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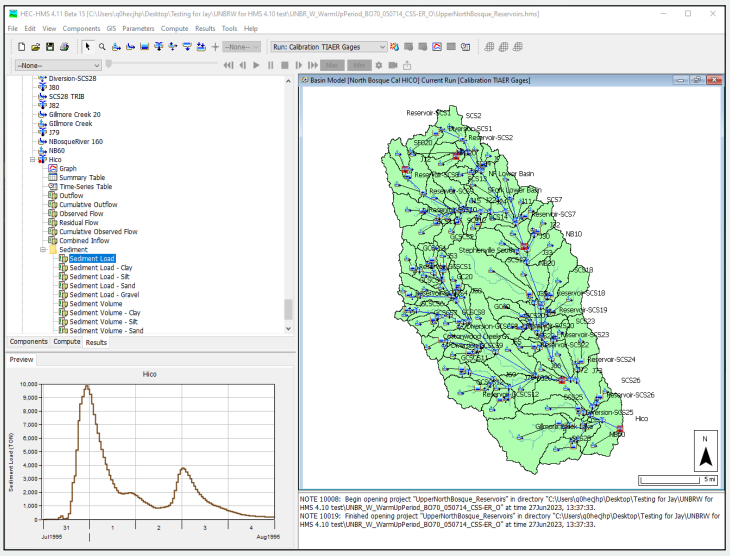
Hydrologic Engineering Center (CEIWR-HEC)
Hydrologic Modeling System (HEC-HMS)

Description



Surface erosion, reservoir sedimentation, and channel sediment transport (including erosion and deposition) are integral components of watershed management, natural resources conservation planning, evaluation of water quality best management practices (BMPs), and total maximum daily loads (TMDLs) studies. These processes, encompassing surface soil erosion and sediment transport, have far-reaching implications for various critical aspects, including agricultural land productivity, the functioning of aquatic ecosystems, the recreational quality of rivers and reservoirs, the navigability of channels, and the operational flexibility of reservoirs in relation to water supply, environmental flows, and flood risk management objectives.

In this context, the utilization of HEC-HMS emerges as a valuable and indispensable tool for enhancing modelers' understanding of the potential impacts stemming from surface erosion and sediment transport within channel and reservoir systems on watershed dynamics. By leveraging the capabilities of HEC-HMS, modelers can achieve more reasonable predictions of peak flows and sediment transport, facilitating the simulation of diverse scenarios while incorporating essential hydrological and sediment data. This software provides users with a powerful tool to conduct thorough evaluations of heightened risks related to sediment transport. These risks encompass erosion and deposition within the system. By doing so, it facilitates the creation of robust strategies for erosion control, the maintenance of water quality, safeguarding critical infrastructure, and the establishment of sustainable water supplies. The illustration depicted below visually represents the surface soil erosion and sediment transport model for the Upper North Bosque River Watershed in Texas. It offers valuable data, including subbasin surface erosion rates, reservoir trap efficiency rates, and sediment trends within the river's reaches. You can access the full paper at this link: https://ascelibrary.org/doi/epdf/10.1061/%28ASCE%29HE.1943-5584.0001205.

Benefits

The HEC-HMS surface erosion and sediment transport capabilities offer significant advantages:

1. Enhanced Understanding of Watershed-Scale Sediment Response: The Surface Erosion and Sediment Transport module in HEC-HMS improves our understanding of sediment yield and transport processes, whether analyzing single events or long-term series. It enables comprehensive analysis of sediment impacts and their influence on precipitation-runoff response.

2. Surface Erosion Prediction in Subbasin Elements: HEC-HMS achieves reasonable surface erosion forecasting through a diverse array of tools. It offers three primary options: the Modified Universal Soil Loss Equation, Build-up Wash-off, and 2D Sediment Transport, along with an additional five debris yield options tailored for post-wildfire conditions. These versatile choices are suitable for a wide range of watershed types, spanning both natural and urban landscapes, and can be tailored to various scenarios and levels of complexity.

3. Prediction of Sediment Transport in Reach Elements: HEC-HMS facilitates prediction of channel sediment transport with seven options for non-cohesive material and one option for cohesive materials. These options cater to various scenarios and levels of detail.

4. Prediction of Sediment Routing in Reservoir Elements: HEC-HMS enables reasonable prediction of reservoir sediment routing, offering six options for fall velocity calculation and two options for trap efficiency calculation. Additionally, HEC-HMS aids in managing reservoir capacity by predicting sediment trap efficiency and calculating sediment deposit volume through the dynamic reservoir volume reduction feature.

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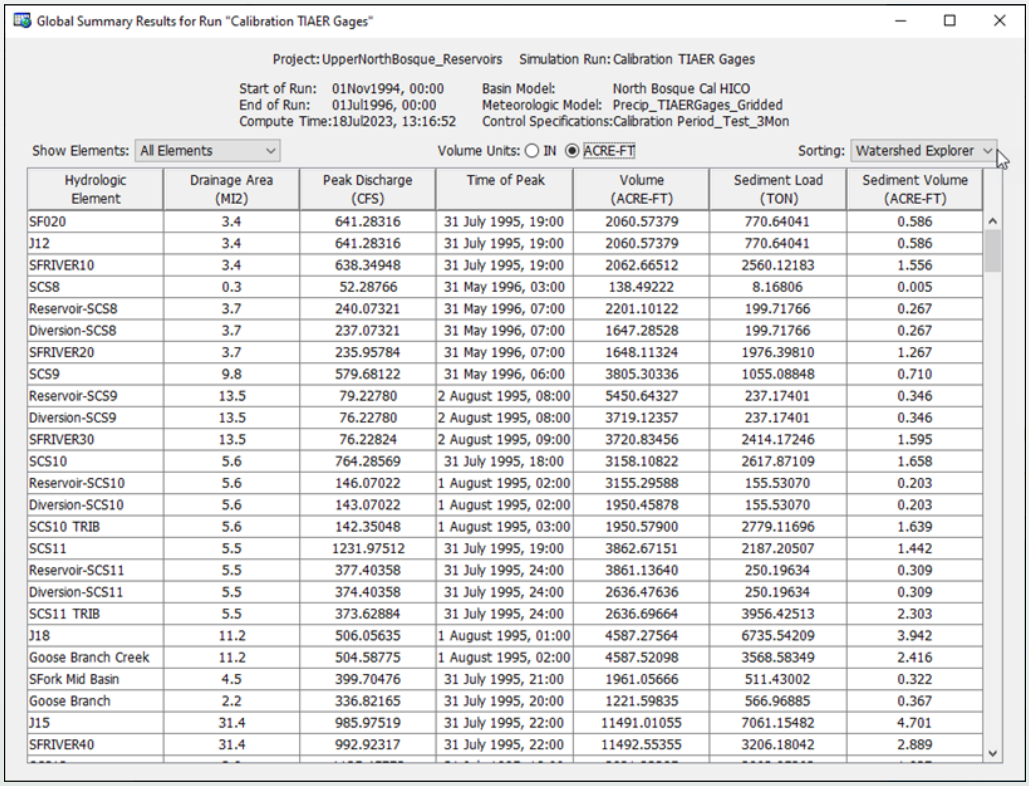
By utilizing the surface erosion and sediment transport capabilities of HEC-HMS, users gain valuable insights into sediment yield and transport environments at the watershed scale. This empowers decision-makers, emergency response teams, and land managers to implement appropriate measures for risk mitigation, ecosystem protection, and community resilience. The following illustration provides a comprehensive overview of the global analysis summary.



Global Summary Results for Run "Calibration TIAER Gages"

Project: UpperNorthBosque_Reservoirs Simulation Run: Calibration TIAER Gages

Start of Run: 01Nov1994, 00:00 Basin Model: North Bosque Cal HICO
End of Run: 01Jul1996, 00:00 Meteorologic Model: Precip_TIAERGages_Gridded
Compute Time: 18Jul2023, 13:16:52 Control Specifications: Calibration Period_Test_3Mon

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)	Sediment Load (TON)	Sediment Volume (ACRE-FT)
SF020	3.4	641.28316	31 July 1995, 19:00	2060.57379	770.64041	0.586
J12	3.4	641.28316	31 July 1995, 19:00	2060.57379	770.64041	0.586
SFRIVER10	3.4	638.34948	31 July 1995, 19:00	2062.66512	2560.12183	1.556
SCS8	0.3	52.28766	31 May 1996, 03:00	138.49222	8.16806	0.005
Reservoir-SCS8	3.7	240.07321	31 May 1996, 07:00	2201.10122	199.71766	0.267
Diversion-SCS8	3.7	237.07321	31 May 1996, 07:00	1647.28528	199.71766	0.267
SFRIVER20	3.7	235.95784	31 May 1996, 07:00	1648.11324	1976.39810	1.267
SCS9	9.8	579.68122	31 May 1996, 06:00	3805.30336	1055.08848	0.710
Reservoir-SCS9	13.5	79.22780	2 August 1995, 08:00	5450.64327	237.17401	0.346
Diversion-SCS9	13.5	76.22780	2 August 1995, 08:00	3719.12357	237.17401	0.346
SFRIVER30	13.5	76.22824	2 August 1995, 09:00	3720.83456	2414.17246	1.595
SCS10	5.6	764.28569	31 July 1995, 18:00	3158.10822	2617.87109	1.658
Reservoir-SCS10	5.6	146.07022	1 August 1995, 02:00	3155.29588	155.53070	0.203
Diversion-SCS10	5.6	143.07022	1 August 1995, 02:00	1950.45878	155.53070	0.203
SCS10 TRIB	5.6	142.35048	1 August 1995, 03:00	1950.57900	2779.11696	1.639
SCS11	5.5	1231.97512	31 July 1995, 19:00	3862.67151	2187.20507	1.442
Reservoir-SCS11	5.5	377.40358	31 July 1995, 24:00	3861.13640	250.19634	0.309
Diversion-SCS11	5.5	374.40358	31 July 1995, 24:00	2636.47636	250.19634	0.309
SCS11 TRIB	5.5	373.62884	31 July 1995, 24:00	2636.69664	3956.42513	2.303
J18	11.2	506.05635	1 August 1995, 01:00	4587.27564	6735.54209	3.942
Goose Branch Creek	11.2	504.58775	1 August 1995, 02:00	4587.52098	3568.58349	2.416
SFork Mid Basin	4.5	399.70476	31 July 1995, 21:00	1961.05666	511.43002	0.322
Goose Branch	2.2	336.82165	31 July 1995, 20:00	1221.59835	566.96885	0.367
J15	31.4	985.97519	31 July 1995, 22:00	11491.01055	7061.15482	4.701
SFRIVER40	31.4	992.92317	31 July 1995, 22:00	11492.55355	3206.18042	2.889

Applications

HEC-HMS, with its surface erosion and sediment transport modeling capabilities, finds application in various areas:

1. Watershed Management, Natural Resources Conservation Planning, Evaluation of Water Quality Best Management Practices (BMPs), and Total Maximum Daily Loads (TMDLs) Determination: HEC-HMS is extensively utilized by the modeling community to develop effective strategies for assessing and managing risks associated with sediment flow. The software's advanced modeling features facilitate a comprehensive understanding of the anticipated increase in peak flows and sediment flows from watersheds, thereby aiding in the formulation of watershed management plans.

2. Estimation of Sediment Load and Volume: HEC-HMS provides improved functionalities for estimating surface sediment loads in both natural and impervious urban environments. This functionality is invaluable for conducting specialized analyses of sediment transport tailored to the scale of the watershed, encompassing subbasin, channel, and reservoir routing processes. HEC-HMS focuses on simulating hydrology and sediment yield and transport dynamics in streams, rivers, and lakes, enabling accurate modeling of runoff and sediment movement throughout the entire watershed, including reservoirs and debris basins.

3. Reservoir Volume Reduction: HEC-HMS provides advanced capabilities for estimating reservoir volume reduction and siltation. This functionality is particularly valuable for conducting long-term analyses of reservoir volume reduction. HEC-HMS focuses on simulating the dynamic processes of reservoir sedimentation, enabling accurate modeling of runoff and sediment movement within reservoirs.

4. Multi-Disciplinary Utility for Diverse Stakeholders: HEC-HMS serves as a versatile tool applicable across various sectors. State and local governments rely on the software for local or regional planning activities, while private architectural and engineering firms leverage its capabilities for designing hydrological systems. Additionally, HEC-HMS serves as an educational resource, assisting university professors in teaching hydrologic modeling and analysis concepts.

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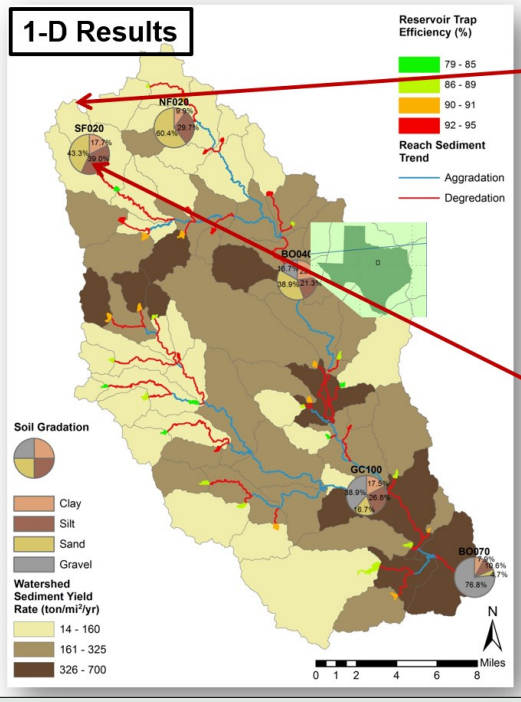
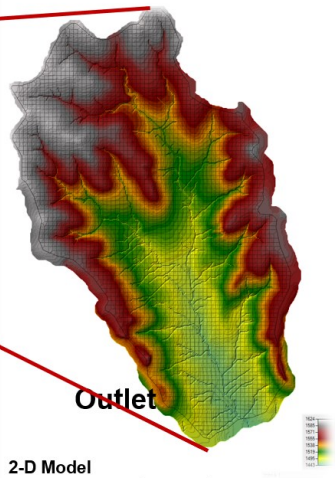
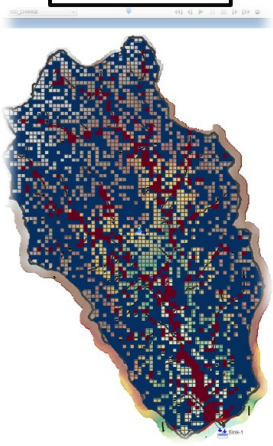
By leveraging the powerful capabilities of HEC-HMS, professionals and researchers can effectively address a wide range of challenges related to hydrology and sediment transport. The software empowers stakeholders to make informed decisions concerning sediment transport management, flood control measures, and emergency response strategies. The figure depicts a comprehensive case study conducted on the Upper North Bosque River Watershed in Texas, which specifically investigates surface erosion and sediment transport dynamics. The study employs the advanced capabilities of HEC-HMS, utilizing both the 1D and 2D modeling approaches.

UPPER NORTH BOSQUE RIVER WATERSHED, TEXAS

1-D Model
- Precipitation: 750 mm/year
- Soil Type: fine sandy loams
- 1D Area: 355.6 mi² (921 km²)
- Elevation: 299 m - 495 m
- Subbasin: 68
- Reservoir: 40







2-D Model
- 2D Area: 3.3 mi² (8.5 km²)
- Elevation: 1457 ft – 1624 ft (444 m – 495 m)
- Terrain Model: 10 m DEM
- Grid Cell Number: 4035
- Grid Cell Size: 150 ft X 150 ft

2-D STM Results
- Water Depth
- Flow Velocity
- Concentration
- Bed Change

Source: https://ascelibrary.org/doi/full/10.1061/%28ASCE%29HE.1943-5584.0001205

Key Features

HEC-HMS includes a number of hydrology features as well as advanced simulation and analysis features:

- Precipitation
- Plant Evapotranspiration
- Snowmelt
- Ground Surface Storage
- Soil Infiltration
- Surface Runoff
- Subsurface Baseflow
- Channel Routing with Losses
- Diversion Structures
- Reservoirs with Operation
- Interior Flood Hydrology
- Storm Events
- Continuous Simulation
- Gridded Models
- Physically-Based Models
- Automatic Parameter Estimation
- Flow Forecasting
- Depth-Area Analysis
- Monte Carlo Uncertainty
- Erosion and Sediment
- Probable Maximum Precipitation
- Ensembles
- **Watershed Scale Surface Erosion & Sediment Transport**
- **Dynamic Reservoir Sediment Volume Reduction/Siltation**

Technology Transfer

Technology transfer material is available from: https://www.hec.usace.army.mil/confluence/hmsdocs/.

- Manuals describing the User Interface, computational methods, applications, and software validation
- Tutorials and Guides with step-by-step instruction and example projects illustrating software application
- Class training material with slides, videos, and hands-on workshops
- Webinars highlighting software capabilities

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