Landlab: a new, open-source, modular, Python-based tool for modelling Earth surface dynamics

Daniel E.J. Hobley\textsuperscript{1}, Gregory E. Tucker\textsuperscript{1,4}, Nicole M. Gasparini\textsuperscript{2}, Jordan M. Adams\textsuperscript{2}, Sai Nudurupati\textsuperscript{3}, Erkan Istanbulluoglu\textsuperscript{3}, Eric Hutton\textsuperscript{4}, and Jenny Knuth\textsuperscript{4}

1 - Cooperative Institute for Research in Environmental Sciences (CIRES) and Department of Geological Sciences, University of Colorado at Boulder. 2 - Department of Earth and Environmental Sciences, Tulane University. 3 - Department of Civil and Environmental Engineering, University of Washington, Seattle. 4 - Community Surface Dynamics Modeling System (CSDMS), University of Colorado at Boulder

ABSTRACT

The ability to model surface processes and to couple them to both subsurface and atmospheric regimes has proven an invaluable tool in the Earth and planetary sciences. However, creation of a new model typically demands a very large investment of time, and modification of an existing model to address a new problem typically means the new work is constrained to its detriment by model adaptations for a different problem. Landlab is a new software framework explicitly designed to accelerate the development of new process models by providing: 1. a set of tools and existing grid structures to make development of new process components faster and easier; 2. a suite of stable, modular, and interoperable process components onto which new components can be added; and 3. a set of example models built with these components. Landlab’s structure makes it ideal not only for fully developed modelling applications, but also for model prototyping and classroom use. Here we illustrate some of Landlab’s capabilities, emphasizing its breadth of application and ease of use.

What is Landlab?

- An open-source, Python-language library that helps geoscience researchers efficiently develop 2D grid-based numerical models
- A set of pre-built model components, each of which models a particular landscape process (see examples)
- A framework for combining components into multi-process models
- Learn more at http://landlab.github.io

GRIDS

Grids are built from primitives such as nodes, links, and cells.

COMPONENTS

- Standard design
- Sharing data through grid object
- Coupling with driver script
- Shallow-water flow over terrain

UTILITIES

- Import ESRI Arc ArcGISr format digital elevation data
- Read and write netCDF files
- Read model parameters from formatted text files
- Suite of plotters, including data overlay

SCRIPTING

Example: a nine-line diffusion model

\begin{verbatim}
mg = landlab.horizontallydiffusive(source, sink, dx, d = model.grid.size / length_of_model()
for i in range(1, nx-sink):
    for j in range(1, ny):
        Q[i, j] = f(h[i, j], s[i, j])
        h[i, j] = h[i, j] + Q[i, j]

Q = f(h, s)
\end{verbatim}

Visualization of output from script.

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