widening rates were reasonably good along the surveyed reach (between river km 11.7 and 13.7) (Figure 5-61). Difficulties were encountered in simulating toe erosion and incision in the reach on outside bends because CONCEPTS is a one-dimensional model.

The 50-year simulation of the Upper Truckee River predicts that annually 770 T/y of sediment will be discharged to Lake Tahoe. Of this total, 690 T/y are clays and silts. The majority of sediments (60%) are generated in the first 25 years when channel erosion, particularly bank widening is most active. Almost two-thirds of the total suspended-sediment is simulated to come from streambank erosion. Of the total mass of fine-grained sediments delivered to the lake over the 50-year simulation period, 37% are from streambanks, with the balance from upland sources.

The validation period for Ward Creek is 1981 to 2001. Simulated runoff volumes are lower than measured (Figures 5-68 and 5-69), but annual peak discharges are predicted fairly well (Tables 5-13 through 5-15). The simulated average annual suspended sediment load agrees quite well with those calculated from measured data (Figure 5-80): (1) 504 T (measured) versus 530 T (simulated) at USGS gaging station 10336675, and (2) 1223 T (measured) versus 1293 T (simulated) at USGS gaging station 10336676. The suspended load in water year 1997 has been omitted from the latter values, because the measured value for that year seems to be extremely large and may not be realistic. Based on the simulation results, 79% of the fine suspended load (clay and silt) at the mouth of Ward Creek is contributed from the uplands and 21% from the channel. The coarse suspended load (sands) is mainly generated in the channel (86%).

The 50-year simulation of Ward Creek predicts that annually 1150 T of sediments are discharged into Lake Tahoe. Of this total, 400 T are clays and silts, delivered primarily from upland sources (84%). The majority of sediments (70%) are generated in the first 25 years when channel erosion is more active.

The differences between simulated and measured runoff from the three watersheds can be significantly reduced with improved climate data, mainly precipitation and temperature. Precipitation and temperature are highly dependent on weather patterns and elevation (see Figures 5-21 and 5-22), and therefore, vary widely across each watershed. Precipitation will affect runoff volume, whereas temperature will determine whether precipitation occurs as rain or snow, and the timing of snowmelt. Hence, both simulated runoff volume and timing of runoff could be improved with better climate data, reducing the differences between measured and simulated runoff. Figure 5-31 shows that snowmelt can be represented by a triangular hydrograph superimposed on a certain base flow. However, AnnAGNPS and CONCEPTS do not simulate a base flow. Consequently, the constructed triangular hydrographs may have unrealistically high peaks. Determining the base flow during snowmelt may therefore lead to improved prediction of annual peak discharges.

6.0 GIS ANALYSIS OF EROSION POTENTIAL FROM UPLAND AREAS

6.1 Introduction

Measurements of stream discharge and suspended-sediment concentrations provide a mechanism to calculate sediment transport rates and loadings to Lake Tahoe. A network of stream gages around the Lake Tahoe watershed has proved to be extremely valuable in evaluating sediment contributions from different tributary watersheds. Obtaining quantitative information on the sources of this sediment is a challenge and is one of the critical issues facing the region as potential erosion-control measures and mitigation strategies are considered. Work by Kroll (1976), Glancy (1988), and Hill and Nolan (1991) have provided some information on the relative role of upland-erosion processes on downstream suspended-sediment loads. Results from erosion-plot measurements in the early 1980's in four watersheds show that upland erosion is secondary to erosion from channels (Hill and Nolan, 1991). However, several upland areas in the Lake Tahoe Basin have been identified as major sources of sediment including Ward and Third Creeks (Glancy, 1988; Stubblefield, 2002). The purpose of our basinwide analysis of upland-erosion potential was to determine whether certain climatic and upland parameters could be used to account for differences in total suspended-sediment loads at gaged stations and then extrapolated to other watersheds where no such data were available.

6.2 Data Availability and Preparation

Digital data used for upland erosion-potential analysis was provided by the Tahoe Research Group (TRG). These data consisted of raster and vector layers based on a 1998 coverage for the entire Lake Tahoe Basin. Layers used for this analysis included soils, landuse, streams, roads and trails, geology, and a Digital Elevation Model (DEM) used to create a slope-steepness layer. Additionally, a raster layer representing mean-annual precipitation within the Lake Tahoe Basin was combined with the files provided by the TRG.

It was necessary for all the layers to be in raster format because of the spatial characteristics of the analysis. Vector layers were converted to raster allowing for easier manipulation of the data. Conversion of layers from vector to raster formats was performed using ArcView 8.3. Eight layers were used in the analysis based on the availability of digital data files and their potential utility in selecting functional parameters that could be derived from the data. Layers that were used included soils, landuse/landcover, geology, roads, streams, trails, precipitation and slope. Preparation of the soils, landuse/landcover, geology, roads, trails and stream layers required a three-step process:

(1) editing the layer-attribute table to include the erodibility factor (k);
(2) classifying the layer based on erodibility; and
(3) converting the layer to a raster.

This three-step approach was slightly different for some of the layers and is discussed in the section of each individual layer.

When converting a polygon vector layer to a raster, ArcView uses attribute values of the vector layer from the attribute table. Therefore, each cell in the new raster will have the same value from the attribute table assigned before conversion. When vector layers were converted to raster format they were assigned different resolutions. Streams, trails and unpaved roads had a 5 by 5 m resolution. Soils, landuse/landcover, paved roads, geology and slope layers were converted to a 10 by 10 m grid layer. The mean annual-precipitation raster was created with a resolution of 20 by 20 m.

Before adding the raster layers, each was paramerterized so that the range of each variable was equal. The reclassification assured objectivity between layers and served to avoid biasing results when the layers were combined. A scale of 1 to 5 was selected for each variable comprising the classification. Most layers did not need to be classified because their potential-erodibility class was assigned to them before rasterization. The soils layer needed be reclassified because absolute values of the *k*-factors were one to two orders of magnitude less than other assigned values. The soils-classification process is explained in the *k*-factor section. The scale for all layers comprising the potential-erosion analysis ranged from 1 to 5 with 1 being the least erodible and 5 the most erodible.

6.2.1 Soil-erodibility factor (*k*-factor)

As an index of the potential for entrainment of soil particles from upland areas, an erodibility factor was included in the analysis. Before converting the soils vector layer to a raster, the Lake Tahoe Basin soils vector layer was classified by soil erodibility factor or *k*-factor. The *k*-factor indicates the degree of detachment of the soil under the effect of rainfall or surface runoff (Renard *et al*, 1997). Soils with similar or different characteristics were unified according to a common *k*-factor. Values of soil *k*-factor in the Lake Tahoe Basin ranged from 0.01 to 0.24. The layer was converted to a 10 by 10 m resolution raster. The *k*-factor values of this new raster were then separated into 5 equal intervals. Intervals were determined by subtracting the lowest from the highest *k*-factors, then dividing this product by 5, the number of intervals. This new layer did not contain integer values for *k*-factor and needed to be reclassified before it was be used in the analysis. Table 6-1 shows how the original k-factors were sub-divided and reclassified for the raster layer.

Soils with the lowest *k*-factor were encountered in the southwest, and somewhat in the west and northeast parts of the basin. Lowlands along the Upper Truckee River, General and Incline Creeks show intermediate erodibility values. Higher erodibility factors were encountered on the east slopes of the Lake Tahoe Basin. Areas with the highest *k*-factor values were encountered in the northwest, north and partially in the south and east slopes of the Lake Tahoe Basin. Figure 6-1 represents soil categories and the soils *k*-factor distribution throughout the Lake Tahoe Basin.

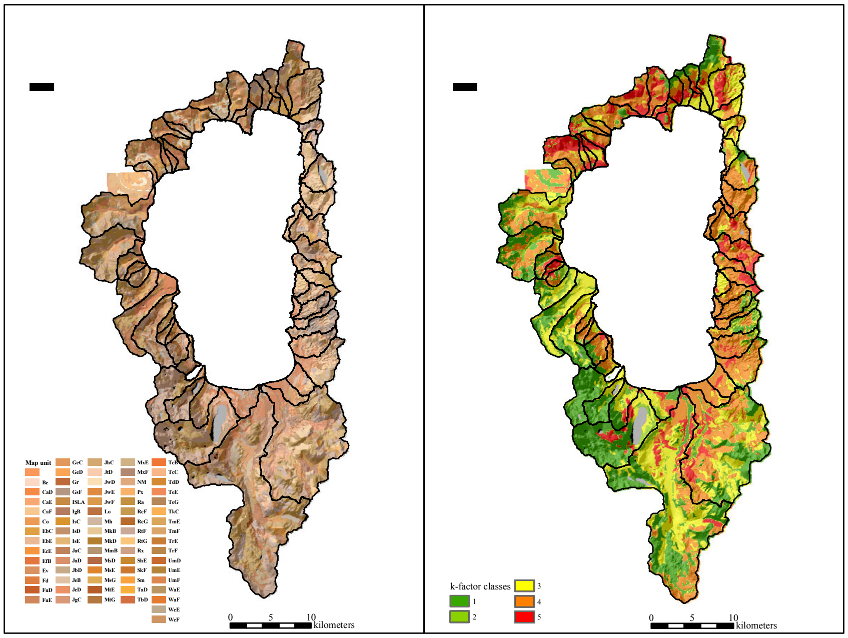

Figure 6-1. Distribution of soils categories (left) and assigned class values for soil-erodibility (*k*-factor) (right).

Table 6-1. Original Soil *k*-factors and assigned soils *k*-factor

Soil *k*-factor	Soil *k*-factor intervals	Assigned erodibility class
0.01	0.01-0.056	1
0.05		
0.1	0.056-0.102	2
0.15	0.102-0.150	3
0.17	0.151-0.194	4
0.24	0.194-0.24	5

6.2.2 Landuse

Differences in the surface characteristics or treatments can have a profound effect on erosion rates. To account for these differences a landuse/landcover layer was used. The attribute table for this layer contained three fields with different levels of landuse/landcover classification. These classification levels increased in number and complexity dividing the landuse into 4, 11 and 22 classes. The larger the number of classes the more complex the classification. The simplest classification was the most general. The other two classifications included further subdivisions of the four basic classes. Landuse/landcover Label 1 included 4 classes, Label 2 Included 11 classes and Label 3 included 22 classes. Table 6-2 shows the three levels of landuse/landcover classification.