Benthic Terrain Modeler: Interpreting the Bathymetric Environment

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The Benthic Terrain Modeler (BTM) is a collection of ArcGIS-based tools for analyzing and classifying the benthic environment. These tools include the creation of bathymetric position index (BPI) grids[1], standardized BPIs, slope, aspect, and rugosity from an input bathymetric data set. Additionally, terrain classification scripts allow users the freedom to create their own zone and structure classifications and define the relationships which characterize them.

The BTM tools transform digital elevation data into a classified product used in both research and natural resource management. However, the tools are general enough that they can be used on any digital elevation data. The inclusion of easily customizable terrain classification allows investigators and managers to create terrain maps in a variety of environments for a broad range of intended uses.

The tools have attracted an audience which use it for a variety of goals. The simple interface, extensive help, and a step-by-step tutorial lend BTM to teaching applications and an introduction to techniques for elevation analysis. In resource management applications, BTM is often used to infer zone and structure classifications for unsampled locations, by creating classifications based on known observed locations and combining them with collected bathymetry. BTM is also used by environmental modellers[2] who use it to produce environmental covariates for regression models, in order to make species habitat predictions. The tools support a variety of useful terrain analysis algorithms. These include the Vector Ruggedness Measure[3], the ratio of surface area to planar area[4] (both of which are to characterize surface roughness or rugosity), trigonometrically transformed aspect, depth statistics (mean, standard deviation, variance) which can be computed at multiple scales, and plan / profile curvature to measure the slope of slope.

BTM[5] has been actively developed since 2005, and the current release, v3.0, has been modernized for the current version of ArcGIS, and actively supported in ArcGIS versions 10.0 and later. Using a Python toolbox, all code (including model parameters and settings) can be easily edited and managed, allowing a simple interface to recreate the “wizard” experience of the earlier version. Classification dictionaries, which used to require a custom authoring environment and produced XML documents, can now be created directly in spreadsheet software, and the tool now directly reads Excel Spreadsheets and CSV files along with the older XML format. BTM is also now open source, with both its code and collaboration facilitated through GitHub. This newly introduced version of BTM provides a series of graphical menus to access the tools via a Python Add-In, along with a Python toolbox which allows the tools to be embedded in scientific workflows. Additionally, each script is stand-alone, and can be embedded into Python applications, or used interactively with an environment such as IPython[6]. Finally, the project now includes an extensive testing framework, which enables reproducible results necessary in many scientific applications.

1. Lundblad ER, Wright DJ, Miller J, et al. A Benthic Terrain Classification Scheme for American Samoa. *Mar Geod*. 2006;29(2):89–111. doi:10.1080/01490410600738021.
2. Costa B, Taylor JC, Kracker L, Battista T, Pittman S. Mapping Reef Fish and the Seascape: Using Acoustics and Spatial Modeling to Guide Coastal Management. Hewitt J, ed. *PLoS One*. 2014;9(1):e85555. doi:10.1371/journal.pone.0085555.
3. Sappington JM, Longshore KM, Thompson DB. Quantifying Landscape Ruggedness for Animal Habitat Analysis: A Case Study Using Bighorn Sheep in the Mojave Desert. *J Wildl Manage*. 2007;71(5):1419–1426. doi:10.2193/2005-723.
4. Jenness JS. Calculating landscape surface area from digital elevation models. 2004;32(1986):829–839.
5. Benthic Terrain Modeler availablefor download at: http://arcgis.com/home/item.html?id=b0d0be66fd33440d97e8c83d220e7926
6. Perez F, Granger B. IPython: a system for interactive scientific computing. *Comput Sci Eng*. 2007:21–29.