APPLICATION OF SURFACE EROSION AND SEDIMENT ROUTING CAPABILITIES OF THE HEC-HMS TO FORT HOOD, TEXAS

EXTENDED ABSTRACT

By Simon Evans, P.E[1], Jang Pak, Ph.D., P.E.[2], and Matt Fleming, P.E.[3]

[1] Hydraulic Engineer, Los Angeles District, U.S Army Corps of Engineers, 915 Wilshire Blvd, Suite 930, Los Angeles, California 90017. Simon.C.Evans@usace.army.mil
[2]Sr. Research Hydraulic Engineer, U.S. Army Corps of Engineers, Institute For Water Resources, Hydrologic Engineering Center, 609 Second Street, Davis, California 95616.
[3]Chief, Hydrology and Hydraulics Technology Division, U.S. Army Corps of Engineers, Institute For Water Resources, Hydrologic Engineering Center, 609 Second Street, Davis, California 95616.

The Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) is a software program used to simulate the hydrologic processes of watersheds. Surface erosion and sediment routing capabilities have recently been added to HEC-HMS version 4.0 (Scharffenberg and Fleming, 2013). These components expand the functionality of HEC-HMS and allow for more diverse applications of the program. This paper demonstrates how the sediment transport capabilities in HEC-HMS version 4.0 can be applied to develop an initial surface erosion and sediment routing model quickly, easily, and cheaply with limited observed data and resources.

The watershed used to demonstrate these capabilities was the House Creek Watershed in Fort Hood, Texas. Fort Hood is an ideal application for the newly released HEC-HMS soil erosion and sediment modeling capabilities. The extensive vehicle maneuver training grounds combined with the installation's highly erodible soils result in impaired lands and degradation of water resources. The project area is approximately 54 square miles and is a sub-watershed of the Cowhouse Watershed. There are two monitoring locations in the main watershed (FH08 and FH01) with an additional monitoring station on Clear Creek, a tributary of House Creek (FH07). The three gages record 15 minute flow data and sediment concentration data for only a few flood events that occurred at irregular intervals.

The HEC-HMS sediment model was developed using a variety of readily available data. Soil Survey Geographic Data Base (SSURGO) data, land use data from the National Land Cover Database 2011, and the USGS 10m DEM were the main data sources for the model. The meteorological model relied on hourly precipitation estimates developed from WSR-88D NEXRAD by the West Gulf River Forecast Center. An analysis period from 1996 to 2001 was established based on the availability of precipitation data, observed flow data, and observed sediment concentration data. Over this period the hydrologic model was roughly calibrated to the limited observed flow data. The surface erosion and sediment routing model was parameterized using SSURGO data, terrain and land use data, and representative soil gradations in order to apply the Modified Universal Soil Loss Equation (MUSLE) to each subbasin (Kelsey and Johnson, 2003). Channel soil gradations from the Upper North Bosque River Watershed were used as representative soil gradations in the Fort Hood model because of the proximity of the watershed and similar soil types. The sediment load output from the model was converted to a sediment concentration, and adjusted to match sediment concentration data observed at FH01, FH07 and FH08.

The limited availability of observed data prevented the traditional approach of calibration followed by a validation period. Instead, the hydrologic model was partially calibrated to two separate time periods that contained significant observed data. The two periods were then evaluated on how closely they reflected observed peak sediment concentrations. The observed sediment concentrations were not continuous data sets, therefore statistics on calibration were not calculated. However, the sedigraphs produced by the HEC-HMS model did provide a reasonable approximation of the observed sediment concentrations. Particularly during the storm event of June 2000 at gage FH01 shown in Figure 4, the peak sediment concentration produced by the HEC-HMS model corresponded with the observed sediment concentration peak. The sedigraphs developed by the HEC-HMS model at gage FH07 shown in Figures 2 and 5 overestimated the sediment concentration compared to the observed data for larger events. This may be due to the fact that the hourly precipitation estimates developed from WSR-88 NEXRAD used in the model have a coarse resolution, and may not accurately define the exact location of high intensity precipitation events in a small watershed like House Creek.

The Fort Hood HEC-HMS surface erosion and sediment transport model confirms that HEC-HMS can be used as a tool to develop a time series of sediment loads in a watershed. In the absence of other sources of data, these sediment loads can be applied as boundary conditions to detailed hydraulic models (Gibson et al., 2010). Often sediment load boundary conditions are estimated through the Universal Soil Loss Equation (USLE) or MUSLE, but this approach requires a separate runoff model and calculation for each event (Gee and MacArthur, 1996). The HEC-HMS sediment transport model provides time series sediment boundary conditions, and may prove computationally faster than other approaches. The HEC-HMS Fort Hood model could be improved by the addition of more observed data. A system of precipitation gages in the watershed would improve the hydrological model by providing detailed, site-specific data. Improved simulation of the precipitation and runoff would improve the accuracy of the soil erosion model. Soil gradations from the channel bed, sediment concentration samples, and additional stream flow gages would all refine the model and allow for more accurate calibration of the sediment transport and hydrologic modeling.

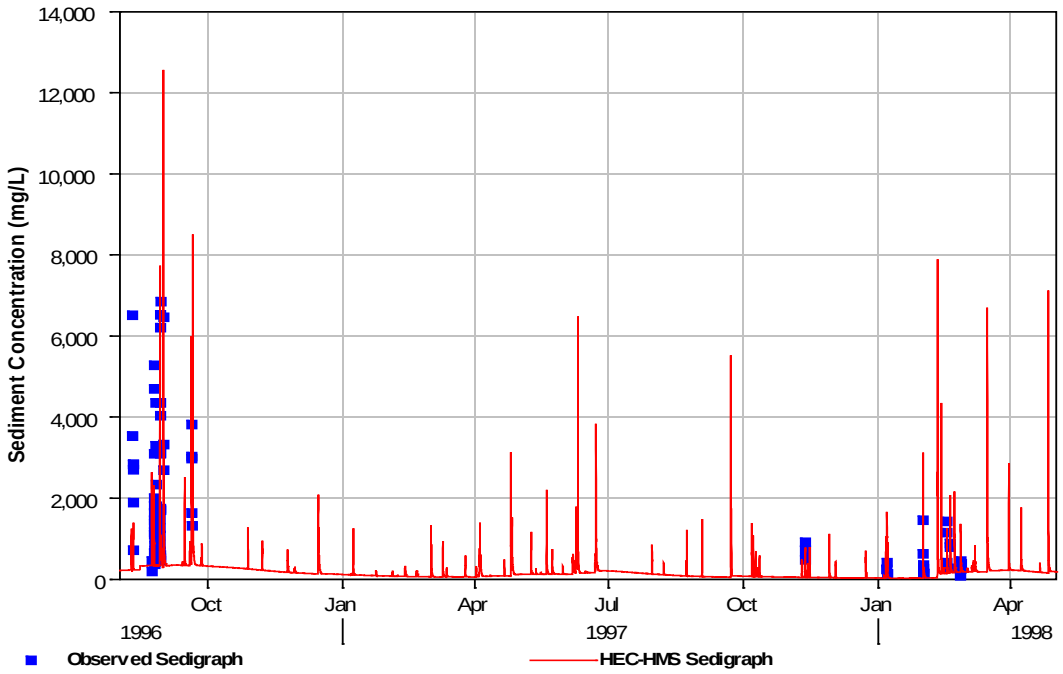

Figure 1 Sediment Concentrations at Gage FH01 for 1996-1998.

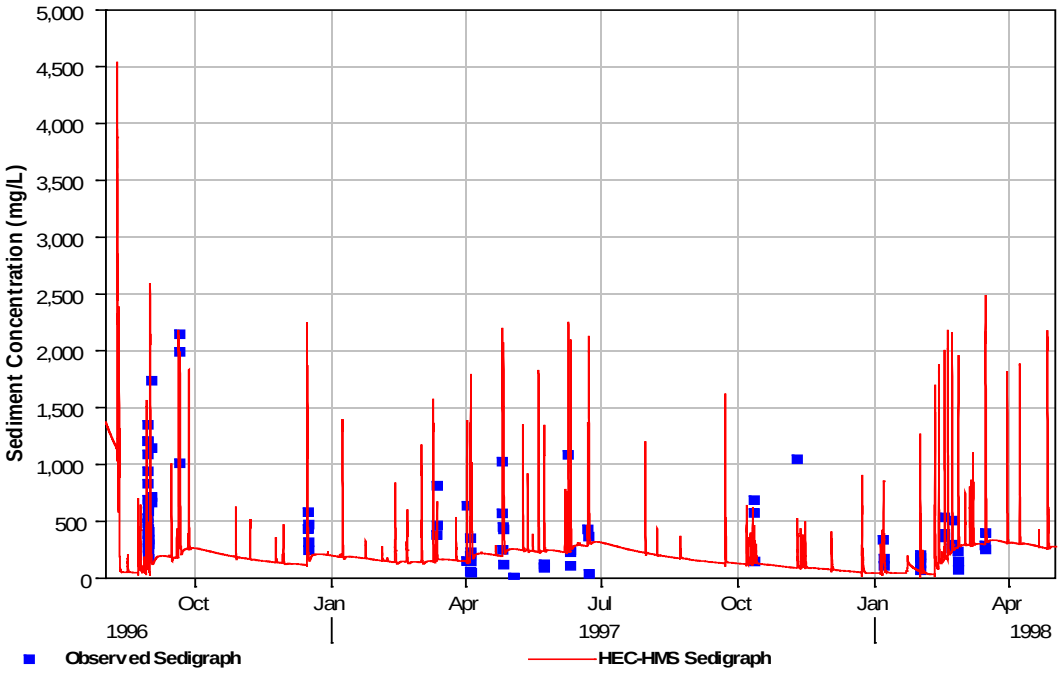

Figure 2 Sediment Concentrations at Gage FH07 for 1996-1998.

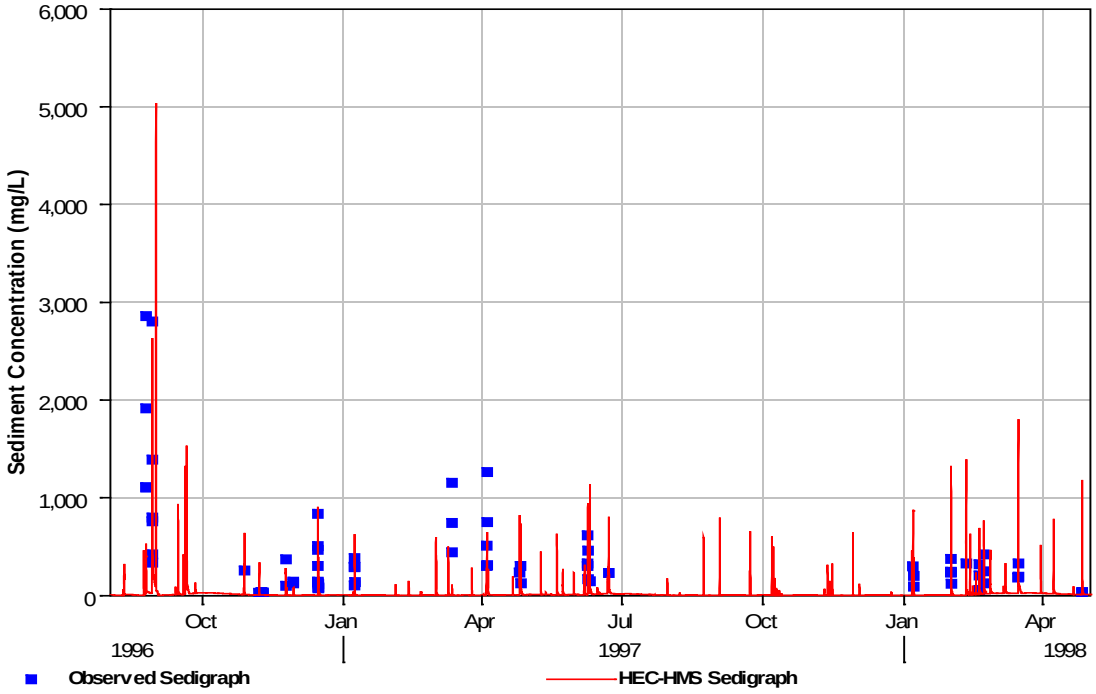

Figure 3 Sediment Concentrations at Gage FH08 for 1996-1998.

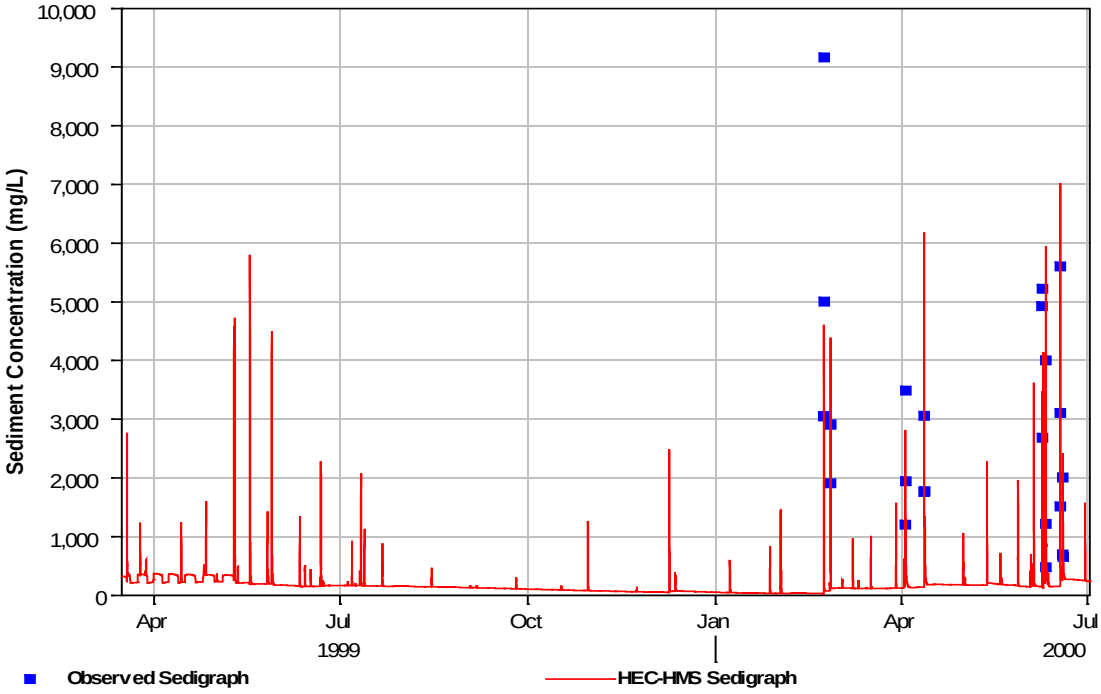

Figure 4 Sediment Concentrations at Gage FH01 for 1999-2000.

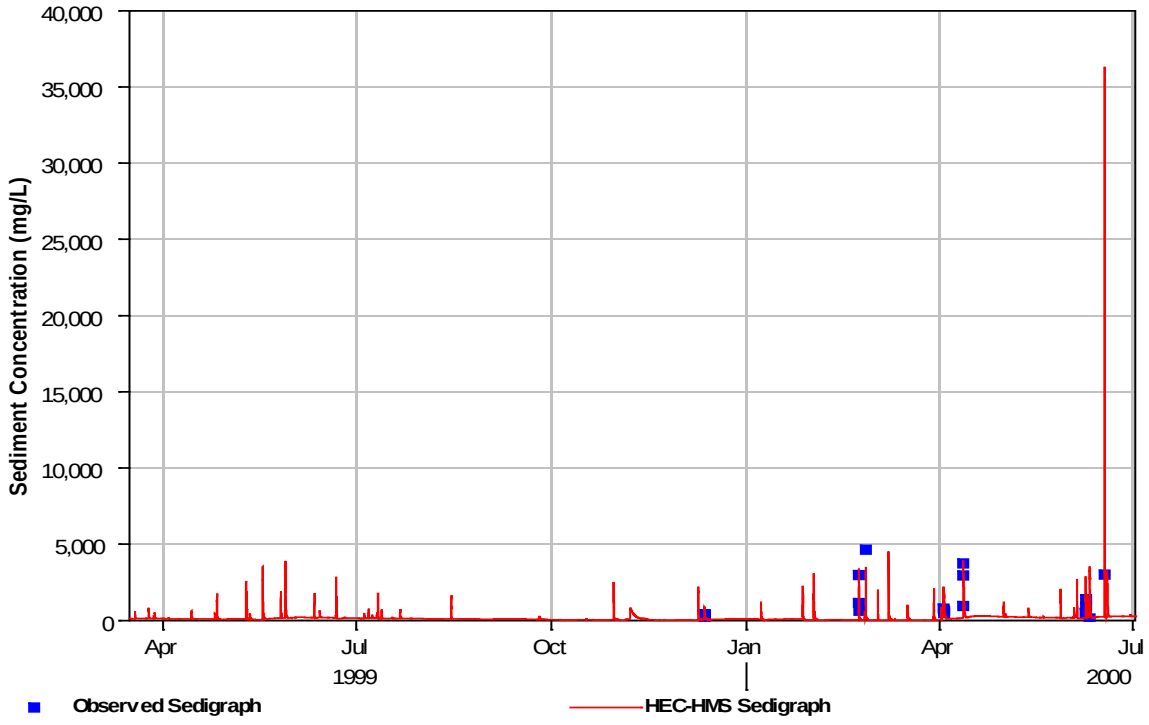

Figure 5 Sediment Concentrations at Gage FH07 for 1999-2000.

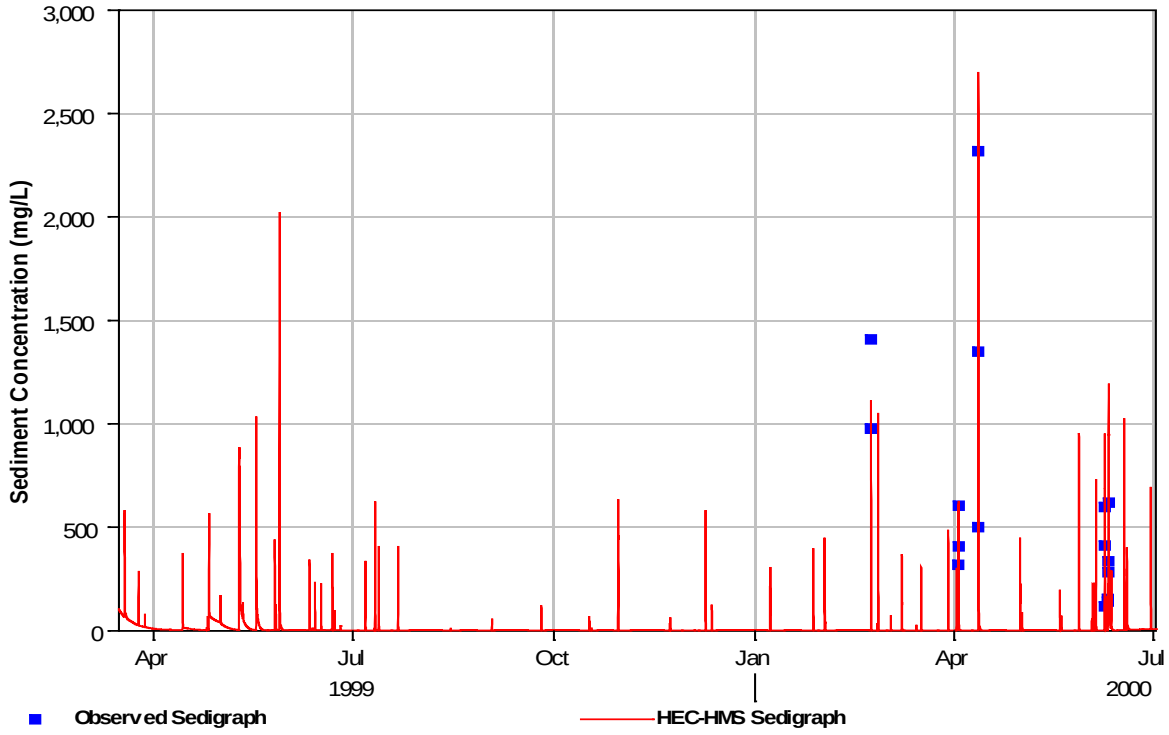

Figure 6 Sediment Concentrations at Gage FH08 for 1999-2000.

REFERENCES

Gee, D.M., and MacArthur, R.C. (1996). *TP-152 use of land surface erosion techniques with stream channel sedimentation tools.* Hydrologic Engineering Center, Davis, California.

Gibson, S.A., Pak, J.H., and Fleming, M.J. (2010). "Modeling watershed and riverine sediment processes with HEC-HMS and HEC-RAS," Watershed Management Conference, pp 1340-1349.

Kelsey, K. and Johnson, Tony. (2003). "Determining cover management values (C factors) for surface cover best management practices (BMPs)," Proceedings of the International Erosion Control Association's Conference, pp 319-328.

Scharffenberg, W.A., and Fleming, M.J. (2013). Hydrologic Modeling System HEC-HMS: User's Manual. US Army Corps of Engineers, Hydrologic Engineering Center, Davis, California.