3-D Printing for Visualizing Sites: Printing Models Instead of Maps

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Background/Objectives. 3-D printing is a powerful tool for creating physical models of 3-D structures that exist solely in digital form. While the use of 3-D modeling software to visualize environmental data is becoming increasingly common, digital 3-D models can only be viewed on a computer screen using specialized software or as 2-dimensional figures. 3-D printing is a unique and innovative way to leverage these digital 3-D models for the creation of physical scale models. Over the last five years, the cost of desktop 3-D printers has decreased 10-fold, and printers are now widely available for less than $1,000 USD. The variety of materials available for 3-D printing has also expanded over the past few years and includes: acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), polycarbonate, flexible polyurethane, and many others. The printing process starts with a digital 3-D mesh file. The 3-D mesh file is then "sliced" using specialized software which then generates a tool path for each layer. A 3-D printer then uses this input file to deposit a sub-millimeter bead of melted plastic onto a glass plate to build the shape layer by layer. Here we present the use of a desktop 3-D printer to build several physical conceptual site models (CSMs) using existing digital 3-D modeling software.

Approach/Activities. A low-cost desktop 3-D printer was used to create several desktop scale models. 3-D mesh files for these models were generated from existing digital 3-D models built in Environmental Visualization System (EVS) and EarthVision software packages; these 3-D mesh files were then used to successfully print physical models using plastics of varying color and texture. These models ranged in size from 5 cm to 55 cm in the largest dimension. The first model was a conceptual model of a Superfund site in Maryland. This site is a former landfill located in an area with surface water and wetlands. The model for this site showed the site boundary, surrounding topography, water table elevations, and a clay confining layer present below then entire site. The objective of this model was to demonstrate the potential for a simple 3-D printed desktop model to convey primary site hydrogeological features. The second model was of the observed distribution of zero-valent iron (ZVI) emplaced in the subsurface for chlorinated solvent source treatment at a site in Denmark. The objective of the ZVI distribution model was to further our understanding of the CSM and support ongoing remediation efforts. The third model was of the geology and distribution of NAPL at another Superfund site. This site is in a complex geological setting and is located along a major river. The objective of the geology and NAPL model was to communicate the CSM and proposed remediation approach for this site to a range of stakeholders.

Results/Lessons Learned. 3-D printing is a novel tool for communicating with stakeholders, clients, and regulatory agencies. These models can capture the attention of the intended audience and communicate complex, 3-dimensional environmental data unlike any other visualization tool. Applications for 3-D printing for environmental projects include: geologic block models, landfill scale models, models generated from high resolution site characterization datasets, and complex 3-D conceptual site models coupling geology and contaminants. While the cost of 3-D printers and print materials are relatively low, the major cost driver for producing complex 3-D printed models is the effort spent building and processing the digital input files, managing the printing operations, and assembling/finishing the printed model components.