A comparison of long-term sediment transport numerical model results using historical and statistical hydrograph data in the arid Southwestern United States

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Motivation

- There is significant lack of historic stream-flow data in Southwestern United States: arid climate, scarcity of long-running stream gages
- Many design standards in US require an analysis of long-term bed changes: LACDPW, FHWA
- Some federal standards discuss use of historic hydraulic data for use in long-term bed change modeling and suggest use of statistical procedures to represent long-term trends: ACOE TD-13, FEMA REHA

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Problem

- *It is unclear if statistically-generated, long-term hydrographs will produce a bed response similar to that produced using historic hydrographs in one-dimensional sediment transport models*

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Geomorphologic Considerations

- Sediment flux of California rivers during major flood years averages *27 times greater* sediment annual transport than during dry years (Inman & Jenkins 1999)
- Reset events – large discharge events in a stream system that can completely alter the form of the stream
- Geomorphic dominance of reset events overwhelms effects of smaller events (Hecht 1993)

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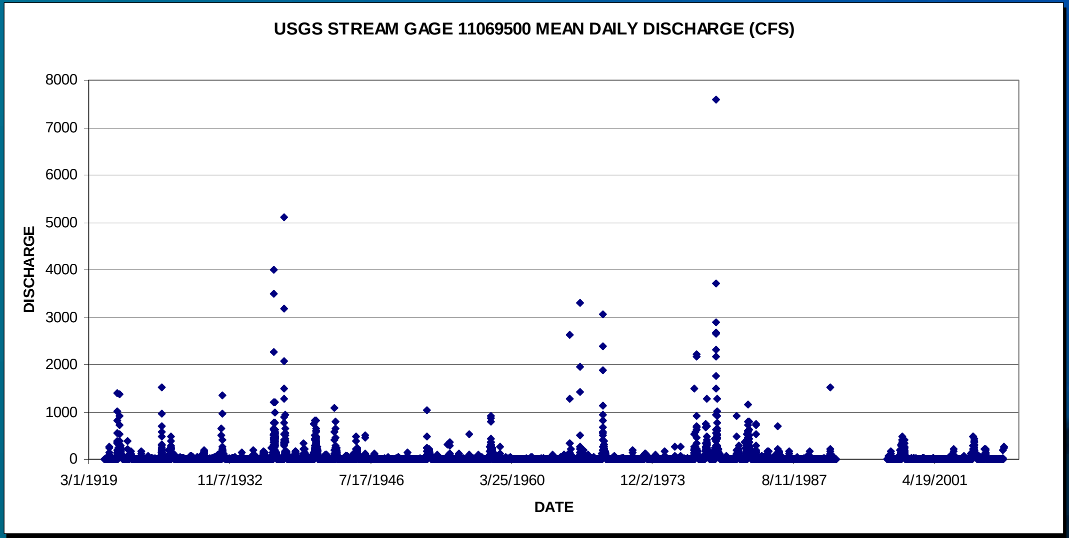
Study Area – San Jacinto River

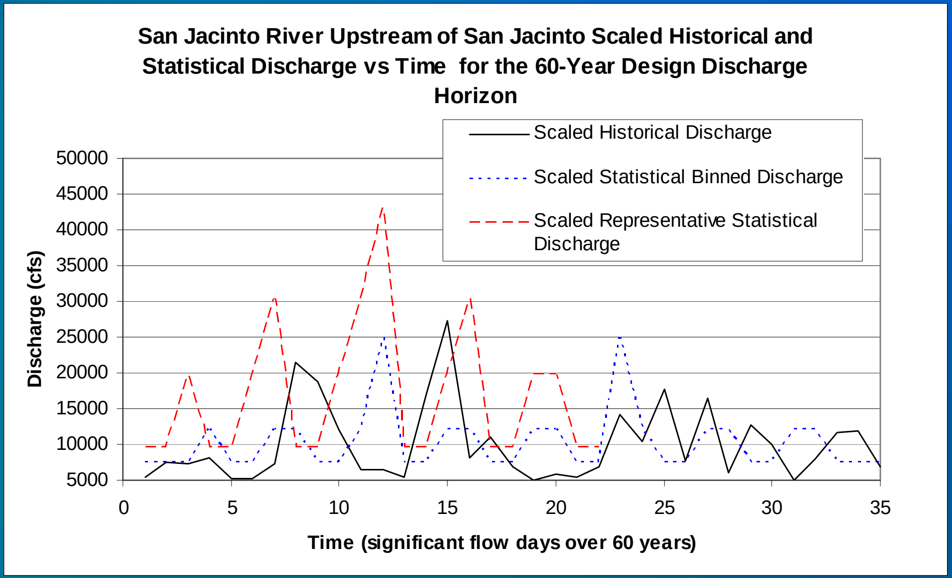
- The study reach on the San Jacinto River extends from downstream of Castile Canyon to upstream of Mystic Lake adjacent to the City of San Jacinto, Riverside County, California

Gage Data

- Two available gage data sets but only one with statistically significant length (>40 yrs): USGS 11069500 – 88 years
- Data problem: daily means only, no daily peaks
- Data Problem: gage is significantly upstream of study reach
- This gage is better than most for both length and available statistics



Hydrology



11069500 Daily Averages Scaled So that Yearly Max of Daily Averages Has LP3 With Q100 = Design Flowrate					
Lower Class Limit	Value	# Members	Lower Class Q	% Events per year (neglect years with no data)	% Events per 60 years
A	3.00	560	1000	6.83	409.76
B	3.70	27	5000	0.33	19.76
C	4.00	18	10000	0.22	13.17
D	4.30	3	20000	0.04	2.20
E	4.70	0	50000	0.00	0.00
F	5.00	0	100000	0.00	0.00

- Events analysis included only events where Q>5000 cfs
- Two types of data scaling were employed: area, peak Q
- Binned, statistically generated and historical long-term hydrographs were created

Modeling

- HEC-6T
- Geometry from approved HEC-RAS
- Design Q from ACOE
- Sediment from recent samples
- Sediment BC – recirculation
- Hydrology from gage

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    LF IS DECIMAL FRACTION, PF IS WHOLE NUM FRACT
I1            250
I4   ENGH      15         1         8
IQ           5000     15000     30000     60000
  LT    T/D  136456   611725  1377820  3348560
LT    T/D   83000    410000  1030000  2550000
LF    VFS  0.0574    0.0481   0.0233    0.0176
LF     FS  0.1663    0.1531   0.1044    0.0868
LF     MS  0.3257    0.3171   0.2892    0.2702
LF     CS  0.2701    0.2782   0.3132    0.3182
LF    VCS  0.1284    0.1426   0.1827    0.2008
LF    VFG  0.0406    0.0470   0.0661    0.0705
LF     FG  0.0104    0.0124   0.0190    0.0247
LF     MG  0.0011    0.0014   0.0022    0.0032
PF  DS     11396.              19.25     12.70     99.90    9.525    99.70    4.760    99.00
PFC 2.00    95.20     1.191    90.20     0.419     60.90     0.30    55.10    0.149    23.10
PFCD.074    10.80
PF  US     30361.              19.25     12.70     99.40    9.525    99.00    4.760    96.80
PFC 2.00    82.60     1.191    66.80     0.419     27.80     0.30    15.70    0.149     4.30
PFCD.074     1.90
$HYD
  ADDED FOR TESTING SEDIMENT BC
  $RE    66
  ADDED TO ACCOUNT FOR AGGRADATION AS DS BOUND
$B      2
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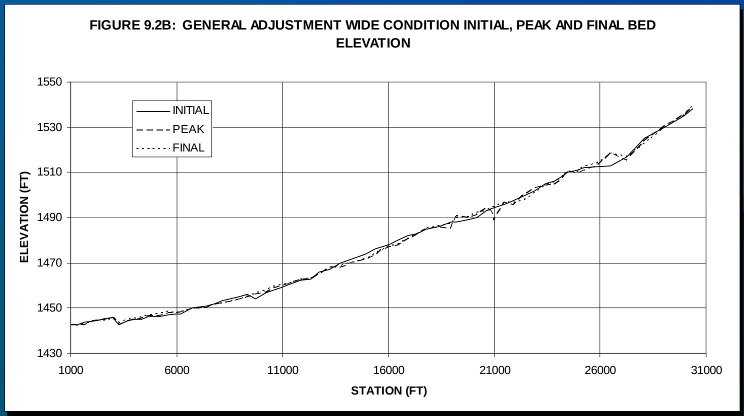
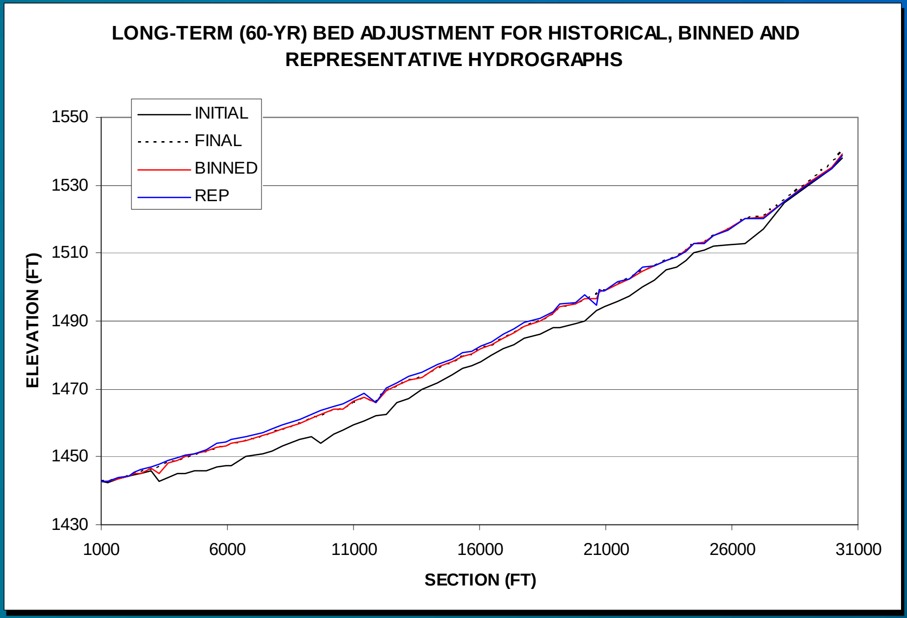
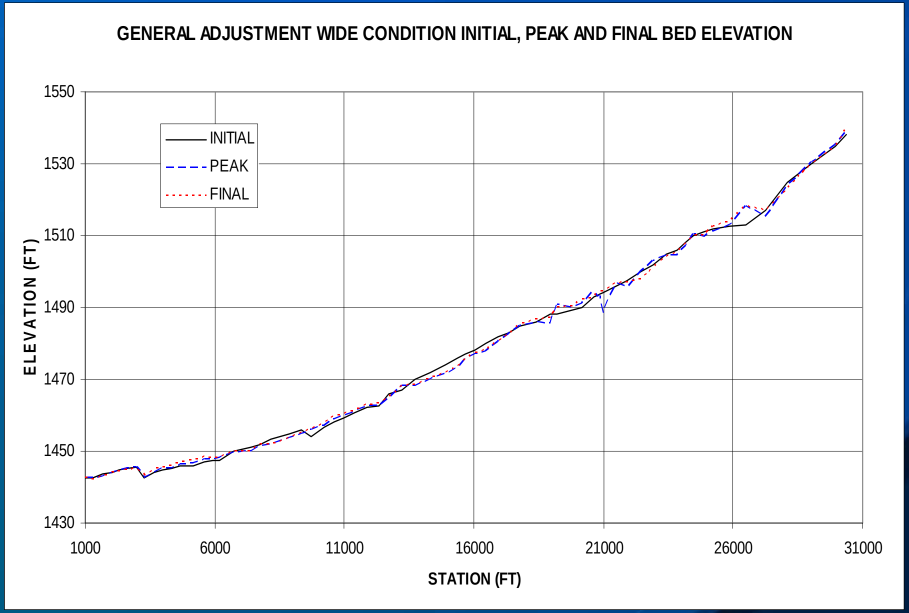


Results and Reset





Volume Comparison

COMPARISON OF RESULTS BY METHOD			
METHOD	AVERAGE BED CHANGE (FT)	VOLUME (CFS*DAY)	AVERAGE Q (CFS)
HISTORICAL	4.0	341769	9959
BINNED	4.0	356000	10171
REPRESENTATIVE	**4.5**	366594	**16663**

- The representative hydrograph resulted in the greatest bed change
- All three hydrographs had similar volumes
- Average discharge is important in aggrading systems

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Conclusion

- Results suggest that “reset” is observable in model output for aggrading systems
- Results suggest that “reset” is a function of the intermittent nature of arid southwest hydrology – no flow for low Q
- Results suggest that “reset” is a function of total runoff volume and average discharge, not peak discharge in aggrading systems
- Results suggest that statistical modeling is an acceptable modeling technique in aggrading systems in the absence of historical data if the volumes and average Q are *appropriately estimated*

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