Actionable Science for Communities

Tri-State Mining District Modeling, Technical and Decision Support – SHC 3.61.1

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Purpose/Utility of Research

The Tri-State Mining District (TSMD) was one of the world's leading zinc and lead mining areas, producing over 400 million tons of crude ore between about 1850 and 1970. The TSMD spans nearly 2,500 square miles and includes parts of Missouri, Kansas, Oklahoma and four Superfund sites **(Figure 1)**. Mine waste has contaminated surface water, groundwater, sediments and flood plain soils with lead, zinc, and other heavy metals. Region 7 is working collaboratively with the National Risk Management Research Laboratory (NRMRL) through the Engineering Technical Support Center (ETSC), Region 6, and other federal, state, and tribal stakeholders. The project team is developing a decision-support model that will help target specific stream and lake areas for multi-site cleanup. The model will focus on characterizing contaminated sediment loadings from the Spring River watershed to the Empire Lake Reservoir **(Figure 2)** and support predictive impact assessment of remediation and restoration strategies on contaminated sediment transport and associated ecological exposures.

Highlights

- Developed a hydrological model using the Soil and Water Assessment Tool (SWAT) to predict the impact of land management practices on water and sediment quality in the Spring River watershed and Empire Lake **(Figure 3)**.
- Created a GIS library with over 100 shape files, delineating multiple land use/land cover scenarios and supporting SWAT modeling and risk management communication **(Figure 4)**.
- Established a dual-agency (USGS, EPA) water quality, flow, sediment, and metals monitoring network to inform SWAT modeling, and on-going Regional risk assessment studies **(Figure 5)**.
- Completed calibration model for flow; monitoring network is providing data for on-going sediment and metals transport calibration with **(Figures 6a & b)**.

Application & Translation

The primary goal of this project is to effectively characterize the watershed transport processes to the terminus at Empire Lake with the SWAT platform and enable users to assess the effectiveness of remediation and restoration efforts in the Spring River watershed, including the dredging of Empire Lake.
This platform may also be applied to metals-contaminated watershed modeling and the model development method may be translated for similar contaminated sites across the Regions. The SWAT model may be used as a cornerstone for decision analysis of long-term environmental management of watersheds.

Intended End users

This project is a response to a request from Region 7 for assistance in remediation and restoration of the Spring River watershed and surrounding areas in the TSMD. The SWAT model will address the Region's needs in the area, particularly with regards to the management of Empire Lake. Remedial Project Managers (RPMs) in Region 7, interested parties in Region 6, relevant state agencies, and impacted tribal nations will use the SWAT platform for risk assessment and remedy selection.

Lessons Learned

- Better characterization of spatiotemporal hydroclimate data improved hydrologic model predictions of flow and sediment
- Higher resolution of geospatial data improved model performance
- Continued model calibration for metals and contaminated sediment transport will provide a framework to improve model predictions of sediment and metals in karst-dominated areas such as the TSMD.

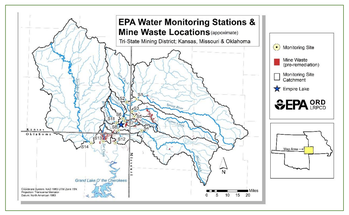

Figure 1. Water monitoring locations in the Spring River, Tar Creek, and Neosho River basins.

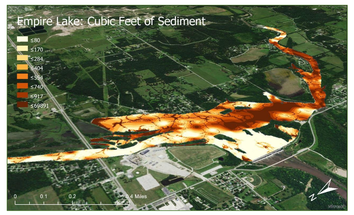

Figure 2. Estimated sediment volume in Empire Lake. A primary goal of this research is to predict, after lake dredging, siltation rates.

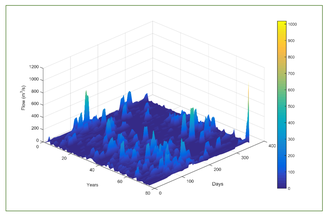

Figure 3. Daily cubic meters of water discharge in Spring River.
By running different land-use scenarios in SWAT we can test how stream discharge can change over time.

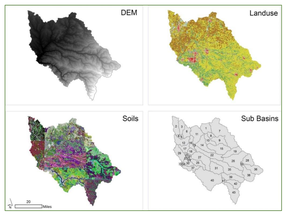

Figure 4. An example of SWAT model inputs: digital elevation, land use, soils, and sub-basin maps.

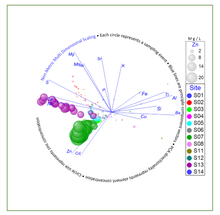

Figure 5. Water chemistry for 12 streams in the TSMD. Current stream monitoring will help to predict zinc and cadmium fate and transport.

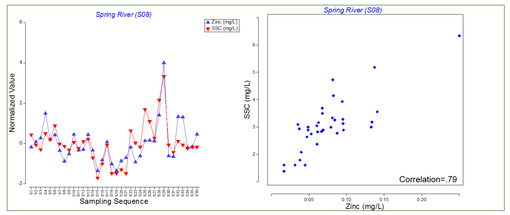

Figure 6a. Relationship between zinc and suspended-sediment concentration (SSC) and zinc.
After modeling daily sediment transport in the TSMD watershed, daily sediment bound zinc loading can be estimated.

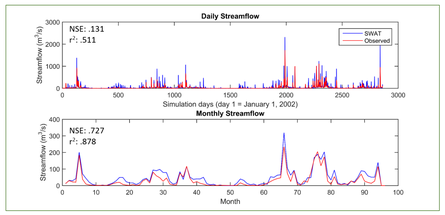

Figure 6b. Observed and SWAT predicted daily and monthly stream discharge—a major component in fate/transport modeling.