Hydrological Analysis Report for Willapa Bay

1. Basin Information

Willapa Bay Overview

Willapa Bay, located in the Pacific Northwest, spans a basin area of 3282.29 km². This report focuses on hydrological simulations conducted for the period from January 1, 2020, to December 31, 2022. The primary analysis site is USGS gauge #12010000, positioned at coordinates (46.373994, -123.743482).

Basin & Gauge Map

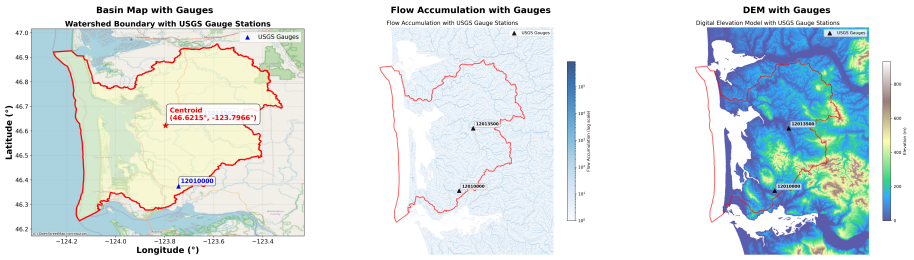

Figure 1: Basin & Gauge Map

The basin outline is marked in red, with USGS gauges #12010000 and #12013500 highlighted. Gauge #12010000 is downstream relative to #12013500. The red star indicates the basin's centroid at (46.6215, -123.7966). The region's varied topography influences hydrological flow paths and gauge readings.

2. Fundamental Basin Data

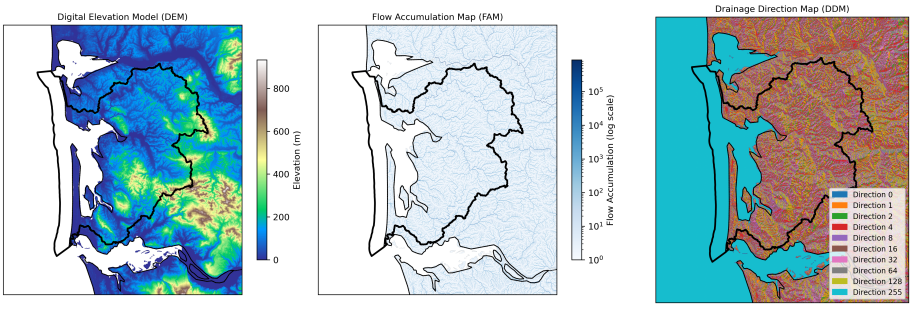

Figure 2: Fundamental Basin Data

The Digital Elevation Model (DEM) reveals elevations from 0 to over 800 meters, indicating significant topographic variation. The Flow Accumulation Map

(FAM) uses a logarithmic scale to show areas of increased flow concentration, highlighting a well-defined drainage network. The Drainage Direction Map (DDM) illustrates complex drainage patterns, suggesting high drainage density, particularly in elevated areas. These features collectively impact water movement and accumulation within the basin.

3. Analysis Sections

Simulation vs Observation Comparison

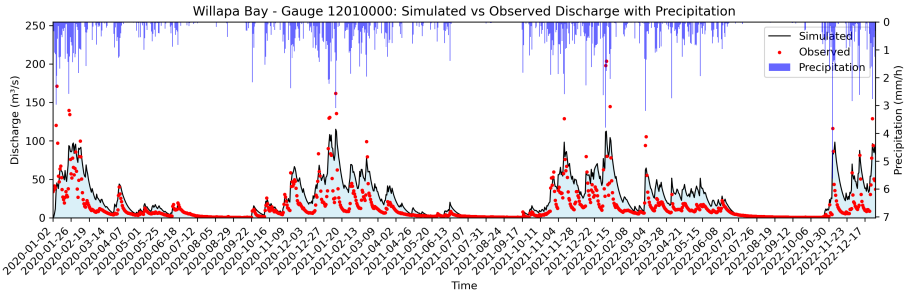

Figure 3: Simulation vs Observation

The hydrograph displays simulated discharge (black line), observed discharge (red dots), and precipitation (blue bars) over time. Precipitation events correlate with rises in both observed and simulated discharge, indicating a responsive system. However, discrepancies exist: observed discharge peaks sometimes exceed simulation outputs, and some observed peaks lag in response timing relative to precipitation peaks. This suggests a slight underestimation bias in the simulated model during high flow events, indicating room for calibration to better fit observed data.

Model Performance Metrics

Metric	Value
Nash-Sutcliffe Coefficient of Efficiency (NSCE)	0.317
Kling-Gupta Efficiency (KGE)	0.271
Correlation Coefficient	0.788
Bias (m^3/s)	9.81 (68.6%)
Root Mean Square Error (RMSE) (m^3/s)	18.63

CREST Parameters

Water Balance Parameters

Parameter	Value	Description
Water capacity ratio (WM)	150.0	Maximum soil water capacity in mm.
Infiltration curve exponent (B)	5.0	Controls water partitioning to runoff.
Impervious area ratio (IM)	0.2	Represents urbanized areas.
PET adjustment factor (KE)	0.7	Affects potential evapotranspiration.
Soil saturated hydraulic conductivity (FC)	80.0	Rate at which water enters soil (mm/hr).
Initial soil water value (IWU)	25.0	Initial soil moisture (mm).

Kinematic Wave (Routing) Parameters

Parameter	Value	Description
Drainage threshold (TH)	150.0	Defines river cells based on flow accumulation (km^2).
Interflow speed multiplier (UNDER)	1.5	Higher values accelerate subsurface flow.
Interflow reservoir leakage coefficient (LEAKI)	0.1	Higher values increase interflow drainage rate.
Initial interflow reservoir value (ISU)	0.0	Initial subsurface water.
Channel flow multiplier (ALPHA)	1.2	In Q = A equation.
Channel flow exponent (BETA)	0.5	In Q = A equation.
Overland flow multiplier (ALPHA0)	1.5	Similar to ALPHA but for non-channel cells.

4. Discussion Points

Model Performance Evaluation

The model's NSCE and KGE values suggest moderate performance, with room for improvement in capturing peak flows and reducing bias. The correlation coefficient indicates a strong relationship between observed and simulated streamflow, but the bias and RMSE highlight discrepancies that need addressing.

Warmup Period Considerations

Given the bias of 9.81 m^3/s (68.6%), a longer warmup period may be necessary to stabilize initial conditions and improve model accuracy.

Recommendations for Simulation Period and Next Steps

- Consider recalibrating model parameters, particularly those influencing peak flow simulation.
- Extend the warmup period to reduce initial condition biases.
- Conduct sensitivity analysis to identify parameters with the most significant impact on model performance.
- Explore alternative modeling approaches or incorporate additional data sources to enhance simulation accuracy.

This report provides a comprehensive overview of the hydrological simulation for Willapa Bay, highlighting key areas for model refinement and future research directions.