CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1. SUMMARY

In summary, the CASC2D-SED model was reviewed in chapter 3. The interception process has been included in the current version of the model. The upland erosion scheme has been modified to include sediment routing by advection in capacity limited transport conditions. The sediment routing by size fraction has been added in channels. In channels, suspended sediment is transported by advection processes regardless of the transport capacity. In overland and channels, the transport capacity is first fulfilled with the suspended sediment volume and, if needed, with the previously deposited sediment. After moving the suspended and previously deposited sediment, any remaining transport capacity will be used to erode the upland cells. The newly implemented sediment settling concept allows for a differential treatment of silt and sand fractions in upland cells and allow sediment deposition in impoundments. As a result, silt and clay fractions are transported as washload while sand moves it as bed-material load. Finally, in Chapter 3, the output time-series grids from CASC2D-SED have been coupled with Arc/Info® for their automatic display and, if desired, the creation of an MPEG movie.

In Chapter 4, the extensively monitored Goodwin Creek watershed has been selected as the study site to test the new CASC2D-SED erosion model. The raster GIS input data is resampled from 30-m up to 330-m to study the effects of grid cell size on upland erosion simulations.

In chapter 5, the CASC2D-SED model is calibrated for one event and validated for two other events. Resulting hydrographs and sediment graphs are obtained at the outlet and at other internal locations. The sediment transport at the basin outlet is shown by size fractions for the calibration event. Observed and simulated values of sediment yield are obtained for all the gaging stations and events. Geovisualization of the erosion dynamics shows sediment transport by size fraction and displays spatial erosion and deposition patterns for the calibration event.

In chapter 6, the effects of grid cell size on upland erosion rates are presented for two different cases. In the first case, the precipitation is uniform with constant rainfall intensity, the soils are impervious and there is only one soil and land use type. In the second case, the rainfall is spatially and temporally distributed and the soils and land use are spatially distributed. The effects of grid resolution on simulated erosion rates are presented in terms of gross erosion, sediment yield, spatial distribution of net erosion and sediment delivery ratios.

7.2. CONCLUSIONS

With reference to the objectives stated in Chapter 1, the results of the calibration and validation runs of CASC2D-SED on Goodwin Creek, MS, lead to the following conclusions:

(1) **a.** CASC2D-SED is able to simulate the hydrological response of a watershed subject to a spatially and temporally variable rainfall field. Simulated hydrographs and sediment graphs are very close to the observed ones. Predicted sediment yields vary within a range of ±50% of the observed values. This is in agreement with observed rating curves in the basin.

b. The differences in settling velocities and transport capacities for each size fraction result in different percentages of eroded material leaving the watershed at the outlet. The clay fraction, representing the smallest percentage in the parent material, made up most of the sediment yield at the outlet. This fraction is carried mostly as washload, with little deposition in the watershed or the channels. The sand fraction, carried primarily as bed-material load, has the largest deposition rates and thus a small percentage of this fraction is found at the outlet.

(2) Geovisualization of the CASC2D-SED output grids in terms of MPEG movies shows the time sequence of spatial distribution of upland erosion or sedimentation, suspended sediment concentration, sediment flux by size fraction and net aggradation / degradation on the watershed. This three-dimensional representation shows that the simulated zones of erosion are generally coupled with steep slopes, depending on the land use or soil type. Zones of deposition were simulated in valley bottoms or forested areas.

(3) **a.** Resampling the Goodwin Creek watershed from 30-m to up to 330-m affects the basin representation by changing the slope distribution and the channel network definition. Resampling of the basin's DEM to 330-m results in channel and drainage area capturing. The area percentage for land use and soil type do not change significantly with resampling.

b. The following general conclusions are derived from the study of the grid cell size effect on the upland erosion predictions. For an increasing grid cell size (x):

a. Equilibrium sediment discharge decreases approximately with the inverse of the grid cell size. Gross erosion depends, among other factors, on terrain slope and unit discharge, with the stronger dependency on the first one. The normalized gross erosion decreases with $x^{-1.5}$. Taking into account not only erosion but also deposition, the predicted sediment yield values are less sensitive to the model grid cell size than the gross erosion predictions. The normalized sediment yield decreases approximately with the inverse of the grid cell size. Resampling of the soil type and land use grids affects simulated averaged sediment yield

b. The area covered with net deposition decreases while the area with negligible soil erosion increases with grid cell size. These values affect in turn the sediment delivery ratio (SDR). Simulated values for the smaller grid cell sizes (30-m to 150-m) represent erosion and deposition patterns more realistically than the coarser grids.

c. The sediment delivery ratios increase for increasing coarser spatial resolutions and are not greatly affected by rainfall intensity. Differences in SDR for the smaller spatial resolutions are due to differences in the silt fraction. The clay SDR is close to one, indicating that most of the eroded clay leave the basin as washload. The SDR simulated for the case of the 30- and 90-m grid cell size for the uniform conditions and the distributed conditions fall within observed SDR range by Boyce (1975) for the Goodwin Creek drainage area

The selected grid cell size for the erosion model should be able to reasonably represent the landscape and enable the identification of erosion-vulnerable regions in a watershed for the implementation of a suitable erosion control measures. One may conclude that the use of grid cell sizes smaller than 150-m when modeling erosion with CASC2D-SED are preferable because (1) they represent erosion and deposition patterns more realistically than the coarser resolution grids; and (2) the values of the sediment delivery ratios are closer to field measurements. The use of larger grid cell sizes are discouraged due to distortions in the landscape representation and the coarse resolution at which the location of erosion and deposition areas are simulated.