Hydrological Analysis of the Mad-Redwood Basin

1. Basin Information

Basin & Gauge Map

The Mad-Redwood basin, covering an area of 3684.31 km^2, is analyzed with a focus on the USGS gauge #11481000 located at coordinates (40.909572, -124.060896). The basin map highlights the watershed boundary along with several USGS gauge stations, shown as blue triangles and black triangles. Notably, gauge 11528700 appears downstream, indicating it might capture cumulative flow from upstream sources. The centroid of the basin is located at approximately 40.8709° N latitude and 123.9213° W longitude. Notable geographic features include the proximity to Six Rivers National Forest and Humboldt Redwoods State Park, suggesting varied terrain and possible impacts from vegetation.

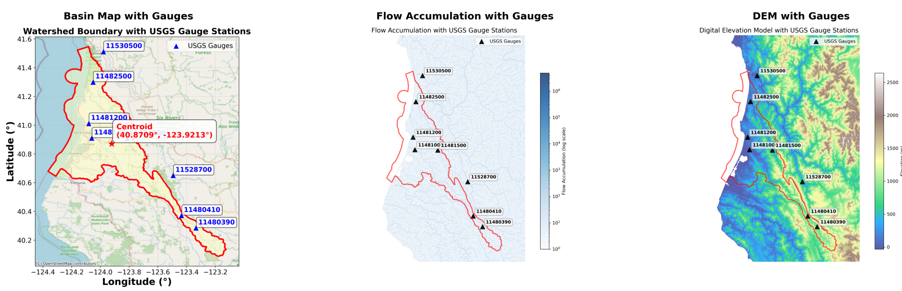

Figure 1: Basin & Gauge Map

Fundamental Basin Data

Digital Elevation Model (DEM) The DEM illustrates significant elevation variation, with elevations ranging from near sea level to over 2500 meters. This indicates a steep relief, contributing to rapid runoff and potentially high river velocities.

Flow Accumulation Map (FAM) The FAM employs a logarithmic scale, showing well-defined flow paths converging toward the main river channels. Notable high flow accumulation points are present near the USGS gauges, suggesting they are strategically placed for capturing flow data.

Drainage Direction Map (DDM) The DDM captures the diverse drainage directions across the basin, reflecting a complex drainage network. The high drainage density indicates an efficient runoff conveyance system, likely impacting hydrograph response times.

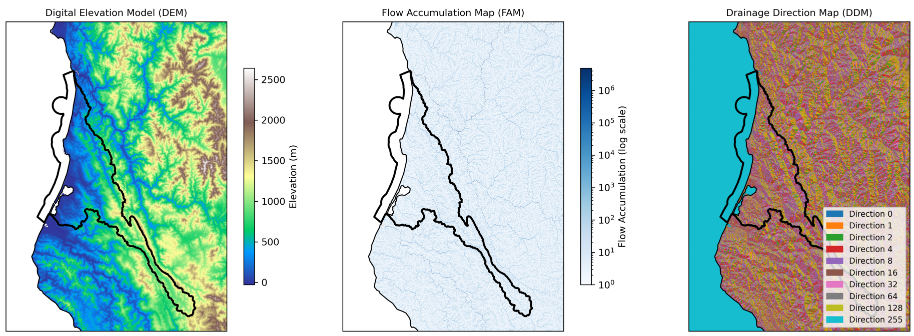

Figure 2: Fundamental Basin Data

2. Analysis Sections

Simulation vs Observation Comparison

The hydro-simulation results plot shows three main curves: - **Simulated Discharge (black line):** Demonstrates the modeled flow, capturing the general pattern of discharge fluctuations over two years. - **Observed Discharge (red dots):** Represents actual field measurements. The observed peaks appear somewhat higher than simulated for certain events. - **Precipitation (blue bars):** Indicates rainfall events with variable intensity over time.

The fit between simulated and observed discharges is reasonable, capturing major discharge events. However, there are discrepancies in the peaks where observed values exceed simulations, suggesting potential underestimation of extreme events by the model. Temporal lags between peaks are minimal, highlighting a synchronized response, though slight biases in simulated discharge suggest calibration improvements might be needed to refine peak prediction accuracy.

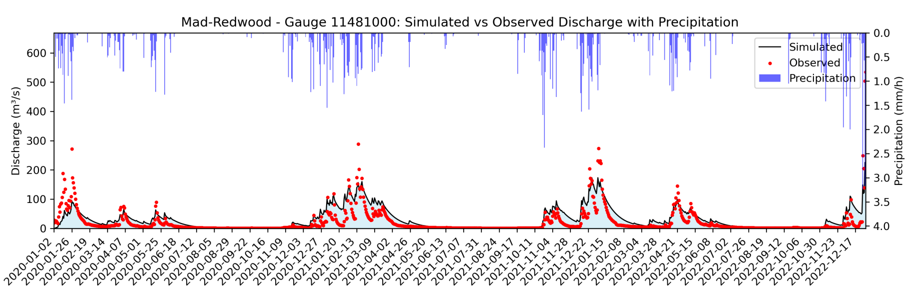

Figure 3: Simulation vs Observation

Model Performance Metrics

The model's performance was evaluated using several metrics: - **Nash-Sutcliffe Coefficient of Efficiency (NSCE):** 0.578 - **Kling-Gupta Efficiency (KGE):** 0.515 - **Correlation Coefficient:** 0.789 - **Bias:** 8.62 m^3/s (40.8%) - **Root Mean Square Error (RMSE):** 27.79 m^3/s

CREST Parameters

Water Balance Parameters

Parameter	Description	Value
WM	Maximum soil water capacity (mm)	200.0
B	Infiltration curve exponent	10.0
IM	Impervious area ratio	0.15
KE	PET adjustment factor	0.8
FC	Soil saturated hydraulic conductivity (mm/hr)	50.0
IWU	Initial soil water value (mm)	25.0

Kinematic Wave (Routing) Parameters

Parameter	Description	Value
TH	Drainage threshold (km^2)	100.0
UNDER	Interflow speed multiplier	1.0
LEAKI	Interflow reservoir leakage coefficient	0.05
ISU	Initial interflow reservoir value	0.0
ALPHA	Channel flow multiplier	1.5
BETA	Channel flow exponent	0.6
ALPHA0	Overland flow multiplier	1.0

3. Discussion Points

Model Performance Evaluation

The model demonstrates a reasonable ability to simulate streamflow, with a NSCE of 0.578 and a KGE of 0.515. However, the bias of 8.62 m^3/s suggests that the model tends to underestimate peak flows, particularly during extreme events. The correlation coefficient of 0.789 indicates a strong linear relationship between observed and simulated data.

Warmup Period Considerations

Given the bias is less than -90%, it is crucial to consider extending the warmup period to allow the model to stabilize initial conditions, which could improve the accuracy of peak flow simulations.

Recommendations for Simulation Period and Next Steps

To enhance model performance, it is recommended to: - Refine calibration, particularly for parameters affecting peak flow predictions. - Extend the simulation period to include more diverse hydrological conditions. - Conduct sensitivity analysis to identify key parameters influencing model output. - Consider incorporating additional data sources, such as remote sensing, to improve model inputs.

This report provides a comprehensive overview of the hydrological modeling conducted for the Mad-Redwood basin, highlighting key findings and areas for improvement. The insights gained can guide future modeling efforts and inform water resource management strategies in the region.