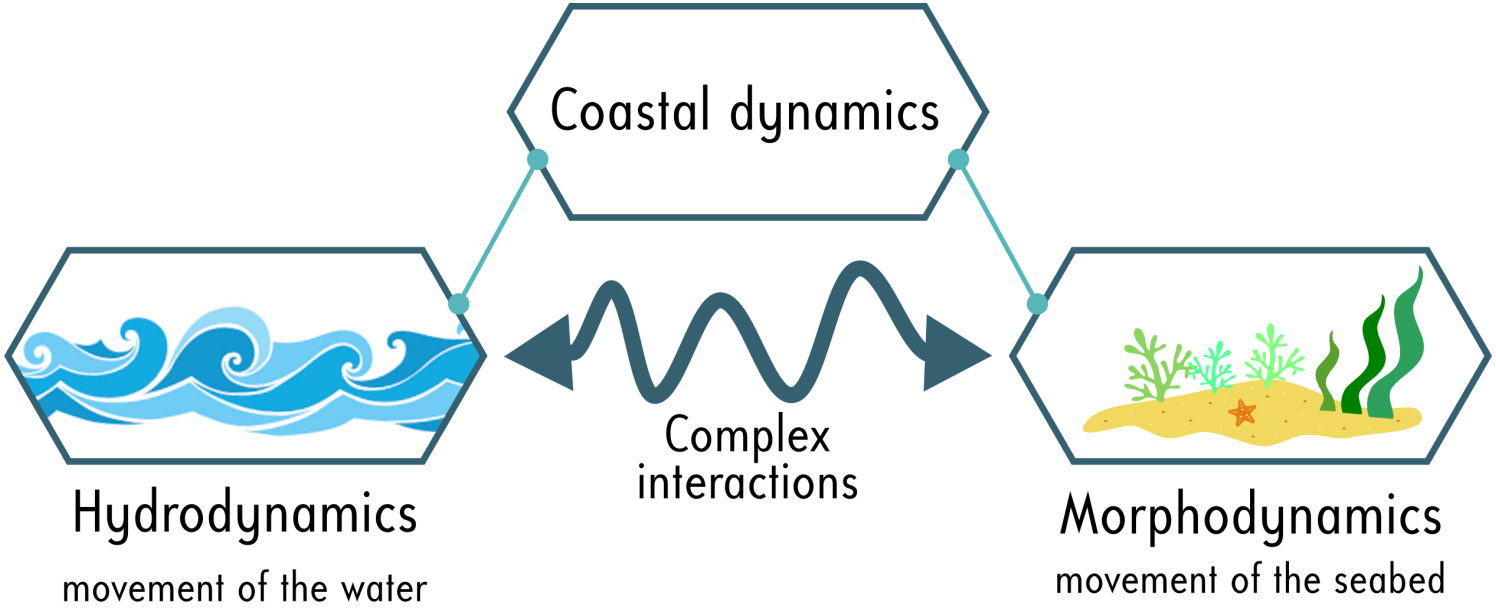
Optimization theory applied to coastal dynamics

24/05/2019

M. Cook[1,3,4], F. Bouchette[1,3], B. Mohammadi[1,2,3], N. Fraysse[4]

[1] GEOSCIENCES-M, Univ Montpellier, CNRS, Montpellier, France, megan.cook@umontpellier.fr, frederic.bouchette@umontpellier.fr
[2] IMAG, Univ Montpellier, CNRS, Montpellier, France, bijan.mohammadi@umontpellier.fr
[3] GLADYS, Univ Montpellier, CNRS, Le Grau du Roi, France
[4] BRL Ingénierie, Nîmes, France, nicolas.fraysse@brl.fr

Settings



Assumption The seabed evolves in order to minimize a wave-related quantity.

Objective Identify the driving force behind morphodynamics.

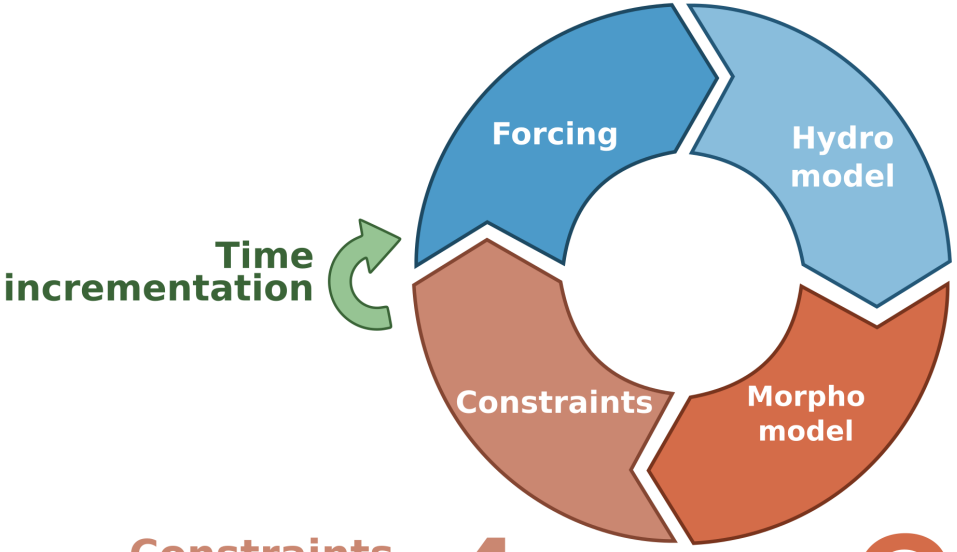
Workflow

1 Forcing

Provides time-dependent data of the incoming wave (e.g., wave height, angle, period).

2 Hydrodynamic model

Provides the morphodynamic model with the hydrodynamic data it requires.



4 Constraints

Adds more physics to the morphodynamic model.

3 Morphodynamic model

Determines the evolution of the seabed based on wave energy minimisation, using data provided by the hydrodynamic model.

Morphodynamic model based on wave energy minimization

The seabed evolves in order to minimize...

$$J(\psi) = \frac{1}{8}\int_0^{x_B} \rho_w g H(\psi, x)^2 dx \qquad [J.m^{-1}]$$

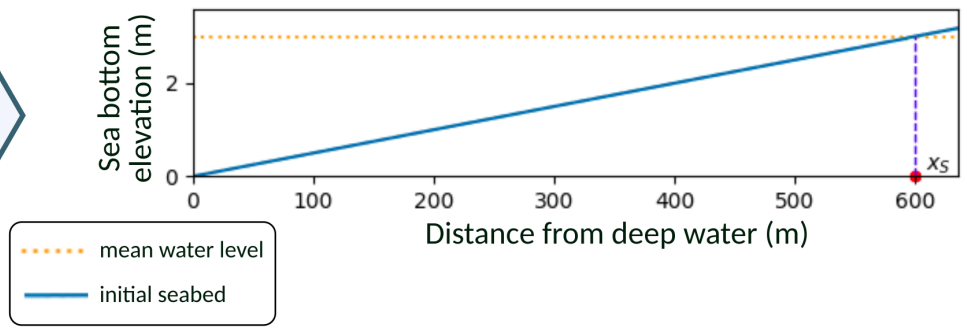
- x_B: x coordinate of wave breaking
- g: gravitational acceleration $g \approx 9.81\ m.s^{-2}$
- 0: x coordinate of deep water
- ρ_w: water density $\rho_w \approx 1000\ kg.m^{-3}$
- $H(\psi, x)$: wave height provided by the hydro model

Our choice of J

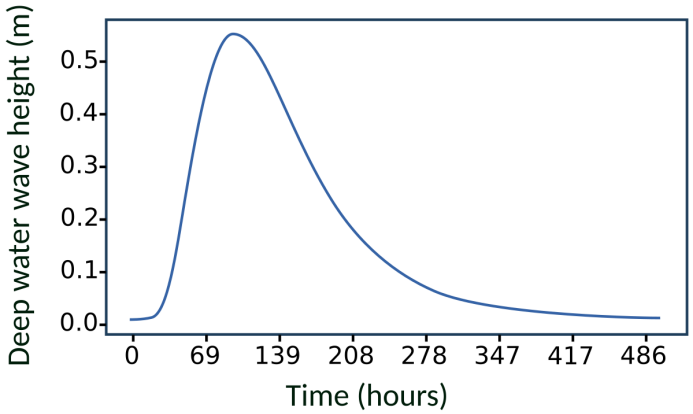
Potential energy of the waves.

FIRST RESULTS

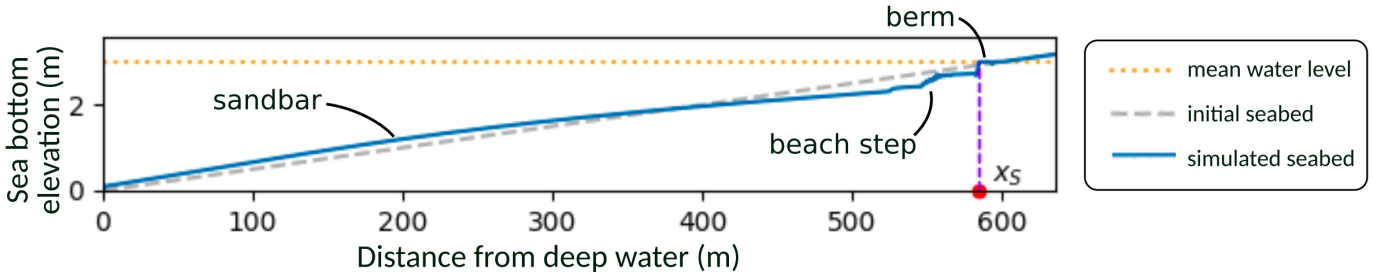
We start with a linear seabed.



We apply the optimizer onto the seabed, over the course of a simple storm.

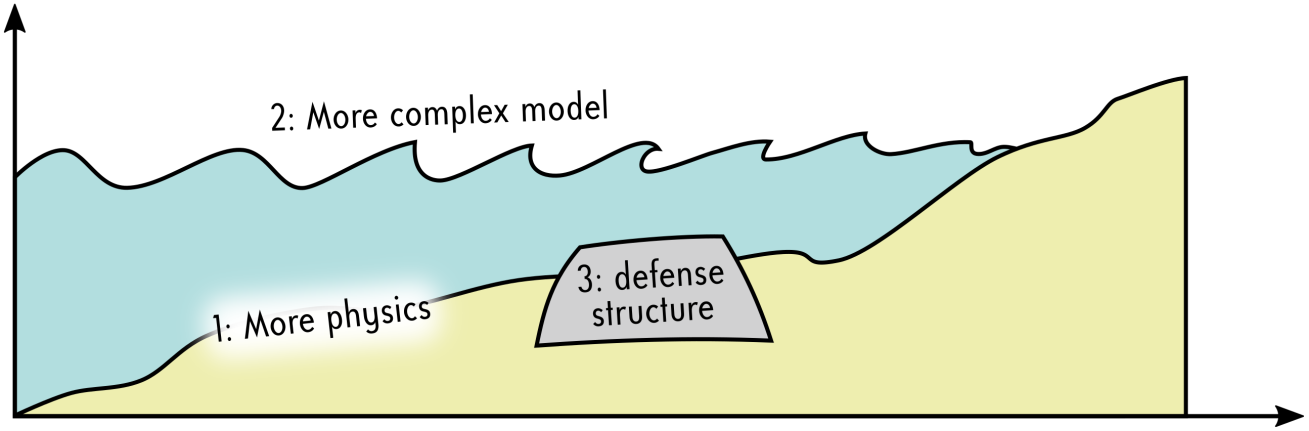


We observe the following results.



What's next ?

1. Analyse the natural mechanisms behind coastal dynamics by searching for the driving force J.
2. Complexify the model, using a more advanced hydrodynamic model.
3. Introduce defense structures and optimize their shape at the same time as the morphodynamic optimization.



Thank you for your attention !