CHAPTER 7

RECOMMENDATIONS FOR FURTHER RESEARCH

The research conducted in this thesis has led to some useful results and conclusions on watershed modeling with GIS and WEPP, however it has also uncovered many areas that need additional study. The purpose of this chapter is therefore to identify and discuss the need for further research in the areas of GIS modeling and integration and the limitations of the current WEPP model.

7.1. Watershed modeling with GIS and DEMs

In this thesis the Arc View™ GIS, TOPAZ, and additional FORTAN code were used to disceretize a watershed and create input files for the WEPP watershed model. This project has solely concentrated on the use of raster based information that represent digital elevation models, soils and management maps. A vector based system could also be examined or maybe combined with a raster system to increase data availability and reliability. Additionally, the practicality of directly using Triangular networks (TINs) could also be studied.

Multiple flow algorithms could also be tested and evaluated for the discretization and flow routing of watersheds. An important advantage of using multiple flow algorithms would be in dealing with the problems of convergence and divergence. This is especially true for hillslopes that drain into the top of a channel.

The automatic identification of a critical source area (CSA) based on topography, management and soils for the identification of an appropriate channel network is another area that needs further research and development. Currently, channels are being defined by selecting a CSA to visually match channels identified through aerial photography or field studies. Additional methods of automatically identifying where a channel starts are needed. Limited research has been conducted in this area, because large quantities of watersheds and very detailed data are needed to study small channel networks. On the other hand, research on large scale channel networks has been conducted extensively using several approaches. One of these large scale approaches has been the use of fractals to estimate the distribution of the network (Tarboton, 1996 and Tarboton et al., 1988). Other approaches have dealt with creating physically-based models to determine the start of the network. It is believed that similar methods could be implemented on a small watershed scale system to identify ephemeral gullies or channels. Additionally if the channel is man-made, routines could be developed to overlay vector-based map layers of these channels on a DEM. Identification of channels is an area that offers vast opportunity for research.

It is believed that with the future availability of DEMs through advanced satellites, airborne laser technology, or high accuracy GPS surveying, the advantages of using these types of methods will be apparent not only for research purposes but for routine land management and erosion assessments. However, additional research will be needed to evaluate which of these methods is appropriate for modeling under different watershed conditions. Not only is it necessary to identify which methods produce more accurate DEMs, but also which ones are more economically feasible.

7.2. The WEPP model and GIS

The current integration of WEPP with GIS was limited to watersheds with uniform soils, crops, management, climate, and other factors. Further research is needed to determine spatially variable effects of these factors when using them as GIS map layers. WEPP

also has the capabilities to simulate a wide range of watershed conditions including multiple OFEs, impoundments, irrigation, tile drainage, and others. The implementation of each of these with a GIS offers a range of challenges and opportunities to conduct further research.

The effect of topography on the overall soil loss will be affected by the type of crop, soil or management practice. Topography and therefore resolution of DEM may not have a significant effect on overall soil loss under certain types of conditions. For example in a study by Flanagan and Nearing (1991), for WEPP simulations using fall plow corn conditions, soil detachment was sensitive to slope length whereas for no-till corn it was not. Similarly, the effects of slope gradient can be affected by different crops, soils or management practices. However, this should not affect how the Hillslope and Flowpath methods work, but rather what topographic data accuracy is needed. In some cases, very rough topographic data would be sufficient for simulations whereas in other cases more accurate DEM data might be needed. Further research could determine the extent of data and DEM accuracy needed for simulations under various watershed conditions.

Additional research is needed on large scale applications of WEPP. Even though WEPP was mainly developed for small agricultural watersheds, applications to larger watersheds are often desired and methodologies of doing this need to be developed.

Further research is also needed to study unevenly distributed inflow of runoff and sediment from hillslopes along channels. Currently, the WEPP model distributes the inflow from adjacent hillslopes uniformly throughout the channel. However, unevenly distributed inflow to the channel can be simulated with methods such as the Flowpath method. Improvements of the channel flow equations and modification of the WEPP code are necessary to simulate accurate flow routing to the outlet of the watershed.

Finally, a great deal or research could be devoted to developing a grid-based erosion model using similar principles as the WEPP model. The idea of a GRID based WEPP

came about early in the development of WEPP. Originally it was suggested that there should be three versions of the WEPP model, hillslope, watershed, and grid. However, due to time constraints, lack of funds, or lack of specific research on three dimensional erosion modeling, the GRID version was dropped. With current erosion research techniques for watersheds such as magnetic tracer beads and isotopes and Cesium 137 (Ritchie, 1990, and Spomer et al., 1985), new methods of quantifying spatially-varied erosion will help in improving current watershed modeling. Creating a true grid-based WEPP would offer diverse challenges in programming and recoding of WEPP as well as research and theoretical challenges on three dimensional modeling.