Applications of Erosion Hotspots for Watershed Investigation in the Appalachian Hills of the United States

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Abstract: Soil erosion, more than any other factor, has more significant and direct impacts on a hydrological watershed in terms of environmental problems. After deriving the erosion hotspots, this study used them to investigate two watersheds, Hocking River Basin and Atwood Lake Basin, in Ohio. Each watershed was divided into 30×30 m grids, respectively, using the geographic information system (GIS), while the revised universal soil loss equation (RUSLE) was applied to estimate the soil erosion for each grid. Grid values of soil erosion estimates are ranked numerically from the lowest to the highest. Grids of soil erosion estimates equal to or greater than the top 5% value are defined as erosion hotspots to form the erosion hotspot image. Then, assigning individual parameters of land slope, soil type, and land use to be 1, to neutralize individual effects in the RUSLE modeling, three different erosion hotspot images were derived in a similar manner. Overlaying each of these three erosion hotspot images with the original erosion hotspot image, it was found that the land slope factor as a representative topography of the watershed has the most significant effect on erosion hotspots for both watersheds compared with soil types and land uses. Generally, the erosion estimate increases as the land slope increases, but the combination of soil type factor with land slope factor results in more effects on erosion hotspots in the Hocking River Basin than their counterparts in the Atwood Lake Basin. On the other hand, the combination of the land use factor with land slope factor has more effects on erosion hotspots in the Atwood Lake Basin than in the Hocking River Basin. **DOI: 10.1061/(ASCE)IR.1943-4774.0000974.** *© 2015 American Society of Civil Engineers.*

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Introduction

Soil erosion is widespread and adversely affects natural and human-managed ecosystems, resulting in habitat changes of zooplankton and phytoplankton, channel blockage, navigation failure, and difficulty in water treatment. Soil erosion has been recognized as a leading problem in river and lake systems. Particles detached from soil form sediment. Different soil types, vegetation covers, and topography characteristics result in varied levels of sedimentation due to their vulnerability to erosion (Renard et al. 1997). Input and output of sediments through a river reach keep the system in dynamic equilibrium. In such a balanced system, the soil's form and character remains stable (Hack 1960; Strahler 1957). When each side of the sediment flow is changed, the balance will be broken. Soil erosion occurs when sediment eroded is faster than its accumulation. Three major types of soil erosion caused by gravity, water, and wind are generally considered in a soil erosion model (Renard et al. 1997).

Wischmeier and Smith (1965) developed the universal soil loss equation (USLE) based on numerous data collected from a cropland east of the Rocky Mountains, aiming to estimate long-term soil erosion by water. Later, this method was modified and improved for conservation planning (Wischmeier and Smith 1978). Since then, it has been widely used as an empirical model for estimating soil erosion. However, it has a limitation of estimating erosion for gently sloping cropland situations; thus, a suitable estimation model for more dynamic topography is required. As a result, the revised universal soil loss equation (RUSLE) was developed in 1995 and adopted by the U.S. Department of Agriculture as an effective method for predicting soil erosion (Renard et al. 1997). RUSLE can be applied to estimate potential soil erosion for different land uses, such as steep sloping cropland, rangeland, and forests. After the geographic information system (GIS) was introduced (Warren et al. 1989) in environmental study, it has been applied with RUSLE for soil erosion estimation. The GIS-based RUSLE can analyze effects of soil type, rainfall, topography, and vegetation cover on soil erosion based on a relatively large scale for soil loss estimation (Chang et al. 2003; Chang and Bayes 2013).

RUSLE has been commonly used as an empirical model to estimate surface soil erosion (Angima et al. 2003; Chang and Bayes 2013; Sadeghi et al. 2011; Taguas et al. 2010). The GIS-based RUSLE can integrate effects of individual RUSLE factor on the GIS platform, and can be used either in various sizes of watersheds (Shi et al. 2004; Taguas et al. 2010; Zhou et al. 2008). The effectiveness of the RUSLE-GIS methodology enables assessing erosion parameters and predicting spatiotemporal distributed soil erosion (Fernandez et al. 2003; Onori et al. 2006; Tian et al. 2009; Zhou et al. 2008). The model was utilized to pinpoint site-specific erosion risk in areas with different climates and topologies. Generally, greater erosivity happened in winter, while lower values occurred in summer (Sadeghi et al. 2011). Higher values of soil erodibility factor and slope length and steepness factor occurred in erosion points located half-way up the hillslope, and lower values were shown at deposition points close to the outlet (Taguas et al. 2010). Identification of soil erosion problems by RUSLE has been helpful for

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