Spatial-Temporal GIS Modeling

of the Relationship between Precipitation and Streamflow

Abstract

This study attempted to model the relationship between falling precipitation and streamflow through the use of Geographic Information Systems (GIS). A goal was to illustrate how spatial-temporal GIS tools enhance the ability of analysts to model real world phenomena. NEXRAD radar precipitation data is very useful for both meteorologists and hydrologists. However, its use in GIS has been limited due to conversion difficulties. Climate scientists have used spatial-temporal NetCDF (Network Common Data form) format including NEXRAD data. In 2006, ESRI® introduced ArcGIS 9.2® with multidimensional tool that enables the easy conversion of NetCDF to GIS. NetCDF formatted NEXRAD Stage IV data was acquired and converted to GIS format for 2005, and then compared with streamflow on the Platte River in Iowa and Missouri. Streamflow amounts were measured at the lowermost basin stream gauge near Sharps Station, Missouri. The basin was subdivided into five equivalent segments for analysis. Four flood events that occurred in 2005 were analyzed to determine the amount of rainfall and runoff that fell on any of the segments which would lead to a flood event. Runoff was estimated using NRCS' Curve Number Method for each soil-landuse-NEXRAD grid cell. Estimated travel time was calculated to determine contributing segments. The four flood events were animated using ArcGIS Tracking Analyst® and

Microsoft Movie Maker® to illustrate the rainfall's real-time effect on stream rise. Results showed the calculated average curve number for the basin to be 76.75. Analysis of precipitation to flood indicated a minimum of 0.9 inches of runoff or approximately 2.7 inches of rain over an entire segment will lead to a flood at Sharps Station gauge. Flood events occurring in winter with frozen soils require 0.9 inches of rain and runoff. The 2005 cumulative NEXRAD precipitation was compared to 5 permanent precipitation gauges in the basin showing an overestimation of 4.8 percent, indicating radar inflates true rainfall totals. This study concludes that increased emphasis on spatial-temporal tools in GIS will lead to a better understanding of how time affects streamflow and other natural processes.