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INDEXES FOR TARGETING BUFFER PLACEMENT TO IMPROVE WATER QUALITY

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ABSTRACT: The effectiveness of vegetative buffers for improving stream water quality has long been regarded as being greater in some locations than others (Walter et al. 2007). Many approaches have been advanced for identifying relatively more-effective locations.

The simplest targeting model places vegetative buffers along the downhill margins of agricultural fields. There, they are more likely to intercept and retain pollutants in runoff. This model can be refined by focusing on cultivated and manure-applied fields, particularly ones that are steep and highly-erodible, because these fields tend to contribute greater pollutant load to runoff than others. Other simple models focus on landscape position, such as riparian areas through which runoff is expected to pass before entering streams, or site conditions, such as wetland soils, which offer more favorable slope and soil chemistry for retaining and transforming pollutants in runoff. Each of these examples represent one of the three characteristics of a well-targeted vegetative buffer: (1) downhill from larger sources of pollutant load; (2) in the pathway of runoff flow from sources to streams, and; (3) where site characteristics are more-favorable for immobilizing pollutants with a buffer.

The emergence of GIS technology and widespread availability of digital spatial databases on land uses, streams, and soils have enhanced planners' ability to use these simple models, alone or in combination, for targeting buffers in large planning areas. These simple models, however, may lack sufficient spatial resolution for effectively managing runoff with vegetative buffers. Resolution at the scale of whole fields, stream networks, and soil map units fail to account for field runoff that converges into concentrated flow paths and traverses only small portions of field margins and riparian zones, and for wetlands that do not lie in those paths. Buffer area that does not intercept runoff is not very effective.

Newer models employ digital topographic maps (DEMs) for determining runoff pathways and slope conditions at horizontal resolutions as fine 1 m^2. The simplest of these, Wetness Index (Moore et al. 1991), employs only the DEM to identify where flow converges from larger source areas to flatter locations. It has been interpreted variously to indicate where more runoff accumulates and either infiltrates and deposits its sediment (Tomer et al. 2003), raises the water table into interaction with the rooting zone (Burkart et al. 2004), or exfiltrates into erosive overland flow (Walter et al. 2002), depending upon local hydrologic circumstances. The Topographic Index (Walter et al. 2002) refines the Wetness Index to more-accurately identify the exfiltration-prone sites by accounting for soil properties. The Water Inflow Index (Dosskey et al. 2011) combines size of source area with soil properties to more-accurately gauge where the amount of overland runoff flow would be greater, while the related Sediment Retention Index (Dosskey et al. 2011) gauges the corresponding amount of sediment that would deposit in a buffer at those locations. These DEM-based indexes tend to target buffers to similar locations because larger source area correlates with larger runoff load and potential for retaining pollutants from that runoff with a buffer.

Planners must choose between alternative targeting models by comparing their relative merits and disadvantages. While the DEM-based mathematical targeting models promise greater accuracy and precision, the simpler categorical models, such as cultivated field margins, riparian zones, and wetlands, are easier to understand and apply. A better choice of model is one that is simpler to use but accurate enough to achieve planning goals.

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