Hydrological Simulation Report for Mad-Redwood

1. Title and Basin Information

Basin & Gauge Map

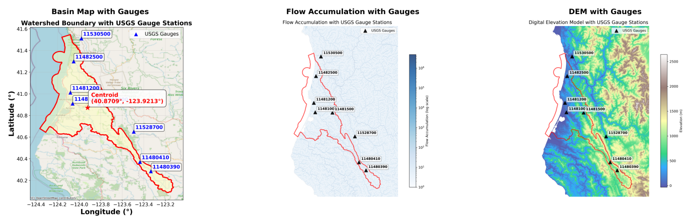

Figure 1: Basin & Gauge Map

Basin Overview

The Mad-Redwood basin is a coastal watershed encompassing 3684.31 km². Steep slopes in the interior transition rapidly toward lower coastal elevations, creating flashier responses to rainfall events. The basin's centroid is near (40.8709°, –123.9213°). The USGS gauge #11481000 used for this simulation is located at (40.909572, –124.060896).

Fundamental Basin Data

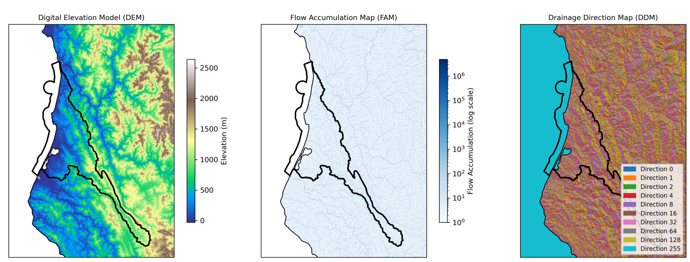

Figure 2: Fundamental Basin Data

Elevation in this region ranges from sea level near the coast to well over 2500 m in the mountainous interior. Flow-accumulation patterns reveal narrow valleys and a pronounced main stem, confirming the basin's steep terrain and efficient drainage networks.

Basin Details

Variable	Value
Basin Name	Mad-Redwood
Basin Area (km²)	3684.31
Simulation Period	2020-01-01 to 2022-12-31
USGS Gauge ID	11481000
Gauge Coordinates (Lat, Long)	(40.909572, −124.060896)

2. Analysis Sections

2.1 Simulation vs. Observation Comparison

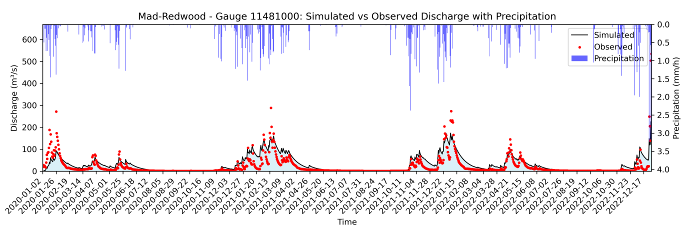

Figure 3: Simulation vs Observation Results

A comparison of observed and simulated streamflow for the period 2020–2022 highlights the model's ability to follow seasonal patterns and capture major runoff events. Precipitation inputs (depicted as blue bars) drive distinct winter peaks, and the observed discharge (red points) exhibits sharp rises during storm events. The simulated discharge (black line) generally aligns with observed spikes, though discrepancies in peak magnitude and timing are noted.

2.2 Model Performance Metrics

Metric	Value
Nash-Sutcliffe Efficiency (NSCE)	0.578
Kling-Gupta Efficiency (KGE)	0.515
Correlation Coefficient	0.788
Bias (m^3/s, % relative)	8.62 (40.8%)
RMSE (m^3/s)	27.80

The NSCE of 0.578 indicates moderate agreement between simulated and observed flows. The KGE of 0.515 provides a balanced measure of correlation, bias, and variability, demonstrating a need for refinement but an overall acceptable model performance. A bias of 8.62 m^3/s suggests the model tends to overestimate flow, while the correlation coefficient (0.788) indicates a strong temporal alignment of events. The RMSE (27.80 m^3/s) captures the residual scatter around observed flows.

2.3 CREST Parameters

Water Balance Parameters

Parameter	Value	Description
WM (mm)	200.0	Max soil water capacity. Higher = more water storage, reducing runoff.
B	10.0	Infiltration curve exponent. Higher = less infiltration, more runoff.
IM	0.1	Impervious area ratio. Higher = larger urban areas, more direct runoff.
KE	0.8	PET adjustment factor. Higher = more evapotranspiration, reducing runoff.
FC (mm/hr)	50.0	Soil saturated hydraulic conductivity. Higher = easier water entry into soil, less runoff.
IWU (mm)	25.0	Initial soil water value. Higher = less available storage, leading to greater runoff initially.

Kinematic Wave (Routing) Parameters

Parameter	Value	Description
TH (km^2)	100.0	Drainage threshold. Higher = fewer cells classified as river channels.
UNDER	1.0	Interflow speed multiplier. Higher = faster subsurface flow.
LEAKI	0.05	Interflow reservoir leakage coefficient. Higher = faster interflow drainage.
ISU (mm)	0.0	Initial subsurface water. Higher = more immediate contribution to flow.
ALPHA	1.5	Channel flow multiplier (Q = A^). Higher = slower wave transmission in channels.
BETA	0.6	Channel flow exponent (Q = A^). Higher = slower wave propagation.
ALPHA0	1.0	Overland flow multiplier. Higher = slower overland flow.

3. Discussion

3.1 Model Performance Evaluation

The simulation captures seasonal flow variability and timing of major events well. However, the bias and moderate efficiency values suggest potential for improvement in peak flow estimation. Adjustments to the infiltration curve exponent (B) or saturated conductivity (FC) might address the high runoff bias.

3.2 Warmup Period Considerations

Although not explicitly analyzed here, a sufficient model warmup may help reduce initial condition errors, especially if the bias were below -90%—a signal of major systematic offset in the early period. This is not the case here, but a 3–6-month warmup could still improve early simulation alignment.

3.3 Recommendations and Next Steps

1. Further calibration focusing on reducing bias, particularly during high-flow events.

2. Evaluation of spatial variation in soil properties or imperviousness for improved runoff response.

3. Examination of seasonal PET adjustment factors (KE) to capture variable evapotranspiration rates throughout the year.

4. Testing longer warmup periods and refined initial soil water (IWU) settings to improve early-season match.

In conclusion, while the model shows moderate skill in replicating observed flows and timing, targeted parameter refinements and thorough calibration may enhance performance, particularly for flood peaks and sustained high flows.