Two-dimensional Flow and Sediment Transport Modeling under Extreme Floods at Lower Cache Creek, California

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Goal
to evaluate the impacts of
• basin management strategies
• changing climate conditions
on the flow and sediment trapping under various flood events at Lower Cache Creek System
The main function of the CCSB is to entrap sediment and preserve the floodway capacity of the Yolo Bypass.
Current condition vs an alternative modification scenario

Bed elevation

Current condition

- Inlet
- Training channel
- CCSB
- Outlet
- Road 102

Alternative 2A

- (A) New Levee (6 miles)
- (B) Inlet Weir (3,000 ft)
- (C) Removal of training levee (5,250 ft)
CCHE2D Modeling

Developed at the University of Mississippi
depth-averaged Navier-Stokes equations
non-cohesive and cohesive sediment under non-uniform conditions

highly heterogeneous geometry of the basin
size of sub-mesh varies significantly
Requiring dense computational nodes (more than 60,000 nodes)
**Calibration**

Model was calibrated for channel roughness: (Wu and Wang, 1999) is the best option.

<table>
<thead>
<tr>
<th>Event</th>
<th>18-22 March 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flow at Cache Creek at Yolo</td>
<td>15,900 cfs</td>
</tr>
<tr>
<td><strong>Mode</strong></td>
<td>Calibration</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Rd 102</td>
</tr>
<tr>
<td><strong>NRMSE</strong></td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Nash Coefficient</strong></td>
<td>0.93</td>
</tr>
</tbody>
</table>

- Inflow discharge at Yolo
- Water Surface Elevation (WSE) at Rd 102
- WSE at Site C
- WSE at Overflow Weir

March 18-22, 2011

Rd 102 to Rd102: 13.5km reach
Yolo to Rd102: ~14.5 km²
Validation

March 23-27, 2011

Peak Flow at Cache Creek at Yolo: 14,300 cfs

Mode: Validation

Location: Site C

NRMSE: 0.07

Nash Coefficient: 0.90

NRMSE: 0.08

Nash Coefficient: 0.87
Water depth differences, alternative modification scenario minus current condition
Bed change differences within CCSB: alternative modification minus current condition

- higher bed elevation in the east of new weir, and middle CCSB
- lower bed elevation in the south CCSB
## Sediment Trap Efficiency

<table>
<thead>
<tr>
<th>Flow Event</th>
<th>Probability of exceedance</th>
<th>Full Simulation Domain</th>
<th>CCSB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Current Condition</td>
<td>Alternative Scenario</td>
</tr>
<tr>
<td>10-year</td>
<td>0.1</td>
<td>80</td>
<td>83</td>
</tr>
<tr>
<td>50-year</td>
<td>0.02</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>100-year</td>
<td>0.01</td>
<td>88</td>
<td>90</td>
</tr>
<tr>
<td>200-year</td>
<td>0.005</td>
<td>93</td>
<td>92</td>
</tr>
</tbody>
</table>
Impacts of climate change on flow and sediment trapping of CCSB


Hydroclimate modeling study over Cache Watershed in 21st century provided the IC/BC.