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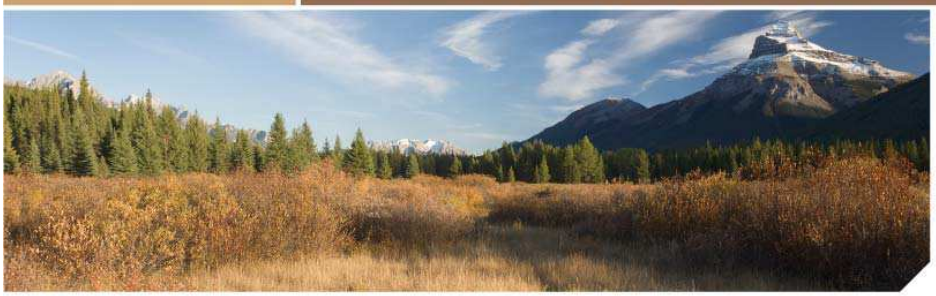

Safe and Healthy Communities Research Program

Task 2.1.5.2.4
OpenTERRAworks GIS-Tool
Supporting Predictive Analysis of the Future Before it Happens

OpenTERRAworks - A 2D/3D Landscape Design Tool

An open, Dot-Spatial-based toolset supporting comparative baseline and futures scenario modeling.

For those who can't wait for satellites to tell us the future.....

Change Happens!

Human activities involving significant terrain alteration (e.g., earthworks operations associated with mines, urban development, landslides) can lead to broad-ranging changes in the surrounding terrestrial and aquatic environments. Potential aesthetic impacts can be associated with modified relief, soils, and/or change in land cover. Additionally, changes can be seen in spatiotemporal rates of surface runoff and erosion; rerouted flow paths; impacts to water quantity and quality; and species and ecosystem composition.

The General Problem

Due to a lack of open "GIS" design tools, most assessors are basically "***waiting for the future to predict it***". Given opportunity, assessors would rather create the detailed landscape views needed to model it today.

In design and in decision-making, the problem is that the FUTURE IS NOW.

The OpenTERRAworks (OTW) Tool

A multi-scale ***Geographical Information System (GIS)*** toolset to expand the technical capacity of communities and the USEPA to predict hillslope- to watershed-scale effects of proposed, alternative, and legacy landscape designs involving significant terrain modification.

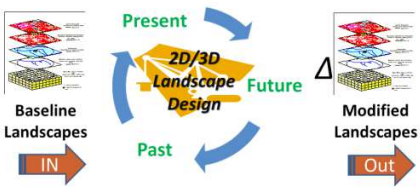

Figure 1. OpenTERRAworks Software System Design Overview.

A product of ORD's SHC Research Program, the OpenTERRAworks Software system is geared for the production of modified datasets representing actual or proposed landscape changes (see Figure 1).

.... OTW is a "substitution" design pattern for readily modifying the large and many datasets that modeling systems consume.

Specifically, the OTW system allows users to more easily modify datasets to represent changes in terrain elevations, soils, land use/land cover, and hydrography. These data capture many key landscape features needed to understand and predict associated environmental outcomes.

OTW is not a model; rather, OTW helps generate data necessary to represent landscape changes in models, and other analytical frameworks; to evaluate potential impacts from 2D/3D landscape change, ideally, before it happens. Figure 2 depicts OTW's workflow.

Get the Data!

By offering default-scale ***baseline design*** data for the conterminous U.S., OTW creates a common starting point for analysis. Many models rely on the following input datasets that characterize landscapes in support of hydrologic and other evaluations:

- The **National Land Cover Database** (NLCD) is a land cover classification scheme applied across the United States at a spatial resolution of 30 meters (USGS, 2012a).

- The **Soil Survey Geographic database (SSURGO)** provides a polygon-based inventory of soils and non-soil areas and is the most detailed available dataset across the United States.

- **Digital Elevation Model (DEM)** datasets are digital representations of terrain elevations.

- The **National Hydrography Dataset (NHDPlus)** contains an interconnected network of surface-water features including lakes, streams, and rivers, with extensive descriptive attributes.

OTW focuses on automated import of the standard data sources listed above and their subsequent modification to represent landscape modifications.

Or Use Your Own Data!

OTW also has the flexibility to work with datasets other than standard, default data sources provided. The key datasets listed can be substituted with different source and/or finer-resolution data systems the user may also have available for analysis.

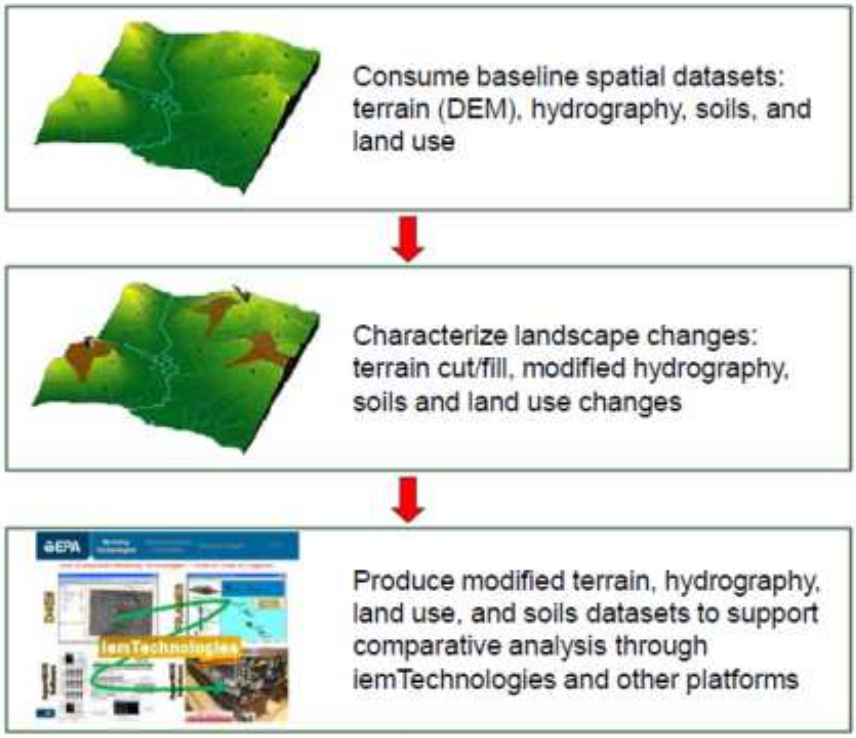

Figure 2: The OpenTERRAworks workflow and relation to downstream analytics.

Have LIDAR? -- Will Travel

The OTW system can import and work with alternative datasets as long as they conform to the required data structures: floating point raster for terrain elevations; discrete-valued raster for land use; and continuous polygon for soils.

For example, a given site may have been characterized at a finer resolution and/or with more accuracy than standard datasets (e.g., through LIDAR or field surveys). Such data can be imported for direct and similar uses. As the expression goes -- *have suitcase, will travel* -- OTW is equally ready to go - to begin posing ***alternative futures*** derived from user-supplied baseline datasets.

Start with a Workspace!

The basic organizational system of OTW is the ***workspace*** which is comprised of one or more related ***sites***. Each *site* is described by one or more ***design paths*** made up of sequential phased designs and/or *branched designs* (Figure 3).

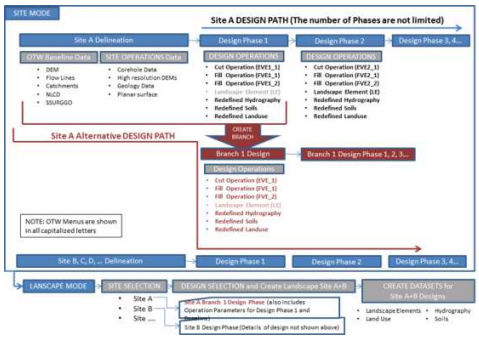

Figure 3: OTW "site" phasing and branching.

Branched designs allow divergence into alternative *design paths* from a single predecessor design in order to represent alternative design options. The predecessor design for each *site design* is referred to as its *basis design*. A ***design set*** is a *site's* collection of all ***site designs***.

Draw a picture to build a site!

OTW strives to simplify the process of building a site and representing landscape changes, whether it be defining a site area or assisting the user in creating a surface coal mine contour "cut". Creating a site simply involves clicking on the map to delineate the site area (Figure 4).

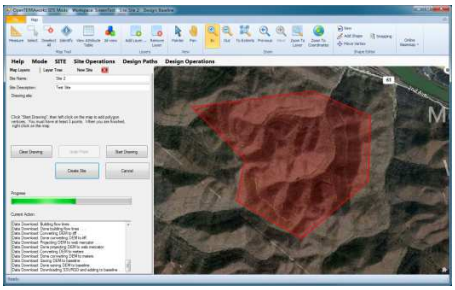

Figure 4: Building a site.

Once a site is named, described, and drawn, the relevant standard (or other user) data is downloaded and stored for later usage/modification. All tools that interact with the map work on this same "click-to-build" paradigm, with supporting panels to enter relevant metadata.

Use OTW to Modify Landscapes

OTW provides tools (Figure 5) to assist with several design tasks: corehole interpolation; planar surface creation for coal bed interfaces; contour cuts; specification of area cuts; definition of valley fills; as well as other spatial methods.

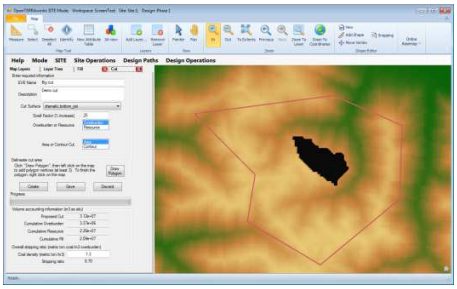

Figure 5: Area cut interface - coal seam.

By using OpenTERRAworks' design tools, a natural progression of the site from baseline all the way to its finished state can be created.

OTW is not just for mining analysis. The tool is seen to easily serve 3D design needs for golf-course or airport "siting" evaluation, as well as post-event analysis of earthquake or volcanic eruptions. "Designed in", but not yet fully implemented, expanded "2D" change scenario modeling , and a "module" envisioned for *retrospective analysis,* aims to soon deliver unchartered facilitation in ease of constructing comparative 2D/3D analysis of the *past*, *present*, and multiple *futures*.

Visualize the results!

In addition to being able to see changes to the site as you draw them, OTW also provides a 3D viewer (Figure 6) to further enhance the user's visualization of each designed landscape.

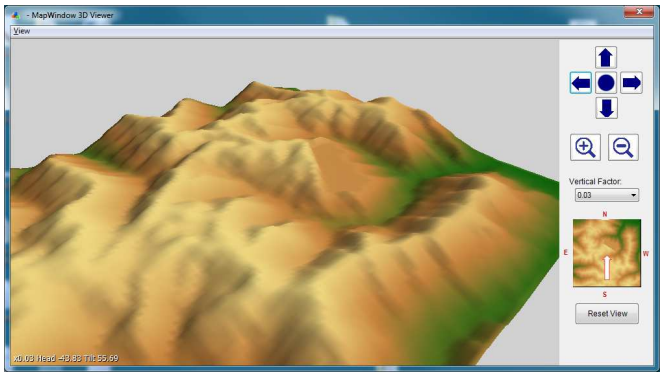

Figure 6: 3D-Visualization of a post-"cut" operation at the site.

Recreate the past, construct the present, and envision the future!

Models capable of predicting impacts from landscape modifications (e.g., process-based watershed models) rely heavily on satellite data or aerial based sensors (e.g., LIDAR) to characterize terrain, land cover, soils, and hydrography (i.e., catchments and stream networks).

Yet, datasets are often only readily available in forms that describe today's or yesterday's conditions.

Potential future land uses cannot be easily simulated without undertaking the significant effort to develop the datasets needed to describe future landscapes. Accordingly, it has remained difficult or impossible for many assessors to predict both impacts and benefits from proposed, future land uses that impart significant landscape 2D/3D change.

To support predictive analyses given these challenges, assessors need tools that facilitate science-driven, integrated assessment (hydrological, hydroecological); tools that readily, and realistically, pose and track spatiotemporal changes in terrain, and associated modifications to land cover, soils, and hydrography. OTW holds the promise to be that toolset.

Join the community!

The OTW core is intended as a public domain project; an open, publically available tool that seeks to form a vibrant community of interested parties; a resource to meet the current and future needs of interested parties across a wide spectrum of community users.

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