Lidar-derived bare-earth digital elevation models (also known as digital terrain models) are useful to geomorphologists because they provide a clear view of the Earth’s surface—above ground elements, such as vegetation and structures, have been removed. Digital elevation models (DEMs) are especially advantageous in areas where extreme vegetation makes performing geologic or geomorphic investigations difficult.

What is an REM?

In floodplains, DEMs can be converted to relative elevation models (REMs) to better visualize fluvial features that are difficult to discern using an aerial photo or standard DEM. REMs, also known as height above river (HAR) rasters, are produced by detrending the baseline elevation to follow the water surface of the stream. Figure 1 shows the difference between a standard DEM and a REM. In the DEM, the baseline elevation (0 feet) is at sea level and the downstream part of the river has a lower elevation than the upstream part. In the REM, the baseline elevation (0 feet) was detrended to follow the water surface of the river—elevations trend higher as one moves away from the river (showing the “relative” height above river).

As seen in Figure 3 at right, REMs are extremely useful in discerning where river channels have migrated in the past by vividly displaying fluvial features such as meander scars, terraces, and oxbow lakes. This type of information is very informative in channel migration and flood studies, as well as in host of other engineering and habitat assessments.

Figure 2 of the Chehalis River compares visualizing fluvial features using (A) aerial photography with a (B) REM in the same area. Surface elevation changes in relation to the river surface enable the (C) delineation of fluvial features that would otherwise have been difficult to discern using photos or a DEM. Image D shows the same area with a monochromatic color scheme applied to the REM. The full map can be seen in Figure 5, upper right.

Creating an REM

REMs can be created using a number of different methods. Two of these techniques, the Cross-Section and IDW methods, are described briefly in the above simplified model diagram. These two methods along with the Kernel Density method (not shown) are described in detail by Sloan and others (2014). All three methods use point or line GIS data that possess elevations extracted from original DEM rasters. The REM to show the subtle elevation changes necessary for accurately represent the water surface at 0 elevation. Some common factors that reduce model accuracy are (1) years with a steep elevation gradient and (2) models that incorporate more than one stream.

REM Cartography

When used for analysis, multi-color gradients can be applied to REMs to show the subtle elevation changes necessary for scientific interpretation. When used for cartographic purposes, however, a monochromatic gradient produces a more aesthetically pleasing effect. Using graphics software such as Adobe Illustrator or Photoshop, the REM can be enhanced and combined with other raster or vector data to produce maps and imagery such as in Figures 5 and 6 above. The REM can also be visualized in perspective view (Figure 7) using GIS applications such as ArcGlobe or Global Mapper.

REMs are also useful in visualizing other kinds of geomorphic features. REMs were used to create enhanced views of ice-age glacial outwash plains in Figure 8 and of Mount St. Helens’ lava flows in Figure 8B.