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Landlab: A numerical modeling framework for evolving Earth surfaces from mountains to the coast

Nicole M. Gasparini[1], Jordan M. Adams[1], Gregory E. Tucker[2,3], Daniel E. J. Hobley[2,3], Eric W. H. Hutton[2,4], Erkan Istanbulluoglu[5], Sai S. Nudurupati[5]

1. Tulane University 2. University of Colorado Boulder 3. CIRES 4. CSDMS COMMUNITY SURFACE DYNAMICS MODELING SYSTEM 5. UNIVERSITY of WASHINGTON

Landlab is an open-source, user-friendly, component-based modeling framework for exploring the evolution of Earth's surface. Landlab itself is not a model. Instead, it is a computational framework that facilitates the development of numerical models of coupled earth surface processes. The Landlab Python library includes a griding engine and process components, along with support functions for tasks such as reading in DEM data and input variables, setting boundary conditions, and plotting and outputting data. **Each user of Landlab builds his or her own unique model.**

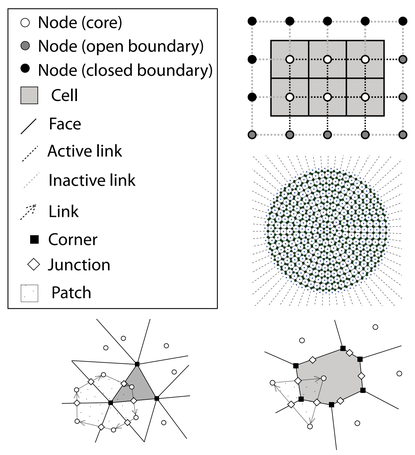
The first step in building a Landlab model is generally initializing a grid and process components. The process components act on the grid to alter grid properties over time. For example, a component exists that can track the growth, death, and succession of vegetation over time. There are also several components that evolve surface elevation, through processes such as fluvial sediment transport and linear diffusion, among others. Users can also build their own process components, taking advantage of existing functions in Landlab such as those that identify grid connectivity and calculate gradients and flux divergence.

The general nature of the framework makes it applicable to diverse environments - from bedrock rivers to a pile of sand - and processes acting over a range of spatial and temporal scales. In this poster we illustrate how a user builds a model using Landlab and propose a number of ways in which Landlab can be applied in coastal environments - from dune migration to channelization of barrier islands. **We seek input from the coastal community as to how the process component library can be expanded to explore the diverse phenomena that act to shape coastal environments.**

Building a Model with Landlab

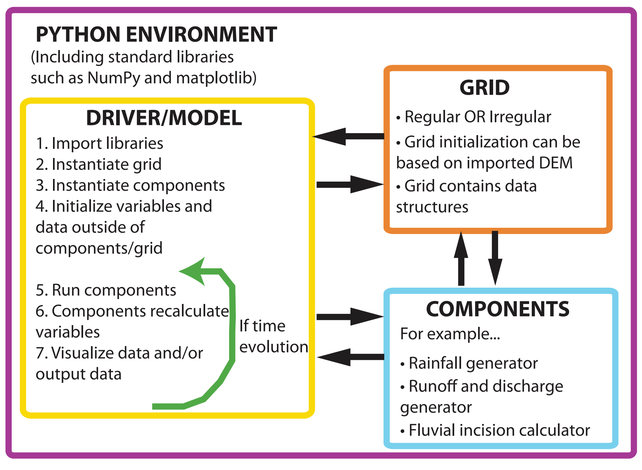
Instantiate a grid

» Can be done in as little as one line of code
» A variety of grid types are available
» Data can be stored at different grid elements (e.g. nodes, links, cells...)
» Data types are already built into the code. Anything that has access to a grid has access to the data stored on it.

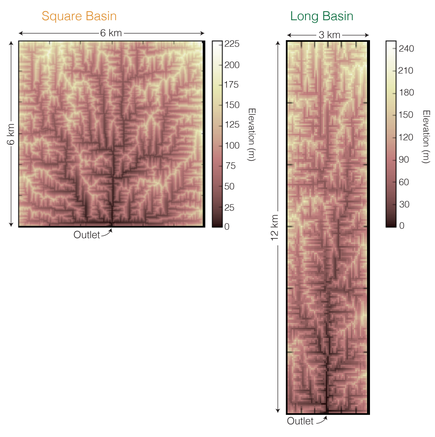


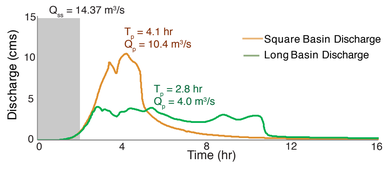
Instantiate components

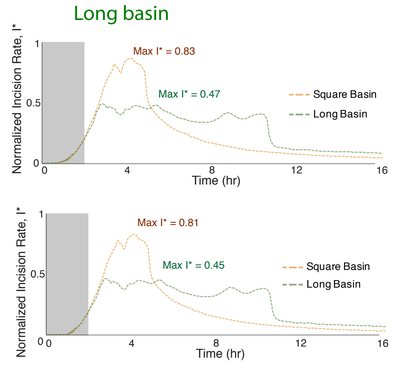
» A component simulates different processes acting on the grid
» A component can drive other components (e.g. rainfall simulator)
» A Landlab user can build a model using pre-made components, or a user can build her/his own components, and mix-and match.



Evolving Fluvial Landscapes, Hydrograph Routing, Non-steady Incision

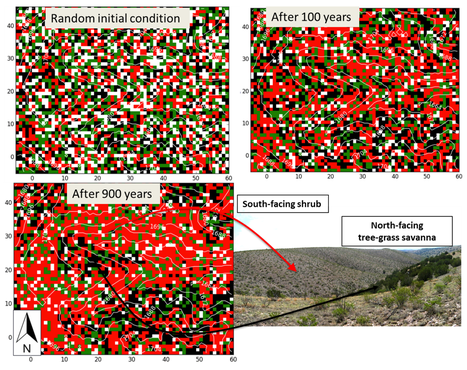






Cellular Plant Competition Model Sevilleta in Central New Mexico

Trees, Shrubs, Grass, Bare



How can we work with the coastal community?

» Rapidly evolving coastal landforms are one potential opportunity
» What processes matter?

» Dauphin Island, Alabama has been heavily impacted by hurricanes (notably Gustave in 2008). Google Earth illustrates this for us.
» Illustrate modeled flow from 100 mm of rain falling in 2.4 hours on a 1 m LiDAR derived DEM from July 2013. For reference, a rain gauge on Dauphin Island recorded ~ 100 mm of rain in 24 hours during Hurricane Isaac (2012).
» **Help us make this informative and useful for your community!**