Using analytic element models to delineate drinking water source protection areas.

Abstract:
Since 1999, Ohio EPA hydrogeologists have used two analytic element models (AEMs), the proprietary software GFLOW and U.S. EPA's WhAEM, to delineate protection areas for 535 public water systems. Both models now use the GFLOW2001 solution engine, integrate well with Geographic Information System (GIS) technology, have a user-friendly graphical interface, are capable of simulating a variety of complex hydrogeologic settings, and do not rely upon a model grid. These features simplify the modeling process and enable AEMs to bridge the gap between existing simplistic delineation methods and more complex numerical models. Ohio EPA hydrogeologists demonstrated that WhAEM2000 and GFLOW2000 were capable of producing capture zones similar to more widely accepted models by applying the AEMs to eight sites that had been previously delineated using other methods. After the Ohio EPA delineated protection areas using AEMs, more simplistic delineation methods used by other states (volumetric equation and arbitrary fixed radii) were applied to the same water systems to compare the differences between various methods. GIS software and two-tailed paired t-tests were used to quantify the differences in protection areas and analyze the data. The results of this analysis demonstrate that AEMs typically produce significantly different protection areas than the most
simplistic delineation methods, in terms of total area and shape. If the volumetric equation had been used instead of AEMs, Ohio would not have protected 265 km² of critical upgradient area and would have overprotected 269 km² of primarily downgradient land. Since an increasing number of land-use restrictions are being tied to drinking water protection areas, this analysis has broad policy implications.