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# DISCUSSION

## Discussion of: Pilkey, O. H., 1990. A time to look back at beach replenishment (editorial), *Journal of Coastal Research*, 6(1), iii-vii. And, Leonard, L.; Clayton, T., and Pilkey, O.H., 1990. An analysis of replenished beach design parameters on U.S. east coast barrier islands, *Journal of Coastal Research*, 6(1) 15-36.

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[Editorial Note: This report was originally prepared for the Gold Coast City Council (Queensland, Australia) as *Gold Coast Coastal Research and Development Report No. 134: The Pilkey Beach Replenishment Critique.* It is reprinted here, in somewhat modified form, as part of the discussion of beach replenishment design parameters.]

### INTRODUCTION

In the 1990 Winter edition of the *Journal of coastal Research* (Vol. 6, No. 1) there are two very important items dealing with beach nourishment. The main paper by Leonard, Clayton and Pilkey (pp. 15-36) considers an analysis of beach design parameters and the second of probably greater importance, is the additional comments by Pilkey alone titled: "A time to look back at Beach Replenishment" (pp. iii-vii). Both items it must be noted, are based only upon works carried out on the Eastern seaboard of the United States of America. Both of these items, as of now, must be rated as definitive texts and they will be widely read and probably widely quoted as well. In general, Pilkey is highly critical of both the design and postplacement behaviour of beach nourishments on the Eastern seaboard and very much questions the effectiveness of the concept of nourishment as leading to an economic and practical resultant on the prototype.

When we read these articles, however, we find that they relate to very different circumstances and design and placement practices to those currently used on the Gold Coast. It might be of interest however, to consider Pilkey's critique and compare the American experience that he reports, with the local Gold Coast experience.

### PLACEMENT LIFE

Pilkey reports that north of Florida, essentially no replenished beach has lasted more than five years and compares this with designer predictions of 10 to 40 years of life. One can only heartily agree with his mistrust for the designer's predictions—these sorts of statements are almost foolish. We cannot tell what the *native* beach will do tomorrow, let alone an artificially nourished beach that many years ahead. Locally, Broadbeach beaches aerial "dry" width variability over a six month period reaches ± 25 m from the mean.

In addressing Pilkey's first point, we note that he does not identify where the fill losses go,

*i.e.* were they transported offshore or alongshore with the drift? A littoral life of 5 years could be quite reasonable for a short length of reclamation, but as far as we can tell from Pilkey's account, the placement the Americans adopt is always only the visible beach option (see Smith and Jackson (1990a)). As we now know only too well, this placement is the most unstable of them all, the one almost certain to erode rapidly and the one most difficult for nature to replace, under even the very best natural beach re-building conditions. We would also expect that the unit volume ($m^3$ per m of run) of their nourishments is far too low for the natural beach variability. The Wrightsville diagram suggests a placement of less than $100m^3$ per m which is almost insignificant on a moderate energy ocean beach. On the Gold Coast, a minimum beach front placement would be at least five times that, or we wouldn't think of even starting the work and we would never try to cram all that volume entirely onto only the visible beach.

## SEDIMENT GRAIN SIZE VS DURABILITY

In Pilkey's studies he reports that he found no evidence that differences between the imported and native sediment grain sizes made any difference to the renourished beach durability for the area that he studied; this would probably be very true. Almost certainly, the target grain size would have been that of only the native *visible* beach, but since the nourishment was going to be very rapidly transported offshore into the wave breaking zone where nature needed it most, and where the native grainsize is different anyway, it was irrelevant how well the imported material matched the native visible beach sediments.

On the other hand, our daily beach observations show us very clearly indeed, that in the toe of the swash zone on the prototype, the beach slope is entirely controlled by the degree of coarseness of the sediments in that zone. Indeed, if necessary, nature will undertake a great deal of winnowing to concentrate coarse sand in this zone by washing away the excess "fines." We also observe that when nourishment sediments are placed in the swash zone the identical thing happens. Particle properties *do* matter on the wet and submerged beach a great deal.

## BEACH LENGTH VS DURABILITY

Pilkey reported that he had found no good relationship between beach fill length and beach durability on the Eastern Seaboard beaches. However, he found that longer beaches held a greater durability on the Gulf Coast. Our Gold Coast studies suggest that the length of the beach fill makes no difference at all to the visual loss of a visible beach placement if the transport is in the offshore direction. Things are a little different, however, if the beach fill loss is mainly in the littoral mode. Then the longer the fill, the lesser the end effects where the littoral losses are highest. Perhaps in the Gulf Coast, with its limited normal climate wave fetch, the offshore transport mode is depressed, or the littoral mode accentuated.

## PRE-AND POST-PROJECT EROSION RATES

Pilkey concluded that standard American beach fill design assumed that pre-project erosion rates (after some initial profile adjustment) would be a good measure of post-project erosion rates. He then quoted "With the single exception of Miami Beach, replenishment beaches have eroded much faster (1 to 12 times) than their natural counterparts." That statement would not surprise us at all. As we discuss above, we think it is foolish to place all beach nourishment on the visible beach, where natural wave attack will accentuate the erosion and force-feed the breaking zone with extra sediment. Remember that "stepped" or "perched" beaches do *not* exist in nature on medium to high energy beaches. Incidentally, from the aerial photographs that we have seen, we would estimate that the Miami Beach nourishment was not entirely a swash zone, wave breaking zone placement and probably it continued further offshore than that. If this is so, then the Miami project *should* have been very much more successful, than the others to the north.

## LOOKING BACK

One of Pilkey's main complaints, is that at least in his area of interest, engineers and geol-

ogists have almost never looked back and monitored what happened to their nourishment placements after completion. If this is so, the lack of monitoring endeavor applied, to us, is frightening and barely believable. On the Gold Coast, we watch our nourishment placements as carefully as we can and survey then as regularly as possible whilst the monitoring budget continues. Even after that we inspect the works and usually take aerial photographs as well. This for example, is why we *have* been able to approximately measure the littoral celerity of most of our individual slug placements in the past.

## COMMUNICATIONS

What seems a strange complaint by Pilkey, is that "we have observed that there is virtually no communication between the scientists who study shore face sediment transport processes and coastal engineering practitioners." It is true of course, that a few coastal scientists regard themselves as rather elevated when compared with coastal engineers, but it might surprise Pilkey to know that on the Gold Coast both the functions of the scientists, researchers, and the coastal engineers are executed by the same people. Here, the engineers cover the whole field of pure research, applied research, development, design and construction. In this, we simply *have* to, because we have found that there are *no* university researchers and/or experts available who are anywhere near being able to help us. On the Gold Coast, we have been observing, collecting and processing data along the same lines as the Corps of Engineers DUCK facility since 1972, and we have progressively applied the lessons we have learned.

## THE IMPACT OF STORMS

This topic represents Pilkey's principal indictment of the excuses given by the designer of Eastern United States of America beach nourishment projects, for their short real, or apparent, life. In this, he is certainly absolutely correct, but as we discuss above and elsewhere, the impact of storms on a beach nourishment placement varies greatly depending upon where the placement is made within the active beach zone. A "visible beach only" nourishment placement is simply a "sitting-duck" for any significant storm and perhaps Pilkey and the American nourishment designers should try and appreciate this. It was exactly this sort of consideration that has lead to the application of offshore storm bar nourishment placement on the Gold Coast (Smith and Jackson, 1990a).

In discussing the effects of storms on replenished beaches (and presumerably natural beaches as well) Pilkey set out his prediction tiers of assumptions necessary as:

(a) Assumption of wave and storm climate.
(b) Assumption of what the climate will do to sand movement.
(c) Projecting the first two assumptions 10 to 50 years into the future.

In all of these things of course, Pilkey is perfectly correct, but perhaps because of our isolation and our grave lack of university researchers who can help us, we have tackled this topic rather differently down here, and proceeded in a different way.

In this we have observed and researched our beach system under the two different states of normal, mild and fairer weather and the second state of major storms. Then in both of these two spheres, we address our recorded data and our predictions entirely in only probabilistic terms and return period expectations. For both endeavours, we collect daily data on beach states and we have two Waveriders constantly deployed offshore. We thus measure the beach variability and the wave variability continuously, such that under "normal" conditions, we have already detected a fair volume of cause and effect relationships, and we will continue to search for more.

Then, we have attacked the storm intensity/return period and its erosive capacity on the beaches in a different way. For this we have relied upon geological evidence of past erosion penetrations and from this we already have deduced a postulated log-gumble storm erosion penetration scenario up to, and including the 1 in 4000 year event (Smith and Jackson, 1990b). Our first study into the return period/intensity of Gold Coast cyclones was conducted in 1972, as reported by Smith (1973), but we still hold a great deal of early prototype data, awaiting processing. Our most urgent is the calibration of our 1986 seabed beach regime shape model that is already about 75% researched, but not yet

quite fit to be transposed from the manual state onto the existing basic computer format. When this is done, however, we believe that we will have a fair chance of meeting many of Pilkey's requirements.

## WHAT THE PUBLIC HEARS

As part of the more serious thrust of his additional comments, Pilkey set-up the following question and answer scenario. Pilkey's view is that after a beach disappears everybody involved tries to put the loss in the best possible light. But in doing so a number of insupportable statements are typically made. Pilkey paraphrased these and added his opinions as to their validity. He also noted that each of the statements pointed a need for much further research.

### (i) Statement

The replenished beach will recover during fair weather.

**Pilkey** False, replenished beaches do not recover from storms like natural beaches. Storm recovery, if any, involves only a small percentage of the lost volume.

**Gold Coast** Our experience is very different from Pilkey's. Our major beach placements are pumped into the fair weather wave breaking zone, not on top of the visible beach, and our experience is that they recover almost completely after storm conditions, remembering that our unit volume/unit length quantities are also comparatively large. Our 1974 Surfers Paradise placement recovered nearly completely after the reasonably close 1976 cyclone attack, our main problem is littoral drift loss.

### (ii) Statement

While the sand lasted, the replenished beach served a protective function for shorefront development during the storm.

**Pilkey** True.

**Gold Coast** We agree too. However, it must be noted that we have a rear beach asymptotic boulder wall (usually buried) to provide the irregular extreme storm protection to our developments. This is another reason why we so strenuously try to avoid upper visible beach nourishment placements.

### (iii) Statement

This loss of sand represents an initial high rate of loss as the profile of the replenished beach is adjusted. Once the profile is adjusted, the erosion rate will slow down.

**Pilkey** Sometimes true. Pilkey observes that his American replenished beach erosion is a series of step like losses with each succeeding storm, with the bigger the storm, the bigger the step.

**Gold Coast** Our experience with "undersized" visible beach placements agrees with Pilkley's. However, the concept of the nourished beach "adjustments" is based upon the assumption of an equilibrium beach profile. We now know very well that such a thing does not exist and the beach only follows a continuing cascade of temporary régime profiles that change by the tide, day and week. For a *visible* beach placement we would rate the statement a false.

### (iv) Statement

The lost sand has simply moved offshore where it continues to serve a protective function for the community.

**Pilkey** Probably False. Pilkey observes that there are few data indicating where the sand goes and no data indicating whether the sand continues to affect wave climate at the shoreline. He also echoes what *we* understand as the normal layman's expectation that beach nourishment must always widen the visible beach significantly and that to be successful, this widening must be "permanent."

**Gold Coast** The Gold Coast experience with the layman's expectations that the visible beach, once replenished, will remain a rigid unchanging "structure" is discussed in Smith and Jackson (1990a), so it does not need to be repeated here. In general, the Gold Coast experience is that for reasonably generous unit rate/

unit length placements, the statement is true; hence our use of the offshore artificial storm bar placement rationale. This concept certainly is very successful on the prototype, as we have seen already. It must be kept in mind all the time however, that in his studies, Pilkey was severely handicapped by a shortage of good *field* data relating to the nourishment projects that he analyzed. Here on the Gold coast, we observe the beaches every day for 365 days a year, thus, we can infer a great deal about what is actually happening out there. Pilkey had to deal with what would have been to him very thin data and this must have been extremely frustrating. By comparison, we on the Gold Coast have *daily* records on the state of our beaches, *i.e.* whether they are eroding, stable, or accreting and we have already discovered, from "reading" the prototype wave breaking sequence and pattern, to know when our local beaches are in temporary régime, or well out of balance. This makes a great deal of difference, when one is trying to monitor the post placement behaviour of a beach nourishment.

**(v) Statement**

The next beach nourishment should last longer because the sand lost form the previous beach reduces the need for profile adjustment of the new beach.

**Pilkey** False.

**Gold coast** False.

**(vi) Statement**

The beach was lost due to unusual and/or unexpected storm activity.

**Pilkey** Misleading. He observes that all beaches have storms and their probability of occurrence should be part of beach design as well as part of the information given to the public. No storms he says are "unexpected."

**Gold Coast** We could not agree more, storms are what nature designed beaches for; but perhaps on the Gold Coast we have simply been lucky with our nourishment post-storm recoveries.

## CLOSURE

In his conclusions, Pilkey takes strong issue with what he states in an eastern seaboard practice for nourishment designers to make specific (and exaggerated) predictions on the life of their projects. We would very much agree with him on this, but it must be remembered that locally we never even try to make these sorts of predictions ourselves and we would be the first to admit that we don't know how to, either. Our experience to date has *only* reached the stage of showing us that all of our nourishment projects *have* been beneficial and well worth the monies spent on them. Our main beach loss problem on the Gold Coast is caused by littoral input starvation and even though we have some long term data on the littoral celerity velocity, we also know that the short term celerity is highly variable. Our estimates give celerities varying between about 0.5 km/y to 3.4 km/y with a long term average of 1.4 km/y. These figures help us to get a feeling about what we are dealing with, but they are nowhere near good enough for us to start announcing realistic predictions. We all have a great deal to learn and a lot of very long term monitoring to undertake, well into the future. What little we have been able to observe so far, is only a *very* small beginning.

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