The Effect of Spatial Resolution on Erosion Patterns in Southeast Minnesota

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Abstract

The use of geographic information systems (GIS) in predicting and estimating soil erosion and deposition loads has become more accurate as technology has advanced. The increased technological capabilities have further enabled researchers to expand and specialize modeling efforts to fit specific scenarios and/or model certain types of erosion processes. The expansion of technology has also extended into the various data sources that are commonly used in erosion modeling. One of the most important data parameters of erosion modeling is the digital elevation model (DEM) or digital terrain model (DTM). DEM data quality is measured by the cell size, with larger cell sizes indicating lower data quality and smaller cell sizes indicating higher data quality. Within the past several decades, the quality of DEMs has increased from 100's of meters in cell size to sub-meter quality. The purpose for this research project is to provide an analysis of soil erosion estimates using LIDAR (2-meter resolution) elevation data compared to 30-meter resolution elevation data in the Trout Brook sub-watershed. The primary objective for this project will be investigated using the Revised Universal Soil Loss Equation (RUSLE) model, a transport capacity limited model, which predicts the spatial distribution of soil erosion and deposition rates for a steady state overland flow.

Introduction

The Trout Brook watershed (11,372 acres, 4,602 ha, 17.768 m^2) is a small sub-watershed located in the Lower Cannon River Watershed with nearly all of the Trout Brook drainage lying in Dakota County. The area of interest is one of 160 sub-watersheds located in the Cannon River watershed. The study area is referenced in Figure 1.

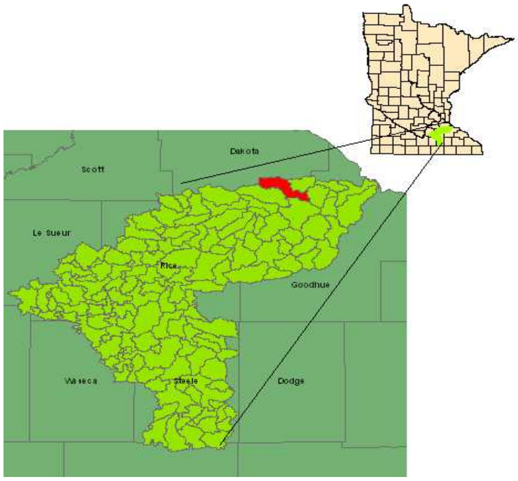

Figure 1. The Cannon River watershed with the study area highlighted in red.

The land use types located in Trout Brook sub-watershed (Table 1; Figure 2) consist mainly of row crops (57%), pasture/hay (36.5%), and deciduous forest (5.2%).

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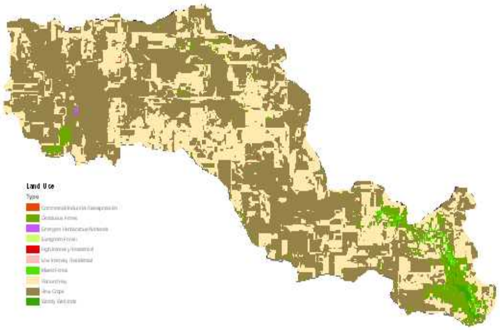

Figure 2. Land use/land cover shapefile of the Trout Brook sub-watershed.

Table 1. The amount of each land use type within the watershed

Land Use Type	Acres (Percent)
Comm./Industrial/Trans.	4.483(0.04)
Deciduous Forest	595.153(5.23)
Em. Herbaceous Wetlands	4.38(0.04)
Evergreen Forest	9.966(0.09)
High Intensity Residential	0.194(0.0)
Low Intensity Residential	2.365(0.02)
Mixed Forest	76.372(0.67)
Pasture/Hay	4164.395(36.62)
Row Crops	6505.512(57.21)
Woody Wetlands	40.339(0.35)
Total	11403.1

The soil profile (Figure 3) for the Trout Brook sub-watershed is heterogeneous with 71 different soil types. The most common soil types within the study area are: Wadena Loam (837 acres; 7.3%), Tallula Silt loam (794 acres; 6.9%), Port Byron Silt Loam (554 acres; 4.9%), and Dickinson Sandy Loam (501 acres; 4.4%).

Figure 3. Soil profile of Trout Brook Sub-watershed.

According to the National Resource Conservation Service (NRCS, 2003), sheet and rill erosion in Minnesota decreased from 2.4 tons/acre/year to 2.0 tons/acre/year from 1982 to 2001. However, the Trout Brook sub-watershed located in Southeastern Minnesota is particularly susceptible to sheet and rill erosion as row crops and pastureland typify the land use. In conjunction, the study area is situated in the Northern Mississippi Valley Loess Hills, which exhibit steep slopes and thin soil (Johnson, 2001). All of these factors have coalesced to create an area of Minnesota that has the highest annual sheet and rill erosion rate for both cropland and pastureland.

Nationally, erosion amounts have been steadily decreasing as land Management practices and sensible urban planning have been implemented. Soil erosion on cropland declined from 3.1 billion tons per year in 1982 to 1.8 billion tons per year in 2001, and sheet and rill erosion dropped by almost 41 percent during this time period (NRCS, 2003). Furthermore, between 1982 and 2001 sheet and rill erosion rates dropped from 4.0 tons per acre per year to 2.7 tons per acre per year (NRCS, 2003). Although there have been great improvements in the reduction of soil erosion nationally, the United States is still losing soil 10 times faster than the natural replenishment rate (Lang, 2006).

One of the effects of surface erosion according to Al-Kaisi (2003) is increasing levels of nitrogen, phosphorus and sediment. According to Lang (2006), about 60 percent of soil that is washed away ends up in rivers, streams and lakes, making waterways more prone to flooding and contamination from fertilizers and pesticides. Soil erosion accounts for nearly half of all pollutant types in the nation's rivers and over one-fifth of all pollutants in the nation's lakes (Johnson, 2001). An end result to an increased amount of nitrogen and phosphorus is an increase in algae and other aquatic flora that decreases the amount of dissolved oxygen in the water. Other less obvious effects of surface erosion are a decrease in value for recreational and commercial activities, a reduction in sport and commercial fish populations, a decrease in boating and swimming opportunities and the interference of navigation and reduction in aesthetic value (Johnson, 2001). The effects of surface erosion on aquatic biotic integrity are increases in water temperature, decreases in the transmission of light through water, and it directly affects respiration and digestion of aquatic species (e.g., gill abrasion).

The main effects of surface erosion on agriculture are “compaction and declining levels of organic matter in the soil are other forms of soil degradation” which results in a loss of cropland productivity (Johnson, 2001). The economic impact of soil erosion in the United States costs the nation about $37.6 billion each year in productivity losses (Lang, 2006). Moreover, the loss of production due to erosion can be caused by deterioration in the physical and chemical soil properties such as infiltration rate, water-holding capacity, loss of nutrients needed for crop production, and loss of soil carbon (Al-Kaisi, 2003). As a result of erosion over the past 40 years, 30 percent of the world's arable land has become unproductive (Lang, 2006). In short, the occurrence of surface erosion causes the properties of the soil in the affected areas to be more susceptible to erosion because of decreases in infiltration capacity and a loss of organic matter.

What is Erosion?

According to Sturhan (1997), surface erosion occurs when detachable soils on sufficiently steep slopes are exposed to overland flow and/or rainfall. The modes of transport for detached soil particles are through gravity and overland flow of water. In a more detailed account of transport/detachment dynamics, Kinnell (2004) states that there are four types of detachment and transport systems which cause and facilitate erosion processes: raindrop detachment with transport by raindrop splash, raindrop detachment with transport by raindrop induced flow transport, raindrop detachment with transport by flow and flow detachment and flow transport. Raindrop detachment with transport by raindrop splash occurs when erosion is driven by the energy derived from raindrops impacting the soil surface. Raindrop energy is used to overcome the bonds that hold particles in the soil surface and may also be used in the transport of the detached particles away from the site of drop impact (Kinnell, 2004). Raindrop detachment with transport by raindrop induced flow transport occurs when water flows develop on the soil surface, raindrops penetrate through the flow to detach soil particles which may then be splashed as a result of the breakup of the raindrop or alternatively may be lifted into the flow where they move downstream as they fall back to the surface (Kinnell, 2004). Raindrop detachment with transport by flow is a result of particles detached by drop impacts which in turn are transported downstream without the need for raindrops to be involved in the transport process (Kinnell, 2004).

The Types of Erosion

The five principal types of erosion consist of: interill erosion, rill erosion, gully erosion, stream channel erosion, and mass wasting. The most common types of erosion on bare soil are rill and interrill erosion. During interrill erosion (also known as sheet erosion) the primary erosive force is rain drop impact, where increasing detachment and erosion rates occur with increasing drop size and drop velocity (Mitasova, 1998). Rill erosion is created from small channels, which form on the surface as a result of increasing amounts of run-off (Mitasova, 1998). Interrill erosion is the dominant process on shallower slopes where the amount of rill erosion increases as the slope or the amount of surface runoff increases (Mitasova, 1998). According to Mitasova (1998), "surface roughness and soil cohesive properties are the primary factors in controlling the degree of interrill and rill erosion that occurs from an exposed area. The amount of vegetation cover is the primary factor affecting surface roughness. Vegetation decreases the velocity of runoff across the surface and protects the soil from rain drop impact."

The amount of energy generated during rill and interrill erosion is directly related to the amount of slope (steepness) and the slope length. Overland flow varies with velocity, which in turn varies with slope; a long slope allows more concentration of water, so the mass increases as the length of overland flow increases. The common conceptualization of rill detachment is expressed in a first-order differential model shown below:

$$Dc/dx = a (1- c/Tc)$$

X is the distance along the rill bed (m), c is sediment concentration (kg m_ 3), Tc is the transport capacity of the flow expressed as concentration (kg m_ 3), and a is an empirical coefficient (Nearing et al., 1989).

Gully erosion is another type of erosion, which can occur during rain-wash events within an agricultural or bare soil landscape. According to the International Corporation (1999) gullies can be either continuous or discontinuous channels that flow in response to runoff events and differ from rills in that they cannot be removed by ordinary tillage or grading practices. The primary cause of gully erosion is from flowing water (International Corporation, 1999). Gullies can form quickly during extreme events on denuded land and can rapidly expand both up and down slope (Maclean, 1997; International Corporation, 1999). The amount of erosion from gully erosion is usually less than the amount that occurs from rill erosion, because the amount of erodible particles are quickly removed from the gully channel, whereas rills are established on an actively eroding surface (Foster, 1985; International Corporation, 1999). Therefore, after initial formation, gullies usually serve as a principal transport mechanism for entrained soils (International Corporation, 1999). Gully erosion can be a significant source of sediment at bare soil landscapes; especially mine sites.

Stream channel erosion is another type of erosion that is characterized by the detachment and entrainment of soil particles along and within the stream channel. Stream channel erosion is governed by the transport capacity of stream flow. The factors that preside over stream flow are the velocity of the flow and local variations in the shear stress in the channel (International Corporation, 1999). According to International Corporation (1999), deposition and entrainment of sediment is dependent on the size of the soil particle and stream flow velocity. Stream channels differ from gullies in that they are permanent channels that transport surface waters (International Corporation, 1999). In northwestern Minnesota where topography is typified as having low relief, stream channel erosion is the dominant form of erosion in stark contrast to southeast Minnesota where sheet and rill erosion are the central types of erosion (Johnson, 2001). The final type of erosion is termed as mass wasting, landslides and debris. According to the

International Corporation (1999), landslides and slope failures occur in steep areas, which contain unstable soils or where the bedrock has unfavorable dip directions and can be augmented by anthropogenic influence. Landsides and slope failures are most likely to occur when the shear strength of soils or rock are reduced by saturation brought on by extreme precipitation event (International Corporation, 1999).

The development of spatially implicit models can be primarily traced back to the conception of the Universal Soil Loss Equation (USLE), which was based off of the Musgrave Equation (Musgrave, 1947; International Corporation, 1999).

At present there are a number of models that are utilized for erosion modeling. The reason for the number and variety of models are that each model serves a specific purpose, provides varied outputs, and requires different pieces of data. An important component that needs to be considered is that the size of the area being researched and the type of erosion model used will affect differently the resulting yearly erosion estimates. Although there are many models available that determine erosion yields under varied circumstance only spatially implicit models that will be used in the research will be reviewed in the following section.

Methodology

Model Information

RUSLE (an updated version of USLE) was the model used to determine erosion amounts within the study area. RUSLE is a well known empirical equation developed for the detachment capacity limited erosion in fields with negligible curvature and no deposition. USLE (Wischmeier and Smith, 1978) is an empirical model that was developed based on 10,000 plot-years of basic runoff and soil loss data from 49 locations across the United States. It is designed to compute long-term average soil erosion rates from sheet and rill erosion under specified conditions (Cochrane, 1999). The considerable amount of field data made possible the prediction of erosion in different types of agricultural fields.

The RUSLE formula has five different variables (A =R x K x LS x C x P) that factor into predicting the amount of sediment yielded under certain circumstances. The factors involved in RUSLE all contribute equally towards calculating the amount of erosion, which occurs within a specified area. R is the rainfall factor which incorporates rainfall energy and runoff; K is soil erodibility; LS is a dimensionless Length-Slope factor to account for variations in length and degree of slope; C is a cover factor to account for the effects of vegetation in reducing erosion; and P is a conservation practice factor (International Corporation, 1999).

According to Grigar (2002), the rainfall and runoff factor(R) in the RUSLE formula is a measure of the erosion force of specific rainfall and is the average summation of EI30 (total kinetic energy of a storm (E) times its maximum 30-minute intensity (I)) values in a normal year's rain. Long-term measurements of rainfall parameters were used to develop specific rainfall factors for many areas of the U.S. (Ditsch and Murdock, 1987). R is an indication of the two most important characteristics of a storm determining its erosivity: amount of rainfall and peak intensity sustained over an extended period (Grigar, 2002). Research indicates that soil loss from cultivated fields is directly related to the energy and intensity of each rainfall (Ditsch and Murdock, 1987). The rainfall factor for the study area is derived from the U.S. Department of Agriculture's Agriculture Handbook 703 is approximately 115.

The erodibility factor (K) is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. It is the average soil loss in tons/acre per unit area for a particular soil in cultivated, continuous fallow with an arbitrarily selected slope length of 72.6 ft. and slope steepness of 9% (Stone and Hilborn, 2000). Texture is the principal factor affecting erodibility, however; structure, organic matter, and permeability also contribute (Stone and Hilborn, 2000). Soil structures affect both susceptibility to detachment and infiltration. Permeability of the soil profile affects erodibility because it affects runoff (Grigar, 2002). According to Grigar (2002), the erodibility factor can be significantly augmented through misuse of the soil and may need to be increased if the subsoil is exposed or where the organic matter has been depleted, the soil's structure destroyed or soil compaction has reduced permeability. The soil data used in this project was derived from the SSURGO database, a product of the National Resource Conservation Service (NRCS, 2003) that was created at a 1:24,000 scale. The spatial distribution of soil erodibility within the Trout Brook sub-watershed illustrated in Figure 4 and contains the 72 different soil types.

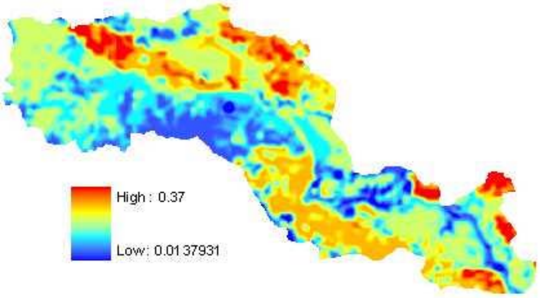

Figure 4. Soil erodibility of Trout Brook sub-watershed.

The Length-Slope factor (LS)

represents a ratio of soil loss under given conditions to that at a site with the "standard" slope steepness of 9% and slope length of 72.6 feet (Stone and Hilborn, 2000). The L and S factors account for the runoff concentration, velocity, and erosive potential in the RUSLE (Cochrane, 1999). The two constituents of this factor are slope length (L) and slope steepness (S) (Van Remortel et al., 2001). Slope length (L) is the effect of slope length on erosion (Grigar, 2002). The slope length is defined as the distance from the point of origin of overland flow to the point where either the slope decreases to the extent that deposition begins, or runoff water enters a well-defined channel (Cochrane, 1999; Wischmeier and Smith, 1978). The effect of slope length on annual runoff per unit area is considered negligible; however, the soil loss per unit area increases as the slope length increases (Cochrane, 1999). Slope steepness (S) represents the effect of slope steepness on erosion (Grigar, 2002). The effects of slope steepness have a greater impact on soil loss than slope length (Cochrane, 1999; Wischmeier and Smith, 1978). As noted by Cooper (2005), the steeper the slope, the greater the erosion, with the worst erosion occurring between 10 and 25 percent slope. The length-slope factor coverages are illustrated in Figures 5 and 6.

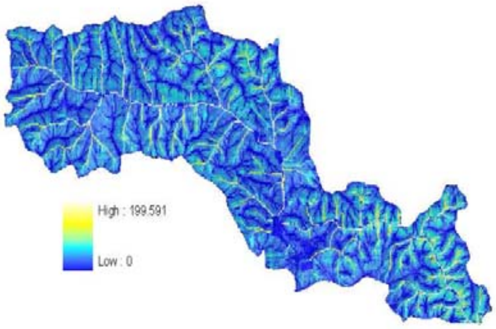

Figure 5. Length-Slope grid expressed in meters (m) derived from 30-meter elevation data.

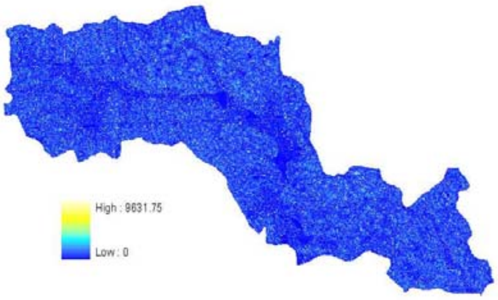

Figure 6. Length-Slope grid expressed in meters (m) derived from 2-meter elevation data.

The C factor may be the most important factor computed in USLE because its range of possible variation affects computed soil loss more than any other and it is the factor most easily changed through soil management to control erosion (Pierce et al., 1986; Foster, 1982). The crop/vegetation and management factor (C) is the ratio of soil loss compared to fallow (bare, exposed) soil (Cooper, 2005). It measures the effect of canopy and ground cover on the hydraulics of raindrop impact and runoff; of cover and management on the amount and rate of runoff.; The C factor is determined by many variables that are influenced by land cover management such as crop canopy, residue mulch, incorporated residues, tillage, and land use residuals (Pierce et al., 1986; Foster, 1982).

The C factor is used to reflect the effect of cropping and management practices on erosion rates and is often used to compare the relative impacts of management options on conservation plans (Grigar, 2002). The C factor is determined by many variables, including weather, that are influenced by management, such as crop canopy, residue mulch, incorporated residues, tillage, and land use residuals (Pierce et al., 1986; Foster, 1982). The cover factor was derived from the 2001 USGS National Land Cover Database. The 30-meter coverage was produced using Landsat Thematic Mapper satellite data and is encompassed by 21 different land use designations. The spatial distribution and erosivity of the land use classes within Trout Brook sub-watershed are shown in Figure 7.

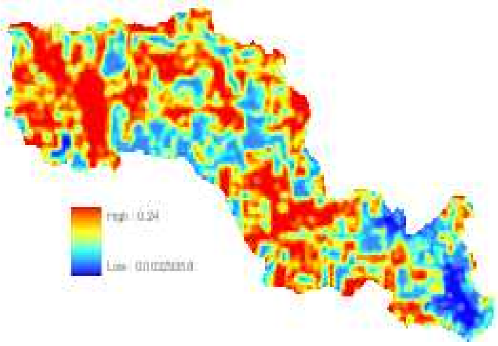

Figure 7. Erosivity profile of land use classes in the study area.

The P factor represents the ratio of soil loss by a support practice to that of straight-row farming up and down the slope (Stone and Hilborn, 2000) and is used to account for the positives impacts of those support practices. The supporting mechanical practices include tillage (furrowing, soil replacement, seeding, etc.), strips of close-growing vegetation, deep ripping, terraces, diversions, and other soil-management practices orientated on or near the contour that result in the collection and storage of moisture and reduction of runoff (Toy et al., 1998; Renard, 1997). Typically, the P factor is set to 1 unless some conservation practice is in use that would augment that value.

Data Pre-Processing

Some of the data used in the RUSLE model required preprocessing to insure quality results. The LS factor empirically expressed in the following notation:

((Flow accumulation grid) * resolution/ 22.1) m * ((sin (slope) * 0.01745)/ 0.09) n)*n

The notation used to calculate the LS factor in ArcGIS raster calculator is included in the below notation:

POW ([flow accumulation grid] * resolution/ 22.1, 0.4) * POW (SIN ([slope] * 0.01475)/0.09, 1.4) *1.4

The parameters m and n are used during the calculation of the LS factor. The parameter n can be adjusted between 1.0-1.4 and m between 0.4 -0.6 depending on the amount of disturbance within the watershed. The higher the m and n values the greater amount of disturbance to the landscape.

The land cover grid was assigned C values depending upon the amount of protection provided to the top soil by the various land cover types, with the higher values representing land cover that provides little protection from erosion. The C grid was then interpolated using the nearest neighbor function to fit the grid to the appropriate cell size for analysis. The soil rainfall runoff erosivity grid was assigned K values dependent upon how erosive a particular soil type is during a rainfall event. The K values were created and updated by the NRCS. The K factor grid was interpolated using the nearest neighbor function on ArcGIS to fit the grid to the appropriate cell size for analysis. The nearest neighbor function was selected as a means to remove abnormalities from the grid and interpolate the grid to a specific GRID cell size.

The use of the FILL function is necessary to fill in unnatural depressions in raw elevation data. If the FILL function is not used while pre-processing the elevation data, the resulting modeled erosion potential will be incorrectly elevated.

Statistical Analysis

Data was compared at three superficial sample sizes (100 points, 500 points, 1000 points). The data points were created randomly within the boundary of the Trout Brook sub-watershed (using Hawth's tools). The random points generated at 100, 500, and 1000-point sample sizes are represented in the Figure 8.

Initially, erosion grids produced using 2-meter and 30-meter elevation data were converted to points. Next, the points were joined to randomly create sample points, creating an instance where erosion amounts modeled using various DEM resolutions can be compared. The use of data at any of the three sample sizes provides consistently similar results as can be seen in Figure 9, which shows the mean of erosion results at 2-meter and 30-meter resolution and 100, 500, and 1000 point sample sizes.

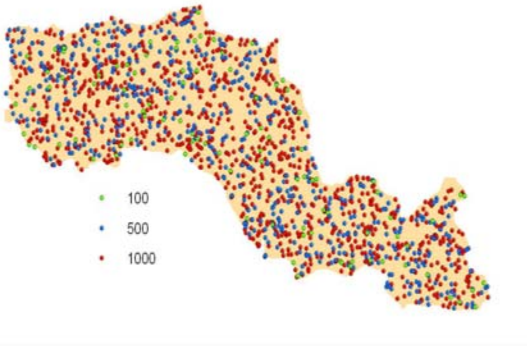

Figure 8. Map of random sampling points used.

Because the data follows a non-normal distribution, the non-parametric Mann-Whitney Test (formula below), an analogue to the two-sample t-test was selected to determine the difference between a 30-meter DEM versus a 2-meter DEM.

$$U = n_1 n_2 + n_1 (n_1 + 1)/2 - R_1$$

Results

Regardless of the sample size (100, 500, or 1000) utilized, the data indicated that the resolution of the elevation data greatly influenced the amount of erosion that was modeled in the Trout Brook sub-watershed. 2-meter and 30-meter resolution erosion data analyzed at a 1000-point sample size provided a significant result as p< .0001(1000, 1000, z = -33.795). 2-meter and 30-meter resolution erosion data analyzed at a 500-point sample size provided a significant result as p< .0001(500,500 z = -24.528). 2-meter and 30-meter resolution erosion data analyzed at a 100-point sample size provided a significant result as p< .0001(100,100 z = -11.252).

Figure 9 illustrates the difference between using 30-meter resolution elevation data versus 2-meter elevation data in the RUSLE erosion model. The average amount of cellular erosion derived from 2-meter elevation data at a 1000-point sample size was 1.4 tons/year, the 500-point sample size was 1.4 tons /year, and the 100-point sample size was 1.5 tons/ year. The average amount of cellular erosion derived using 30-meter elevation data at a 1000-point sample size was .14 tons/year, the 500-point sample size was .14-tons/ year, and the 100-point sample size was .16 tons/year. Regardless of the sample size, the average cellular erosion using 2-meter resolution elevation data was 10 times higher than the average erosion using 30-meter resolution elevation data.

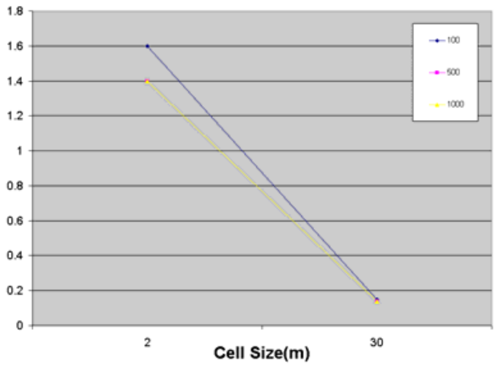

Figure 9. Mean Erosion Amounts derived from 2-meter and 30-meter resolution elevation data.

Figure 10 illustrates predicted erosion amounts calculated using 2-meter resolution elevation data subtracted from erosion amounts calculated using 30-meter resolution elevation data. Areas within figure 10 that exhibit negative values are represented in red, with darker shades representing a greater divergence. Areas within figure 10 that exhibit positive values are represented in blue, with darker regions representing a greater disagreement between the two datasets. As illustrated in figure 10, much of the study area is very homogenous with a per cell difference of -.44 ton/acre/year. The maximum and minimum cellular difference between erosion modeled at 2-meter resolution versus erosion modeled at 30-meter was 5.45 tons/year and –461 tons/year.

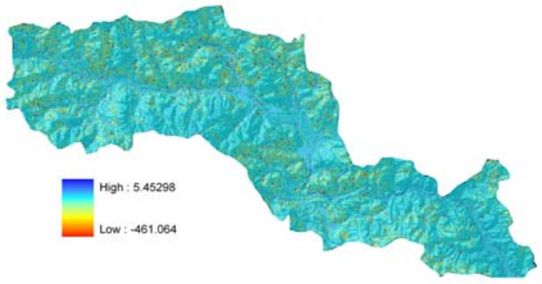

Figure 10. Areal differences in erosion amounts modeled using 30-meter versus 2-meter elevation data.

A visual comparison of figure 11 and figure 12 show that the highest erosion amounts occurred in “channels” created by the topography. These “channels” provide the appropriate geography over which sediments is more easily transported. The maximum cellular erosion amounts derived from 2-meter elevation data was 583.6 tons/year in contrast to maximum erosion amounts derived from 30-meter elevation data are 6.65 tons/year. The average erosion produced using 2-meter resolution elevation data was 815 tons/acre/year where as the average erosion produced using 30–meter resolution elevation data was .6 tons/acre/year. The difference in calculated erosion between the uses of 2-meter elevation data versus 30-meter elevation data is more than 800 percent. The differences between Figure 11 and Figure 12 is not appreciable unless evaluated at the proper scale, as was previously mentioned maximum cellular erosion amounts are vastly different because of differences in spatial resolution.

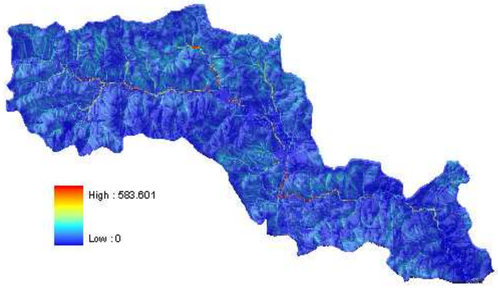

Figure 11. Potential erosion derived from 2-meter elevation data.

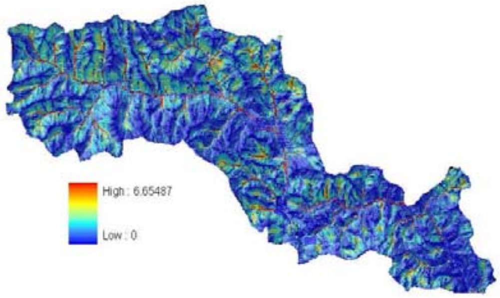

Figure 12. Potential erosion derived from 30-meter elevation data.

The difference in potential erosion modeled using 2-meter elevation data versus 30-meter elevation data can primarily be attributed to the amount of slope generated by the elevation data. The amount of slope generated by 2-meter elevation data (Figure 13) is far superior (71.72 degrees) to the amount of slope generated using 30-meter elevation data (6.21 degrees) (Figure 14). The maximum slope areas in Figure 13 and Figure 14 are located in roughly the same vicinity. A visual comparison between Figure 13 and Figure 14 shows an alignment of areas with lower and higher erosion potential; however as previously mentioned slope values derived from 2-meter elevation data were significantly higher than slope values derived from 30-meter elevation data.

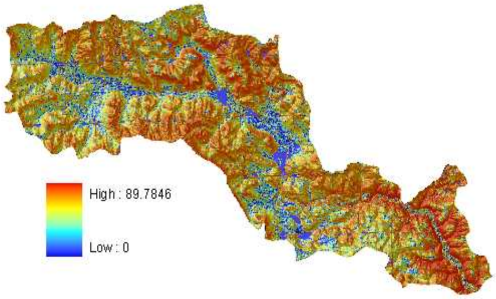

Figure 13. Slope values represented in degrees were derived from 2-meter elevation data.

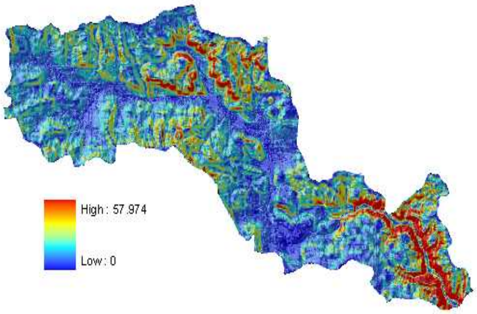

Figure 14. Slope values represented in degrees were derived from 30-meter elevation data.

Average cell slope values derived from 2-meter resolution elevation data were significantly higher than average cell slope values derived from 30-meter resolution elevation data. The disparity between slope values created from 2-meter elevation data versus slope values created from 30-meter elevation data are significant when comparing Figure 16 and Figure 16. In fact, Figure 15 depicting a histogram of slope values derived from 30-meter elevation data is skewed to the far left where as Figure 16 depicting a histogram of slope values derived from 2-meter elevation data is skewed to the far right.

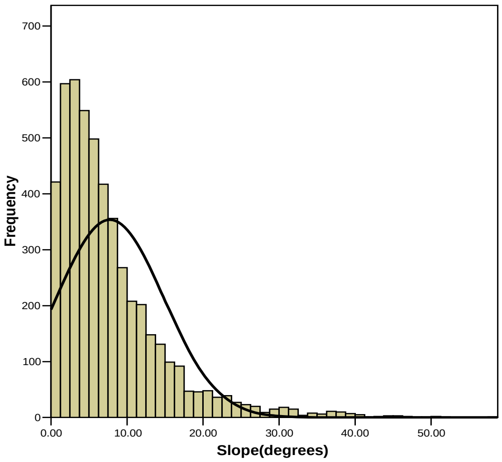

Figure 15. Histogram depicts slope frequency of 30-meter resolution elevation data.

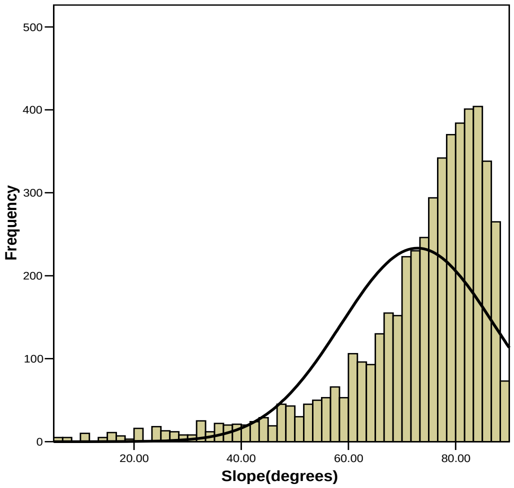

Figure 16. Histogram depicts slope frequency of 2-meter resolution elevation data.

Conclusion/Discussion

The use of 2-meter resolution elevation data produced significantly larger erosion estimates per cell (and per acre) than erosion amounts derived from 30-meter resolution elevation data. The results of this study illustrate that the spatial resolution of elevation data as a whole and more specifically in the Trout Brook sub-watershed have a tremendous effect on the response of erosion models (i.e. RUSLE, USLE, USPED etc.) that use slope as an important component in calculating erosion amounts. These findings are consistent with current literature that state that the average watershed slope becomes flatter with coarser resolution, the steeper slopes decrease in areal extent and are reflected in the decrease in mean slope (Vieux, 2004). The difference in potential erosion amounts modeled using 2-meter resolution elevation data compared to 30-meter resolution elevation data can be directly related to the increase in the amount of information entropy. As the sampling interval increases with increasing cell size, the information loss is greater for surfaces with higher fractal dimension resulting in errors in the hydrological model output (Vieux, 2004). The effect of using 30-meter elevation resolution data as opposed to 2-meter resolution elevation data is a flattened slope; the steeper slopes decrease in areal extent and are reflected in a decrease in mean slope.

A technique that was not used in this project but could be useful when doing any sort of spatial modeling is the Neighborhood Statistics function. The Neighborhood Statistics mean function “computes the mean of the values in the neighborhood” (ESRI, 2007). The Neighborhood Statistics function, if applied to outputs from this project, would drastically lower the maximum amount of cellular erosion derived from either 2-meter or 30-meter elevation data.

The lack of prior erosion data specific to Trout Brook sub-watershed negates an inclusive comparison of erosion data produced from this study. Furthermore, the lack of historical data prohibits any comparison of the accuracy of the data produced from this study to data produced in previous studies. The use of higher resolution elevation data should produce more accurate results as a consequence of higher sampling interval and lower loss of information. However, greater data quality in some cases may not imply greater accuracy but simply more information.

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