Hydrological Simulation Report: Little Bighorn Basin

1. Basin Information

Little Bighorn Basin Overview

The Little Bighorn Basin, encompassing an area of 3359.4 km², is a significant hydrological region characterized by varied topography and complex drainage networks. This report focuses on the hydrological simulation conducted for the period from January 1, 2020, to December 31, 2022, with a particular emphasis on the USGS gauge #06294000 located at coordinates (45.735812, -107.557305).

Basin & Gauge Map

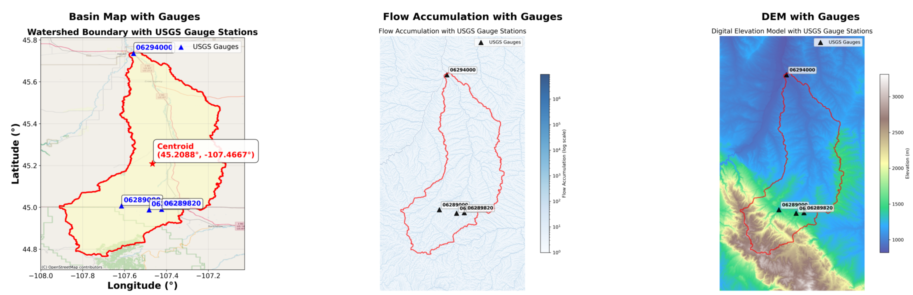

Figure 1: Basin & Gauge Map

The map above highlights the watershed boundary, with a focus on the USGS gauge stations, particularly gauge #06294000, which is strategically positioned to capture cumulative flow from the upper basin areas. The basin's centroid is marked at 45.2088°, -107.4667°.

2. Fundamental Basin Data

Digital Elevation Model (DEM)

The DEM reveals a varied relief with elevations ranging from approximately 1000 to over 3000 meters, influencing the potential energy and flow inertia within the basin.

Flow Accumulation Map (FAM)

The FAM indicates significant flow accumulation in the central and northern portions of the basin, with a dense drainage network channeling towards the downstream gauge.

Drainage Direction Map (DDM)

The DDM shows varied axial flow directions and a complex network of contributing streams and pathways facilitating runoff towards the main outlet.

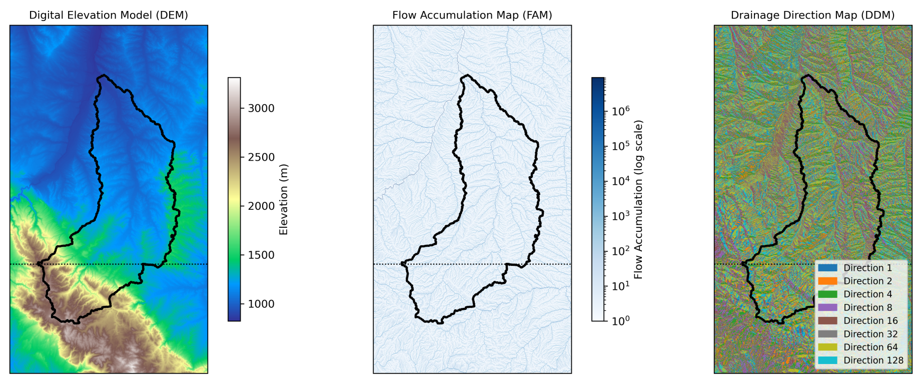

Figure 2: Fundamental Basin Data

3. Analysis Sections

Simulation vs Observation Comparison

The hydrograph below compares simulated discharge, observed discharge, and precipitation at gauge #06294000.

- **Simulated Discharge (Black Curve)**: Peaks correspond with observed hydrologic events, with notable high discharge periods during early and mid-year.
- **Observed Discharge (Red Dots)**: Discrete data points representing actual recorded discharge, aligning relatively well with simulated peaks.
- **Precipitation (Blue Shaded Area/Curve)**: Precipitation events contributing to increased runoff and discharge, with peaks generally preceding discharge peaks.

Comments on Fit and Bias

The simulation curve generally follows the observed data pattern but shows variability in peak magnitudes and timing. There are periods of underestimation or overestimation, indicating areas for calibration improvement. The time-lag and peak mismatches suggest further investigations into runoff routing and basin storage parameters might be necessary.

Model Performance Metrics

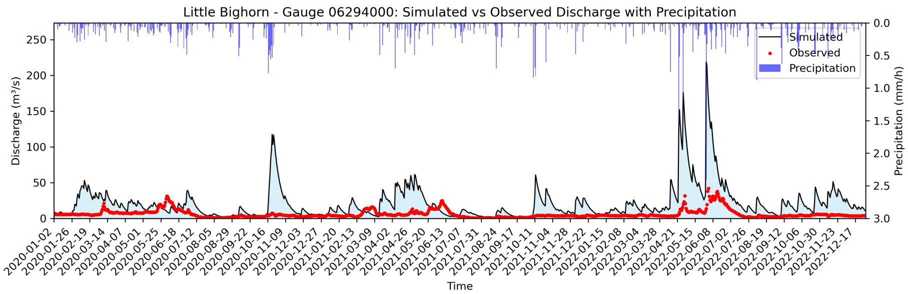

Figure 3: Simulation vs Observation

Metric	Value
Nash-Sutcliffe Coefficient of Efficiency (NSCE)	-21.115
Kling-Gupta Efficiency (KGE)	-3.159
Correlation Coefficient	0.498
Bias (m^3/s)	15.02 (250.7%)
Root Mean Square Error (RMSE) (m^3/s)	26.58

CREST Parameters

Water Balance Parameters

Parameter	Value
Water capacity ratio (WM)	150.0
Infiltration curve exponent (B)	8.0
Impervious area ratio (IM)	0.05
PET adjustment factor (KE)	0.7
Soil saturated hydraulic conductivity (FC)	40.0
Initial soil water value (IWU)	25.0

Kinematic Wave (Routing) Parameters

Parameter	Value
Drainage threshold (TH)	150.0
Interflow speed multiplier (UNDER)	1.5
Interflow reservoir leakage coefficient (LEAKI)	0.1
Initial interflow reservoir value (ISU)	0.0
Channel flow multiplier (ALPHA)	1.2
Channel flow exponent (BETA)	0.6
Overland flow multiplier (ALPHA0)	1.0

4. Discussion Points

Model Performance Evaluation

The model's performance, as indicated by the NSCE and KGE values, suggests significant room for improvement. The correlation coefficient indicates moderate alignment between observed and simulated data, but the high bias and RMSE point to calibration needs.

Warmup Period Considerations

Given the bias of 250.7%, a reassessment of the warmup period is recommended to ensure the model reaches a stable state before the analysis period.

Recommendations for Simulation Period and Next Steps

- **Calibration**: Refine model parameters, particularly those affecting runoff routing and storage.
- **Extended Simulation**: Consider extending the simulation period to capture more hydrological events and improve model robustness.
- **Further Investigation**: Explore alternative parameter sets and routing schemes to enhance model accuracy.

This report provides a comprehensive overview of the hydrological simulation conducted for the Little Bighorn Basin, highlighting key findings and areas for future research and model refinement.