1. Methods

1.1. Model design

We modeled the vertical accretion of a tidal platform ($d\eta/dt$) using a zero-dimensional mass balance approach initially described by **?** and validated by subsequent studies (**????**). The rate of vertical accretion is described as

$$\frac{d\eta(t)}{dt} = \frac{dS_m(t)}{dt} + \frac{dS_o(t)}{dt} + \frac{dP(t)}{dt} + \frac{dM(t)}{dt}, \tag{1}$$

where $dS_m(t)/dt$ is the rate of mineral sedimentation, $dS_o(t)/dt$ is the rate of organic matter sedimentation, $dP(t)/dt$ is the rate of shallow compaction after dewatering of the deposited sediment, and $dM(t)/dt$ is the rate of tectonic subsidence. We considered $dS_o(t)/dt$, $dP(t)/dt$, $dM(t)/dt$ to be constants and used characteristic yearly rates for each; while, $dS_m(t)/dt$ varies within a tidal cycle (**?**) and requires additional treatment.

To solve for $dS_m(t)/dt$, we began by conceptualizing a tidal platform periodically inundated by sinusoidal tides. We first defined depth to be

$$h(t) = \zeta(t) - \eta(t), \tag{2}$$

where $\zeta(t)$ is the water-surface elevation and $\eta(t)$ is the sediment-surface elevation which also implies that

$$\frac{dh(t)}{dt} = \frac{d\zeta(t)}{dt} - \frac{d\eta(t)}{dt}. \tag{3}$$

Independently, we assume while $h(t) > 0$, the rate of mineral sedimentation is

$$\frac{dS_m(t)}{dt} = \frac{w_s C(t)}{\rho_b}, \tag{4}$$

where w_s is the nominal settling velocity of a sediment grain, $C(t)$ is the depth-averaged suspended sediment concentration (SSC) in the water column, and ρ_b is the bulk density of the sediment. We assumed no resuspension of mineral sediment which is practical and consistent with previous studies (**?????**).

In order to solve for $C(t)$ in **??**, we first defined a mass balance of sediment within the water column as

$$\frac{d}{dt}[h(t)C(t)] = -w_s C(t) + C_b \frac{dh(t)}{dt}, \tag{5}$$

which can be expanded and rerranged as

$$\frac{dC(t)}{dt} = -\frac{w_s C(t)}{h(t)} - \frac{1}{h(t)}[C(t) - C_b]\frac{dh(t)}{dt}. \tag{6}$$

We assumed advection of new sediment to only occur during flood tide by constraining mass flux from the boundary term when $dh/dt > 0$. We formalized this mathematically using a Heaviside function which serves as a binary switch and is given as

$$S = \frac{dh}{dt}, \quad H(S) = \begin{cases} 0 & \text{if } S < 0 \\ 1 & \text{if } S \geq 0. \end{cases} \tag{7}$$

?? then becomes

$$\frac{dC(t)}{dt} = -\frac{w_s C(t)}{h(t)} - \frac{H(S)}{h(t)}[C(t) - C_b]\frac{dh(t)}{dt}. \tag{8}$$

?????? were then solved in that order to obtain the change in elevation during one time step.

We integrated this series of equations for each inundation cycle using an explicit Runge-Kutta method of order 5(4) (**?**) implemented in Python using SciPy (**?**). We used an adaptive step size which provided computational efficiency by decreasing step size as needed - i.e. beginning and end of an inundation cycle. To avoid numerical errors due to very small depths in **??**, we only allowed the model to integrate while water depths were >1 mm. Outside of the integration (i.e. while the platform was dry), we continued to apply linear rates for $dS_o(t)/dt$, $dP(t)/dt$, $dM(t)/dt$.

We indentified indundation cycles by filtering the tidal curve for water-surface elevations that were above the corresponding sediment-surface elevation. The time of first element of the filtered data was used to initialize the integration. The adaptive step size method required a continuous function for water-surface elevations so we converted the tidal data to an interpolated univariate spline during the integration. The integration continued until the water-surface elevation fell below the sediment-surface elevation. We repeated this process for all subsequent inundation cycles through the prescribed length of each simulation to obtain a final elevation.

1.2. Field observations and model parameters

Tidal data

The tidal curve was derived from observations at Sutarkhali station. Water-surface elevations were collected every 10 minutes from January 1, 2019 to December 31, 2019 using an Onset U20L-01 HOBO water level data logger. The data were processed and upsampled to 1 s temporal resolution using the oce package in R (3.6.3) (**?**). The tidal curve was then shifted to place mean water at

Software and/or data availability

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