River discharge along the US West Coast margin: identifying river basins that flood concurrently

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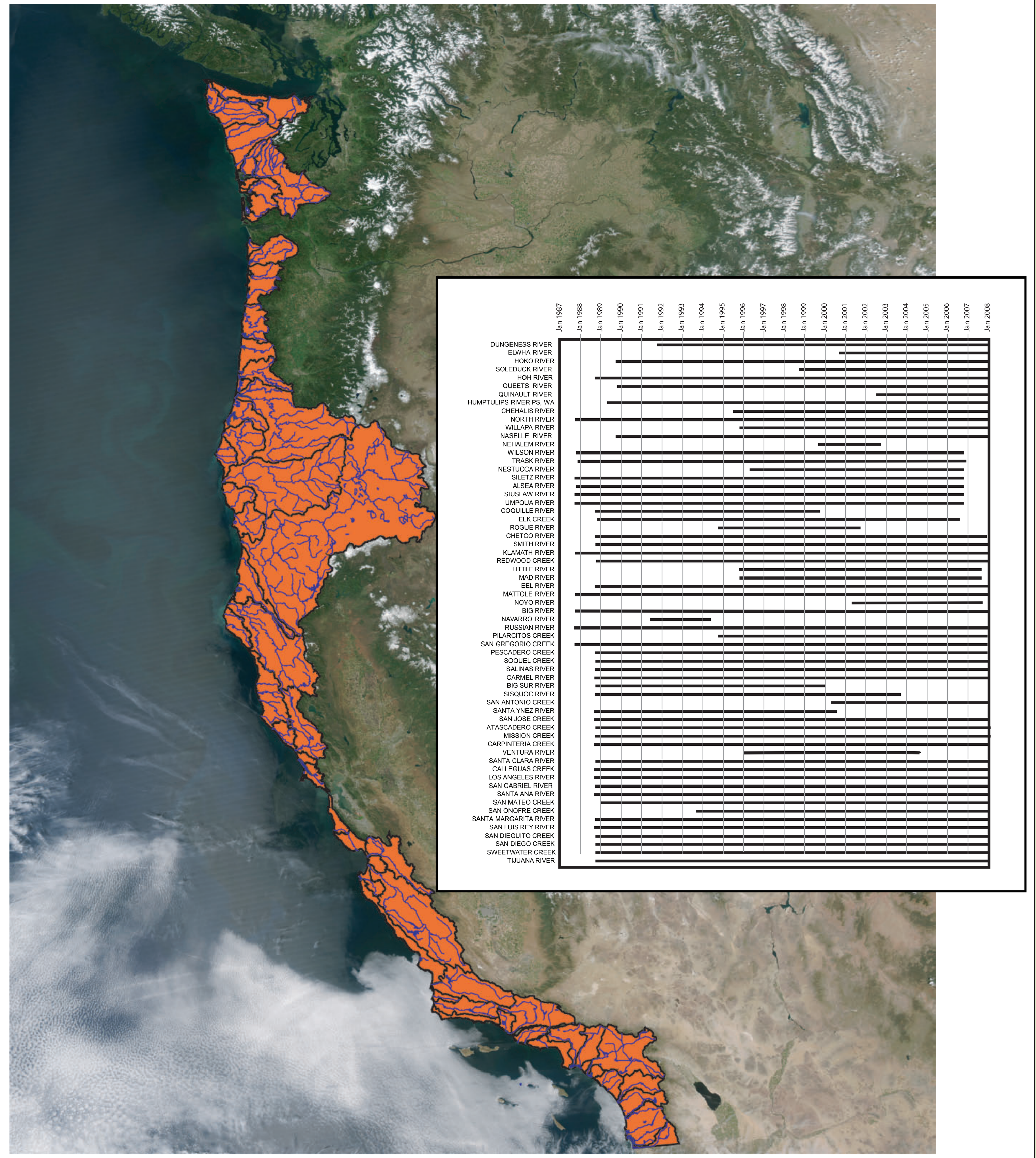
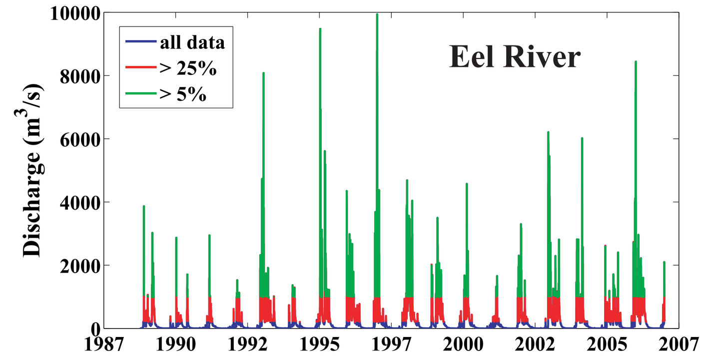
Introduction

The river basins along the US West Coast are generally small, less than 15,000 km^2, and tend to flood immediately after rain events. The storm systems that deliver rain to the West Coast margin are considerably larger than the river basins such that multiple river basins receive rain within hours of each other. Subsequently, these proximal rivers likely disperse fresh water and sediment to the coastal ocean at relatively the same time. Therefore many conceptual and numerical models may underestimate sediment delivery, dispersal, and burial, as well as buoyant circulation on shelves adjacent to small rivers with mountainous catchments. This study quantifies how well river basin discharge correlates.



Methods

Identify USGS gauges of interest along the U.S. West Coast.
Data range from 10/1/1987 to 9/30/2007.
Created MATLAB scripts to process and manipulate data.
Changed 15-min data into hourly data.
Created partial duration series at 5% and 25%.
Generated probability of exceedence curves.
Ran pair-wise correlations for each station.
Accounted for lag and lead of -50 to +50 hours, although focus was on significant correlations exceeding r=0.8 for hours -20 to +20 hours.
Second set of correlations calculated with time offsets commensurate to estimation of flood travel time between the river gauge closest to the coast and the river mouth.
Flood travel time to the river mouth was calculated in two ways:
1) Ran correlation for upstream and downstream flood records above 25% exceedence. Temporal offset of maximum correlation was assumed to be travel time between stations.
2) Attempting to use Mann equation to estimate travel time to river mouth for remainder of rivers.



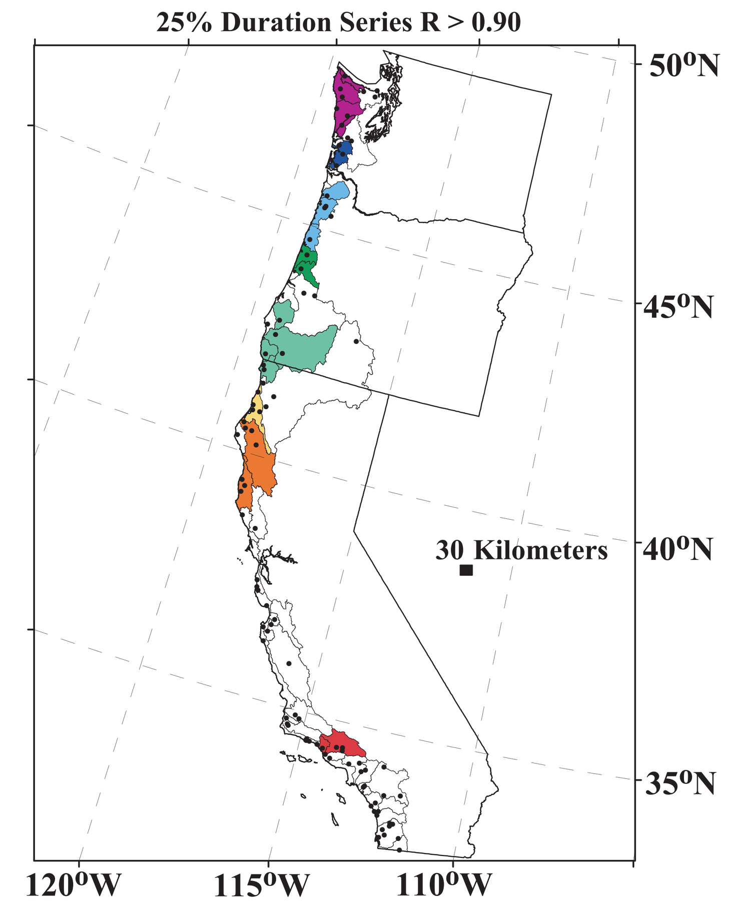


Fig. 1. Correlation R>0.9 between river gauge stations marked by a black circle. Individual river basins outlined; those marked by the same color correlate.

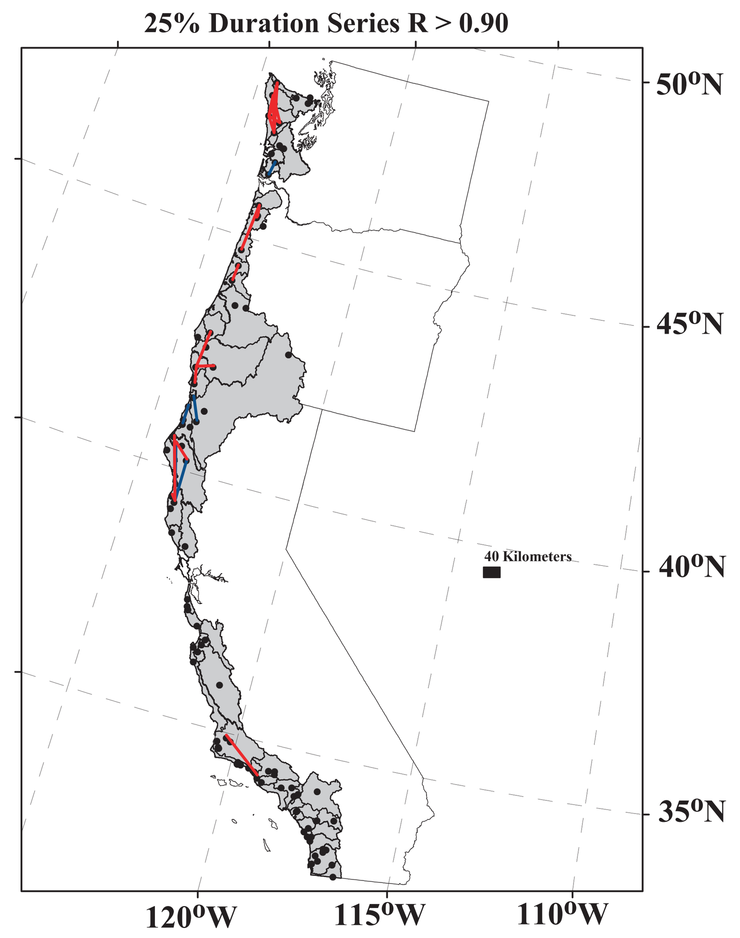


Fig. 2. Correlations between individual gauge stations for R > 0.90. Red indicates a lag./lead relationship of 0-2 hours; blue represents 3-10 hours.

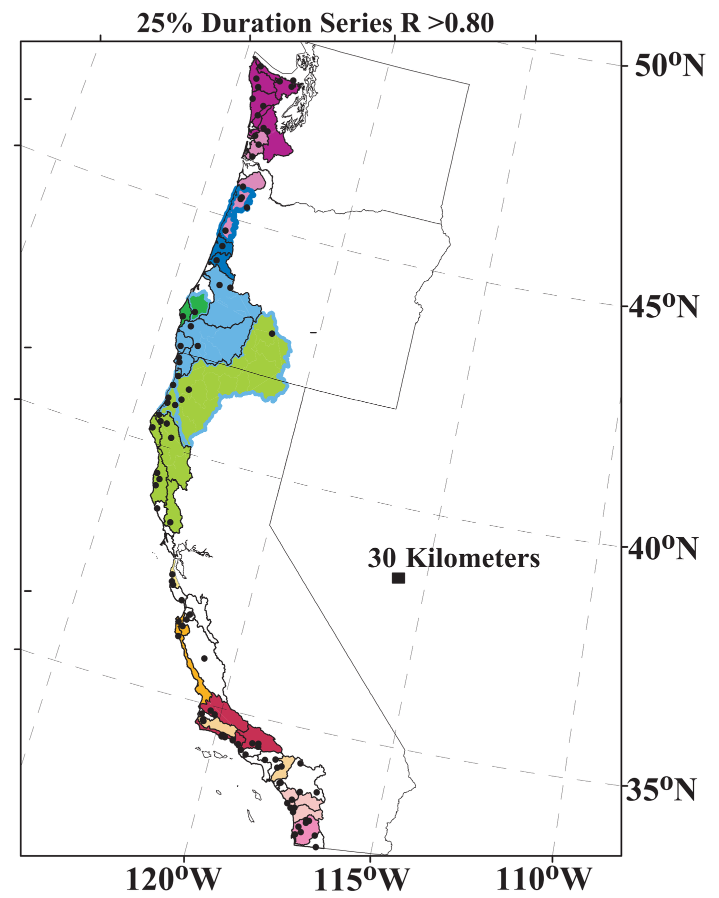


Fig. 3. Correlation R>0.8 between river gauge stations marked by a black circle. Individual river basins outlined; those marked by the same color correlate.

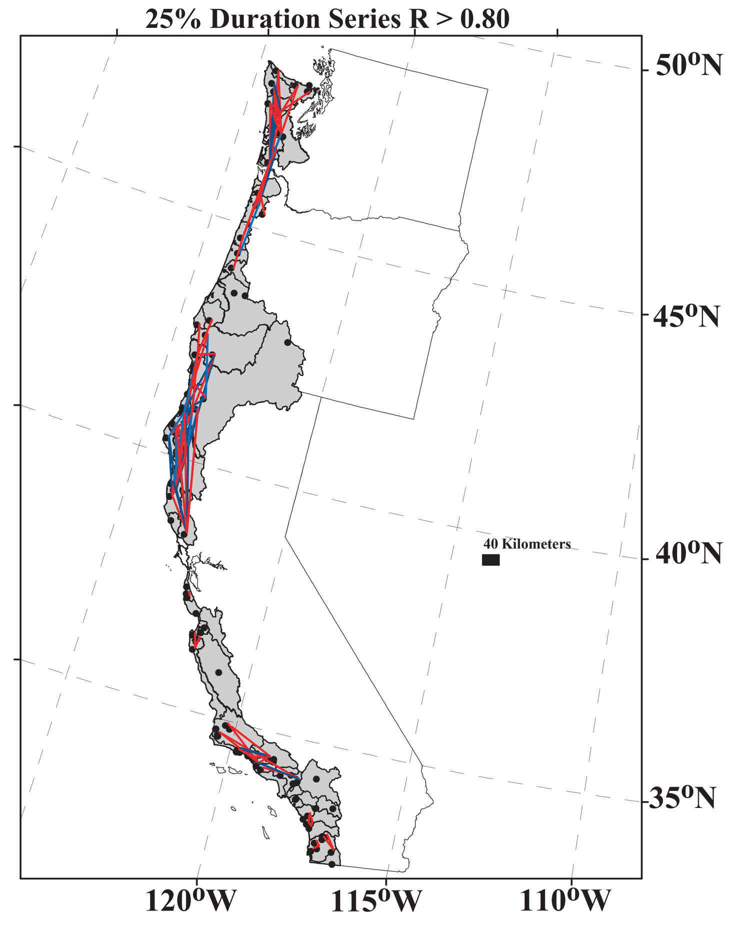


Fig. 4. Correlations between individual gauge stations for R > 0.80. Red indicates a lag./lead relationship of 0-2 hours; blue represents 3-10 hours.

USGS river gauges significantly correlate with each other above R > 0.8 and 0.9 for both the 5 % and 25 % probability of exceedence thresholds

A subset of river gauge records were corrected for the estimated flood travel time to the river mouth. Rivers discharged to the coastal ocean within hours of each other.

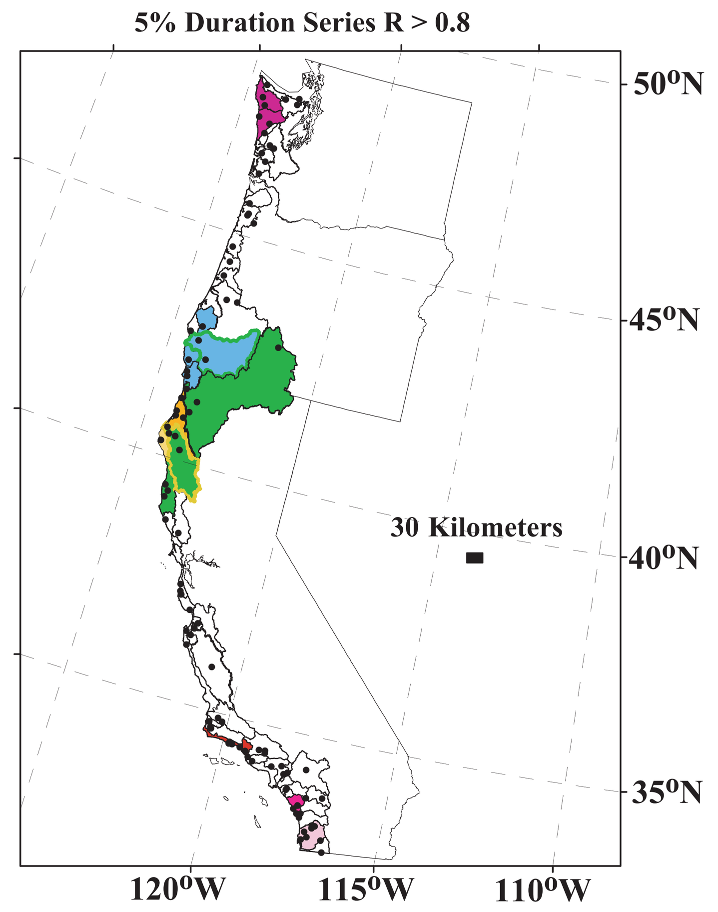


Fig. 5. Correlation R>0.8 between river gauge stations marked by a black circle. Individual river basins outlined; those marked by the same color correlate.

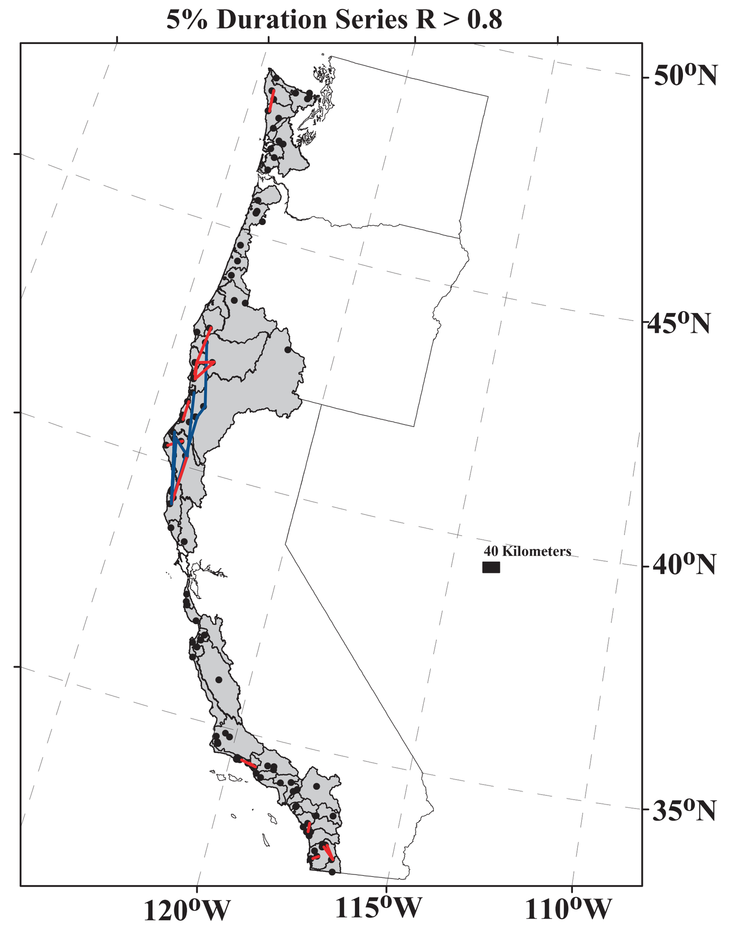


Fig. 6. Correlations between individual gauge stations for R > 0.80. Red indicates a lag./lead relationship of 0-2 hours; blue represents 3-10 hours.

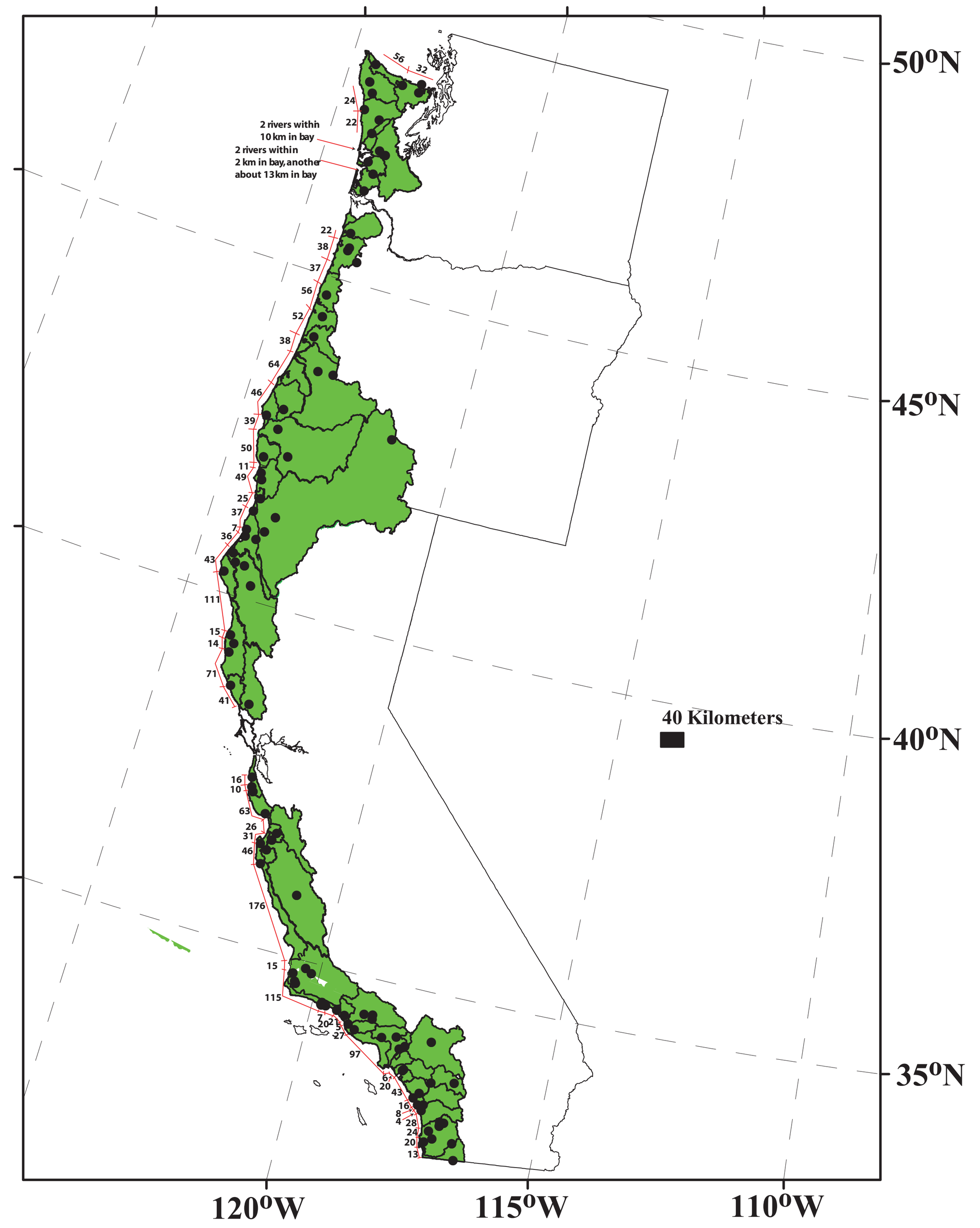


Fig. 7. Distance between river mouths suggest that river plumes may be very close together during floods.

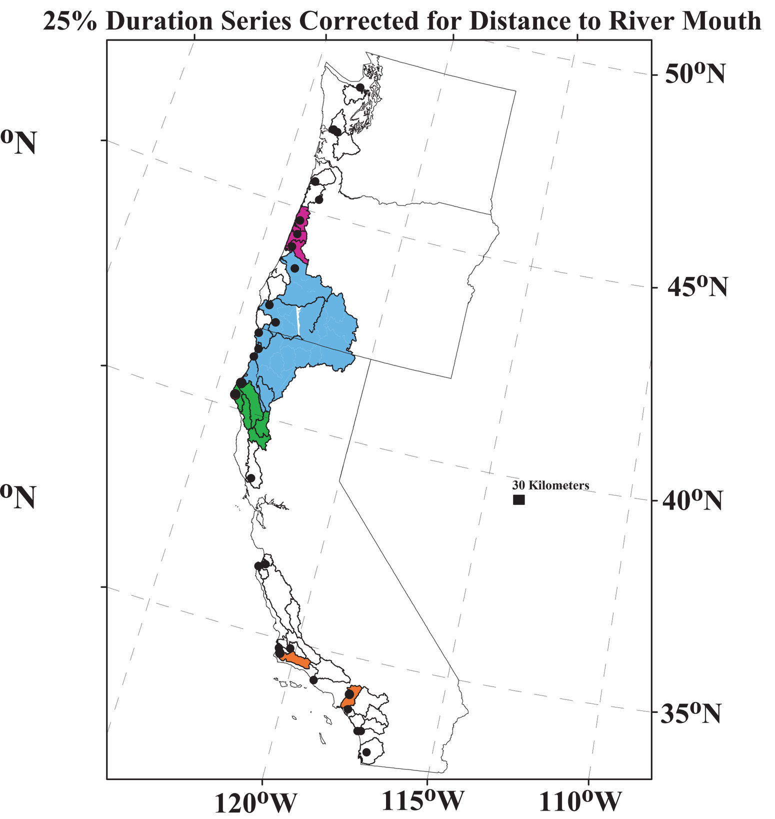


Fig. 8. Correlation R>0.8 between river gauge stations marked by a black circle. Individual river basins outlined; those marked by the same color correlate.

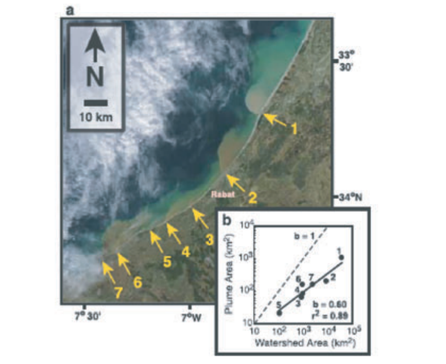


Figure 1. River plumes from flooding Moroccan rivers on 26 November 2002, as recorded by MODIS. (a) True-color representation of plumes. Seven river mouths are identified with yellow arrows (1 – Oued Sebou, 2 – Oued Bou Regreg, 3 – Oued Yquem, 4 – Oued Cherrat, 5 – unnamed, small drainage, 6 – Oued Nefifikh, and 7 – Oued Mellah). A portion of the Oued Sabou plume extends north of the figure boundary. (b) The relationship between watershed drainage area and river plume area.

Warrick and Fong, 2004

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Discussion

Underestimation of freshwater and terrestrial material delivery to coastal ocean during a storm. could affect coastal circulation, transport, and deposition.
Other areas in the wold where this might occur:

Taiwan's rivers may flood in response to Typhoons, depositing hundreds of millions of tons of sediment over a few days.

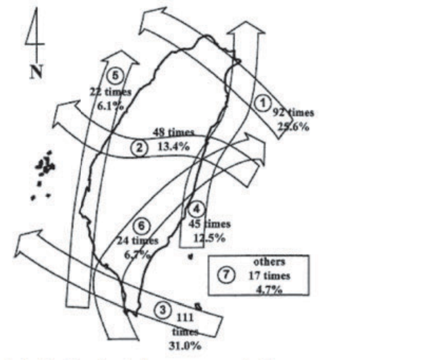
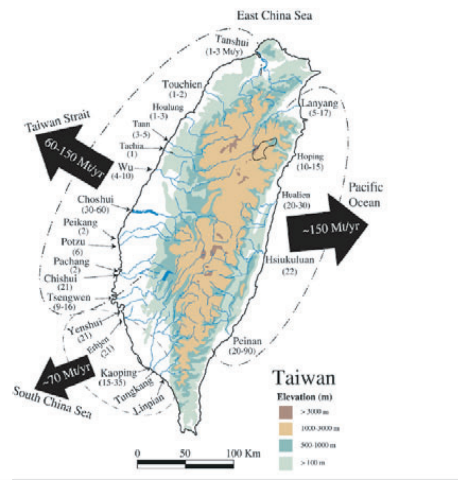


Fig. 1. The categorized paths of a typhoon's low-pressure center in Taiwan from 1897 to 99 (data source: CWB of Taiwan).

Ou et al., 2002



Liu et al., 2008

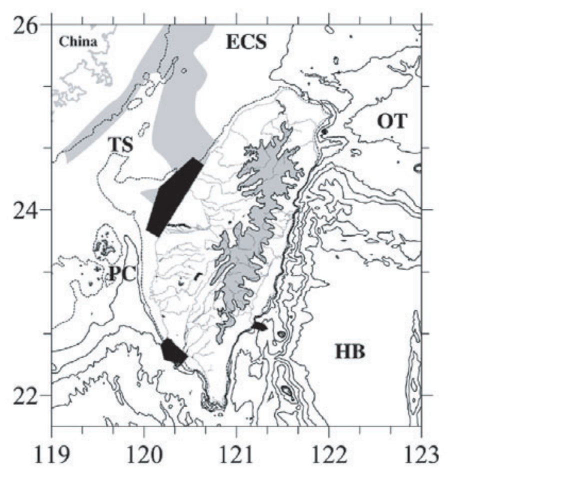
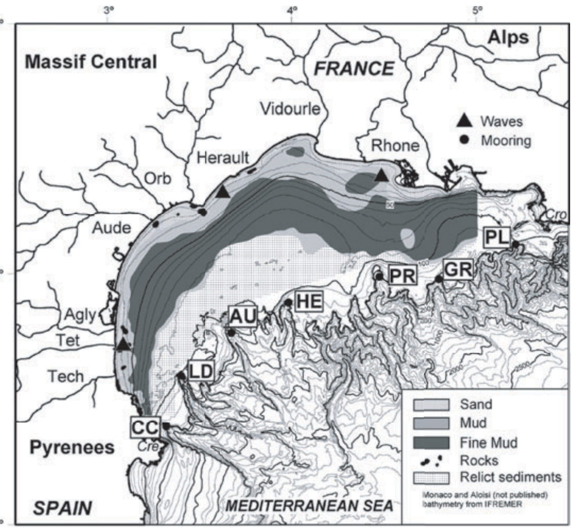


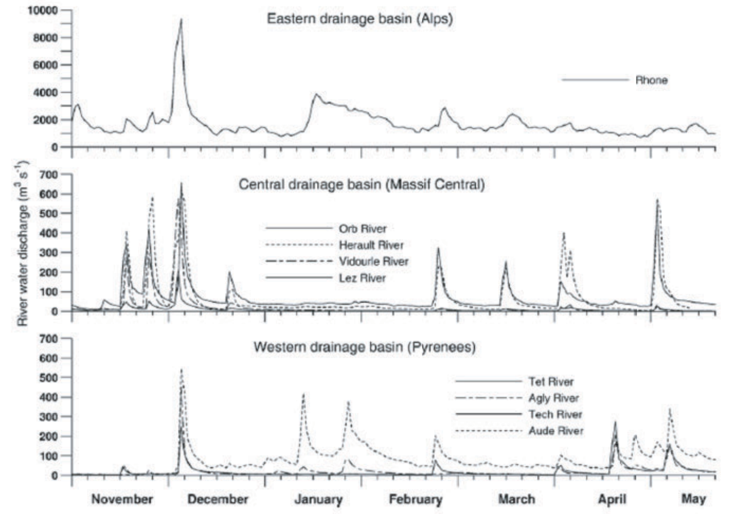
Figure 13. Sediment discharge to the coastal ocean from nine Taiwan rivers following Super-Typhoon Herb, July 31–August 1, 1996. Arrowheads represent 11 MT (southeast), 64 MT (southwest), and 142 MT (northwest), respectively. Bathymetry from Yu and Song (2000). Shelf muds in the Taiwan Strait, defined by >75% silt + clay, are derived from Boggs et al. (1979). HT = Huatong Basin; PC = Penghu Canyon; TS = Taiwan Strait; ECS = East China Sea; OT = Okinawa Trough.

Milliman and Kao, 2008

Storms with south (Marin) winds may cause several rivers along the Gulf of Lions to flood as well as influence sediment transport along the shelf.

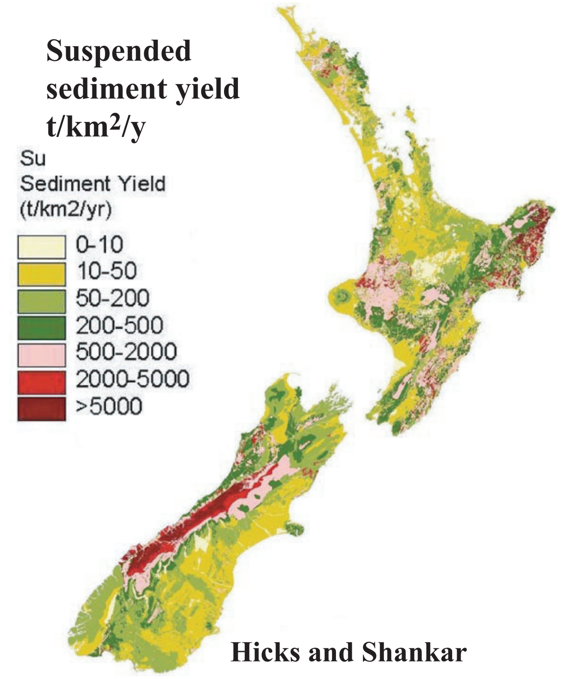


Palanques et al., 2006

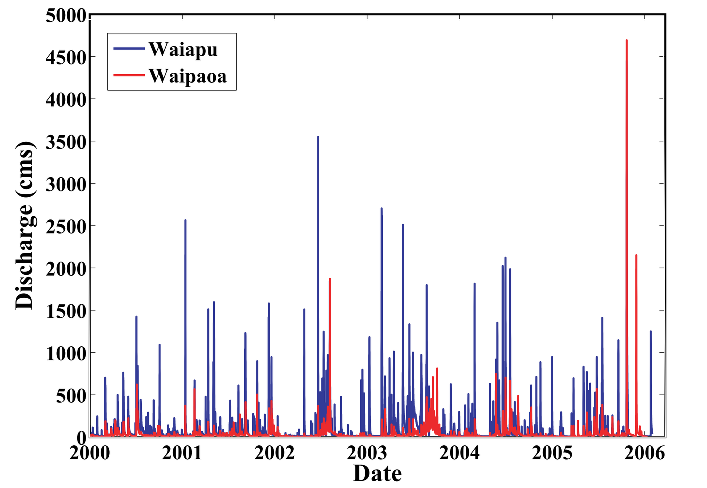


Palanques et al., 2006

Rivers in New Zealand have high sediment loads and yields. The discharge records (above 25%) from the Waiapu ad Waipaoa Rivers correlate, R = 0.63 for a 6 year record.



Hicks and Shankar



Conclusions

1) Several river gauge records above the 25% exceedence threshold correlated significantly with each other above r =0.80 and r=0.90. Groups of rivers that discharged with hours of each other were identified.
2) Fewer groups correlated above the 5% exceedence threshold.
3) More groups of rivers were identified along the Washington and Oregon coasts than along the California coast. This is likely due to the relatively greater rainfall and higher frequency of floods to the north, whereas mid- to southern California river basins are more arid.
4) Although we were able to assess the flood travel time from USGS river gauge stations for a subset of locations, we have yet to find a good way to extrapolate for those rivers that do not have alternate river gauges.

Future Work: Calculate the flood travel time from the USGS river gauge to the river mouth for all locationss. Use the resuls to design numerical modeling experiments that investigate sediment transport and deposition.