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DISCUSSION

Discussion of: Wang, P.; N.C. Kraus, and R.A. Davis. 1998. Total Longshore Sediment Transport Rate in the Surf Zone: Field Measurements and Empirical Predictions. *Journal of Coastal Research,* 14(1), 269–282.

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WANG, KRAUS, and DAVIS (1998) measured surf-zone longshore sediment transport rates using streamer sediment traps at 29 beaches along the southern U.S. Gulf and Atlantic shorelines. Longshore transport was measured during three to five minute intervals, and the results were extrapolated to obtain the annual total longshore transport rates (TSLT). Simultaneously, they observed breaking wave characteristics and calculated the longshore transport rate using the CERC longshore transport formula (USACE, 1984):

$$Q = \frac{K_\ell}{16\sqrt{\gamma}} \rho g^{3/2} H_{sb}{}^{5/2} \sin(2\theta_b) \qquad \text{(Eq. 1)}$$

where θ is the volumetric longshore transport rate (m^3yr^{-1}), K_ℓ is the proportionality coefficient, ρ is the density of water, g is gravitational acceleration, H_{sb} is the significant breaking wave height, and θ_b is the incident breaker angle. They then compare their measured longshore transport rate to the calculated longshore transport rate.

Agreement between the measured annual TLST rate and the calculated annual TSLT rate was poor, differing on average by an entire order of magnitude. In order to produce closer agreement they adjusted the proportionality coefficient, K, from the standard 0.78 (USACE, 1984), to 0.08. WANG *et al.* suggest that the new K figure is appropriate for low energy coasts.

We argue that their results reveal a serious underlying problem with the CERC longshore transport formula, and expose the general lack of knowledge of longshore transport processes. Furthermore, their conclusions cannot be supported by three to five minute data sets which are not representative of all wave heights, wave types, and other longshore transport conditions on the beaches they studied.

This study has two critical problems. The first is the assumption that measurements collected in three to five minute intervals characterize longshore transport conditions for an entire year. The second and more serious problem is that despite formula predictions that were an order of magnitude different from field measurements, they conclude that the CERC formula is valid (as long as K is adjusted from 0.78 to 0.08).

The CERC formula is used frequently in real-world applications. If K must be adjusted for every beach, then of what predictive value is the CERC formula? Isn't it possible that the CERC formula is wrong?

Problem #1: Do three to five minute observations reflect annual conditions?

The sediment trap and wave data were obtained by three to five minute measurements. WANG *et al.* then extrapolated the data from minutes to a year to obtain the TLST. In order to eliminate the large discrepancy between the measured and calculated TLST they change K from 0.78 to 0.08 and state that the adjusted value applies to all low-energy coasts. To obtain the TLST and the value for K from only five minutes of data is unrealistic. Basing their results on five minute measurements:

- ignores storms, when transport rates are highest;
- ignores changes in direction of sand transport;
- ignores temporal changes in bar structure and surf zone morphology; and
- assumes that none of the trapped sand was being directed offshore.

WANG *et al.*'s Table 2 presents the annual TLST as fact, and they validate their measured TLST rates by comparing them to a TLST based on the 30 year record of change on the John's Pass ebb tidal delta. Not only are they mixing environments by comparing beach changes with changes in ebb tidal deltas, but they assume that the 30 year changes on the

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tidal delta reflect purely erosive events without intervening accumulation events.

In addition, WANG *et al.* give no serious consideration to the uncertainty of their own measurements. On at least four beaches with bars, no measurements were obtained on the bar or in the trough due to rough conditions, excluding direct measurements of a major portion of the sediment transport load. No sediment movement was measured outside the surf zone on any of the 29 beaches, which assumes there is no transport seaward of the surf zone.

WANG *et al.* note sampling problems, such as the development of scour holes beneath the bottom streamer bags, and a decrease in hydraulic efficiency of all streamer bags as they filled with sediment. They assume there is no error in the linear interpolations between trap arrays. However, in the final analysis they neglect all of these problems and treat their data as though no uncertainties exist.

Consistently different results measured by streamer traps, sediment tracers, and impoundment suggest that each methodology measures completely different quantities which are biased by the sampling method (BODGE and KRAUS, 1991). According to BODGE and KRAUS (1991), streamer trap measurements underpredict the value of K by a factor of 3.5 to 15. One of the major biases of the method is that bedload transport is not fully captured, although it may constitute a large proportion of the longshore transport load (BODGE and KRAUS, 1991). All of the current field methodologies are indirect and provide only partial data on a very short time scale. It is probable that none of the methodologies measure the true longshore transport rate, and their errors are unknown.

Table 1. *Magnitude of error between the measured longshore transport rates and the rates calculated with the CERC formula for longshore transport at each individual site. Modified from* WANG *et al.* *Table 2.*

Site #	Cubic Yds × 1000 Measured Rate	CERC Rate	Error
1	110	1,400	13x
2	42	655	16
3	6	146	24
4	2	10	5
5	52	136	3
6	8	175	22
7	12	178	15
8	19	249	13
9	6	86	14
10	10	170	17
11	39	234	6
12	37	233	6
13	1	11	11
14	45	240	5
15	3	113	38
16	6	167	28
17	56	367	7
18	60	385	6
19	15	126	8
20	6	85	14
21	8	171	21
22	5	83	17
23	145	961	7
24	34	280	8
25	1	18	18
26	19	116	6
27	23	98	4
28	3	30	10
29	2	12	6

Problem #2: The K problem

The great discrepancy between the measured and predicted longshore transport rates indicates that there are major flaws in either the measurement technique and/or the predictive formula. WANG *et al.* conclude, however, that both are valid. This conclusion is reached by merely changing the value of K in the CREC formula to produce calculated results that are similar to the field results. We believe they have avoided facing the real underlying problem of longshore transport measurement.

A much more reasonable conclusion would have been that the variations in K which they reported cover up the inability of the CERC formula to accurately predict longshore transport rates. WANG *et al.* note a general correspondence in the trend between the measured and modeled transport rates for each beach; i.e., they both tend to increase or decrease concurrently at a seemingly constant proportion (Figure 5, WANG *et al.*). Table 1, however, shows that the actual differences between their beach and model transport rates (Table 2, WANG *et al.*) vary between a factor of 3 to 38 for the 29 beaches. Table 1 indicates that the variation appears random with no obvious spatial trends (i.e., East coast vs. Gulf coast beaches). Thus, the correspondence cited by WANG *et al.* is not real, and the average value of K they suggest, 0.08, appears to have little meaning for the 29 beaches where the modeled and measured transport rates differed by 3 to 38. Extending this K value, as they suggest, to all low energy beaches is even more risky.

WANG *et al.*'s K value of 0.08 extends the range of K values in the literature from 0.08 to 1.6, spanning two orders of magnitude. The K value suggested for the CERC formula in the Shore Protection Manual (USACE, 1984), 0.78, is primarily based on 14 tracer experiments performed on Southern California and Gulf of California beaches (KOMAR and INMAN, 1970). Most longshore transport rates in the U.S. are apparently calculated with the California-derived K of 0.78, even though no widespread field verification has ever been reached.

BODGE and KRAUS (1991) state that the scatter in reported K values is due to "*. . . inadequate recognition of surf or beach conditions which affect LST . . . and/or bias or error in the field database,*" i.e., the CERC formula doesn't work. WANG *et al.* fail to acknowledge this critical source of error in the CERC formula. We believe the different K values are also indicative of a particular mentality by which CERC formula predictions may be fixed by adjusting K to come up with reasonable answers, without addressing these two critical issues. If BODGE and KRAUS (1991) are indeed correct, a fundamental restructuring of the CERC formula is required to account for these processes.

The results offered by WANG *et al.* might be more compelling if they had proposed an explanation as to *which* conditions produced a K value of 0.08 instead of 0.78. However, they made no attempt to relate the differences in K to physical causes. They claim that K is different simply because the beaches they studied were low energy beaches. Our understanding is that the wave height parameter in the CERC formula is supposed to account for the wave energy. If WANG *et al.* are correct in claiming that K is a function of wave energy, then we should see great changes in K on the same beach depending on storm or fair-weather conditions. Once again, this brings into question the concept of extrapolating extremely short term data collected under calm conditions to annual transport rates from highly variable wave conditions.

CONCLUSION

The WANG *et al.* paper is significant because it provides one more basis for distrust of the CERC longshore transport equation. Given that our understanding of longshore transport processes is incomplete, that field measurement techniques are inaccurate and produce inconsistent results, and inherent problems with the CERC formula exist, it is not even clear that we know what "realistic" transport rates are. The logical outcome should be a fundamental re-examination of longshore transport assumptions and predictive methods.

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