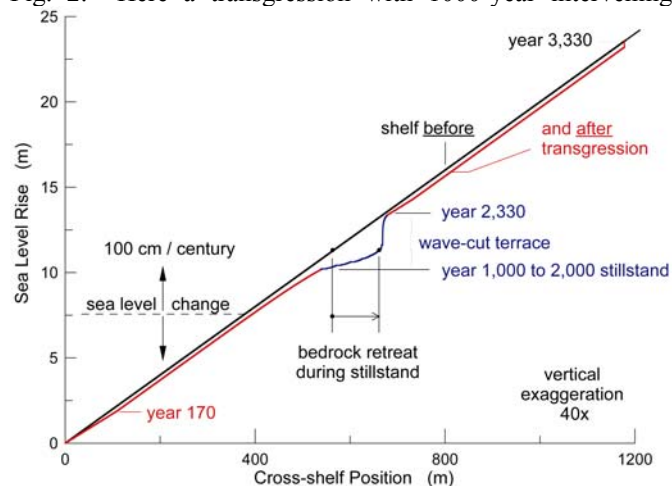


Fig. 2. Test of Bedrock Cutting (BCM) showing change in initial 2% shelf slope (black) due to wave cutting during a transgression/stillstand/transgression sequence (red & blue) (after [1]).

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stillstand was simulated. The width of the platform cut into the bedrock during this stillstand is about 80 m. The model indicates that successions of transgressions and regressions over terraces cut by previous stillstands result in larger, more rounded wave-cut terrace features. These long period simulations are compared with transgressive surfaces in subbottom acoustic profiles along the Oceanside Littoral Cell. The model results were found to give terrace dimensions consistent with the subbottom profile evidence.

REFERENCES

- [1] D. L. Inman, P. M. Masters and S. A. Jenkins, "Facing the coastal challenge: Modeling coastal erosion in southern California," in O. T. Magoon et al., eds., *California and the World Ocean '02*, Amer. Society of Civil Engin., Reston, VA, unpublished.