



## EDITORIAL

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### The Coastal Engineering Literature and the Field Engineer

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#### INTRODUCTION

The coastal engineer who works largely full time in the field and on prototype conditions, keeps up to date, by practicing in two domains concurrently. The first is carried out in the field and consists of observing, collecting data, collating it and researching the results. The second domain the consists of his on-going studies, basically continually reading the literature and where possible attending suitable coastal conferences. The first domain has hardly changed at all in the last 30 years, apart from the deployment of much more sophisticated and often much less reliable sensors, but in only the last 10 years, the second (or study) domain has changed nearly beyond recognition.

Why then should this be so, and what had happened? The second question is much easier to answer than the first, because the results of what has happened are blindly obvious. Almost everything you now read pertaining to the discipline shouts loudly that what used to be the "art" of coastal engineering, is now a pure and wonderful science and executed by even more pure and more wonderful scientists. The bad old days of field studies mounted to investigate what could be seen and experienced on the prototype are gone, this is no place for ad-hoc non-fundamentally based theory studies, and now is the time of only rigorous mathematical analyses all based entirely upon only "pure" scientific principles. Whether this is progressive or retrograde is now largely irrelevant, the mantle of scientific purity *has* been taken up and we cannot read anything else now.

Now, something like 90% of the papers we peruse, have as their only basis, a mathematical model of some kind and clearly to many, the model itself has become more important than the real thing.

Indeed a sinister development that has accelerated over the last five years has been the "model and its predictions syndrome". Some researcher assembles a mathematical model and then applies it to some data, usually only laboratory data. He then makes the data fit the model by calculating "constants" or "factors" until it balances. Then he turns around and runs the analysis in reverse using all the necessary "fudge" factors determined for the "calibration" in the first place and finds that he has ended up exactly where he started, all with the identical result. He then calls these results of simply reversing his calculations, his complete model "predictions" and thus marvels at how good the model is. In fact, he has only generated a closed loop and has got nowhere. As far as addressing reality is concerned, most of these classes of papers are quite useless, nobody else using different data can ever attain exactly the same fudge.

Now we might go back and consider why these changes arrived and what was, and is, behind them. The answer of course is the rise and dominance of the computer. In the sixties and seventies, the main computer families tended to be mainframe machines, so they did not intrude very much into university educational procedures, so research for example, as well as lecturing, tended to remain a simple hands-on simple calculator endeavour.

Then in the early to mid-eighties, came the personal computer (PC) and everybody could now do for themselves what had previously required a mainframe machine and a long wait. Suddenly, the discipline of coastal engineering could fly away from its previous rather grubby foundations on the prototype and crunch vast numbers of calculations at will. Now the sky became the limit, at last un-fettered by limited data, variability and uncertainty; coastal engineering could now be modelled with the full sophistication afforded to other engineering disciplines. The most complex models could now be postulated and assembled in no time and extremely difficult differential equations solved by repeated iteration, in minutes instead of months.

And so, a new coastal fad was born. It started with the educationalists and the university lecturers, who got into the PC "rage" first. Thus to demonstrate their superiority over the students and the older text books of the time, the lecturers, now liberated from impossible volumes of computation, set out to prove just how scientific they really were and formulate models and equations that contained every possible term and condition they could think of. Naturally, the post-graduates, the junior practitioners and soon the students themselves readily learned to do the same thing too. The day of the half-page equation had arrived! "Pure" science had at last taken over and few educated since the mid-eighties now even know how to use graph paper properly, or appreciate what "probability" really means.

To the advocates of this school, the benefits became remarkable. No longer was it necessary to carry out difficult data studies on the prototype, you could now stay in your office all the time, and from a literature search, select such constants, co-efficients, factors and power expressions, as suited you to make your mathematical models "balance". Then if that didn't work, real values were abandoned by "normalising" the results instead. At last coastal "pure science" was free to explore anything at will and soar above the mundane of the past. The revolution was now complete.

Now it is true, from this free-wheeling wide-front approach, many new things and relationships *may* emerge and from some of such studies they *will*, but it may prove dangerous to denigrate the past, purely on this score. Regardless of any grandiose theories, Nature, on the real thing, will go her own way, as she has for eons and she can

be a harsh teacher. We think that there is plenty of room for both classes of study, the pure science, and the pragmatic field approach and hopefully in the near future an effective balance will be attained between the two. However, from our reading of the current coastal literature, it is the former that is almost entirely ascendant. We fear that we may have to pay heavily for the "field" mistakes that will flow from this imbalance for some time ahead. We think that the pendulum *has* swung far too far into the pure theory camp as of right now.

### THE LITERATURE

As the new pure science wave flowed through coastal engineering, it was not long before it began to saturate the coastal literature. Certainly for at least the last 30 years, there have always been pure science papers published but they tended to maintain only a moderate proportion of the total of papers. Looking back, we can now appreciate that within as short a period as five years the "new look" became predominant and some journals since the late eighties have barely published anything else. Finally, by about 1985 the coastal text books and coastal mathematic symposia also became vehicles of the pure science approach, such that one cannot buy any new book that is not couched in these terms. Indeed the text books of the nineties often very nearly consist of nothing less than long chapters of differential equations.

For example a recently upgraded and *very* definitive text on waves says, "... the book is intended for use primarily as a text at the advanced undergraduate or first year graduate level, it is hoped that it will also serve as a reference and will assist one to learn the field through self study". However, if you are a field engineer who has worked on the real thing for many years, then no matter how often you read the book, you find practically nothing that you can equate with what you see on the prototype. The theory may be great, but the field calibrations that you need are mostly absent. In fact further through the text, the same book says: "The desire is to develop a . . . theory to best satisfy the mathematical formulation of . . . water wave theory". The real thing it seems, has become irrelevant, and field experience is not worth considering. This feeling is not ours alone, as a very experienced and practical coastal engineering consultant from Southern California recently put it, "Experience is extremely important in our line of work, primarily, because we have a

hard time mathematically describing what occurs in nature". To that we say "Amen".

### THE PROBLEM

We head this paragraph "The Problem" but why do we think there is one, when nobody else seems to be worried and most of the coastal literature continues to roll ahead on the back of pure theory? Many writers defend the theoretical approach, claiming that in lieu of *ad-hoc* discrete calibration, they are using rational models all aimed at attaining a complete umbrella approach that will explain everything in the end. However, as field engineers our experiences suggest that they are far from "the end" and from the way they are proceeding, they are not very likely to get there either.

The problem is that real-life data is being suppressed in favour of publishing papers based upon theory instead, but in the end none of the theory is worth anything unless it *does* match and predict real life. But without the real-life data being available—how do we know? Furthermore, we can only expect this imbalance against practical papers to increase into the future, the peer review process will ensure this, as more and more coastal engineers are educated on theoretical texts and do theoretical theses studies. For example, Elsevier's prestigious journal "Coastal Engineering" is very rapidly approaching the zero "field-based" paper content already and others are following.

Alternatively, it could be that we field engineers are too out of date and inadequately trained in advanced mathematics to understand the new pure and theoretical concepts that have now been developed. That may partly be so, yet how is it that from our continual exposure to the real thing, we can see processes, reactions and responses that are *there* yet whose existence has apparently totally eluded the office-based "pure theory" men and women? One thing for certain, however, is that any field engineer who continually observes and monitors the prototype, can never hold onto any pre-conceived opinions for very long. Nature after all *does* know best, but this might not be so obvious in some office far removed from the prototype.

### PHYSICAL MODELS

Physical models, *e.g.* wave flumes and tanks *etc.*, hold an honoured place in the study and evaluation of coastal processes. However, as with all study tools, some hydraulic models simulate

the prototype very well, but it remains that some do not and there can be times when it is important to appreciate the difference. Of the latter class, those of most concern are in the categories of hard bottom wave flumes and oscillating flow devices. Yet, in so many cases, we see data derived from these devices applied directly to the development of theoretical equations and mathematical models as full physical values, or constants or coefficients or powers, as if they are proven universal quantities, or numbers. All so often we see some value taken from perhaps a single author and a single model test series and quoted as "it can be taken that  $\bar{x}$  = this value", without any critical review of how the value was obtained, nor the conditions surrounding the test or tests.

Whilst this principle should be applied to every class of data before one adopts it and uses it, in so many cases the procedure is voided and the data results simply taken at face value and applied without question. Regrettably one of the most common examples lies with the use of hard-bottom flat run-up bed wave flume data in applications for prototype shoaling wave conditions. It is almost universally overlooked that real waves consist of a surface form (the potential energy fraction) and a submerged orbit field (the kinetic energy fraction). Yet in most model wave flumes, the shallow waves as generated are nearly pure solitons, that hold no orbital kinetic energy at all. The researchers, it seems, are mesmerised by the surface shape of the model waves alone and don't bother to check *what* kind of wave they are really addressing, nor how comparable is it with the real thing. We need not labour the point any further, we are all aware of examples of this sort of syndrome, but the practise in our view is much too widespread for any comfort either in the present or into the future.

### MATHEMATICAL MODELS AND ASSUMPTIONS

Mathematical models, of course, are the simple alternative to the physical model, and provided you do know what you are dealing with and how it does work, such models can be extremely effective. This is so much so, that most scientific disciplines can be studied by this technique being applied almost alone and this trend is accelerating throughout the scientific world. It is no doubt this very world-wide success rate, that engenders in coastal researchers, the feeling that they *must* be equally successful in *all* coastal process studies.

That this expectation has not been met is only too obvious to the long-term coastal field engineer. To repeat again, what we see relies on the long-term coastal field engineer. To repeat again, what we see on the prototype and what we read about it are only so often very different. Why then should this be so? We have pondered for many years upon this quandary, but we have only come up with the same old explanation. Our knowledge of the most basic aspects of coastal processes is so primitive, that we do not hold a basic foundation of concepts and facts nearly large enough for us to even determine an adequate starting point (or consensus) for starting to build competent coastal mathematical models. Simply, with *no* base, we have *no* reliable starting points.

This may sound extreme, but let us look at pure wave theories. We find that our basic wave theories all go back to Airy and Stokes, or theories evolved over a century ago, but how far have we progressed since then? We find naturally enough that two newer theories have appeared since then, *i.e.* cnoidal theory and stream function theory, but where have *they* got us? They both started out brilliantly, with the latter in particular offering immense promise, but what has happened since? Both theories resulted in some evidence of a substantial “break-in” to Nature’s wave codes, but we still don’t know how to apply them meaningfully on the prototype. All that we have been offered, it seems, is alternatives of no ranked value, so much so, that most practical work still relies on Airy theory, or the oldest of them all. At least within our very limited basic knowledge base, it seems to “work” for much of the time, but it must be only a crude approximation of the real thing.

As a definitive quote of the *status quo*, we might remember the famous popular scientific author James Trefil, in his delightful book *A Scientist on the Seashore* of 1984, when he said, “The breaking wave is a good example of a system in which simple physical laws operate in such a way as to defy the best efforts of modern science to predict behaviour. Even with the best computer models, we cannot at present predict in detail how a wave will break as it moves toward a shore”. Sadly, in this last decade since we haven’t got any further forward either, the latest IUTAM symposium on breaking waves, held in Sydney in July 1991, has not taken us any further ahead at all. To the field engineer, and the number of papers being published aside, we seem to reside in a static discipline, that is making very little basic progress

at all. New mathematical models abound, but new insights are largely absent. The new approach of the “purity” of science in coastal work, it appears, may well be defeating itself from a lack of real-time, real-thing data, however so incompatible it may appear compared with accepted theories.

As a result of this, we have the situation where we do not have a central basic concept of wave and current properties and behaviour on the prototype, so we have to base our model assumptions on something else. Herein lies the basic problem in constructing mathematical models. We thus see what is to us very strange basic assumptions made, generally in lack of anything else, based upon fluvial mechanics and impervious bed theories. Waves, however, are not a purely fluvial phenomenon, but few, if any, seem to have ever tried to check their basic assumptions on the real things. By consensus they are merely accepted without question, model-makers perhaps always want to look forward rather than backward, but real progress has suffered severely on just this simple account.

To us, the most serious challenge in coastal engineering lies now with the most basic and elementary analysis and review of our model *assumptions*.

## OUR KNOWLEDGE SOURCES

Coastal engineering is not a large discipline so there are not very many technical journals and new text books available to us for ongoing education and learning. In fact, in the English speaking world, we are generally limited to those listed below. Then, more or less purely for the record, for each source listed, we assess how valuable and informative each one is to a long term practising on-site field engineer.

### *The Shore Protection Manual*

Although these volumes have not been updated for nearly a decade, they remain the “bible” for field engineering, being based themselves on very practical experience built up over very many years. We find that we still refer to the SPM quite often, even though its design concepts are for shallow water only and most of its examples are obsolete. Yet, it still provides an invaluable “backstop” for coastal studies and designs, because it can usually provide a practical either upper or lower limit, to the natural conditions.

### Corps of Engineers Technical Reports

A steady stream of these reports flows from the Waterways Experimental Station at Vicksburg and they cover an incredibly wide field of research, study and design. The reports are to some extent a continuation of the SPM, but the quality and effectiveness vary quite widely. Some represent almost definitive "state of the art" studies, but some others are plain journeyman placebos. Nevertheless, because of their variety and being so up to date, the series is very important. We Queensland field engineers would learn something of import, be it negative or positive from about 20% of the reports we receive.

### Coastal Engineering

To most coastal researchers and engineers, particularly those outside the U.S.A., this Dutch journal is regarded as the most prestigious in the discipline world-wide. In fact, the journal sees itself as "... intended as an international medium for engineers working in the field of marine and coastal technology. Combining practical application with modern technological and scientific achievements it publishes fundamental studies as well as case histories..." For some years *Coastal Engineering* approximately filled or met this intent, but over the last five to ten years, this intent has become forgotten. The scope of the papers published has become progressively more "pure science" orientated, such that now it does not address engineering at all and it has become taken over completely by academics and research station scientists. The science may well be world class, but it is no use to engineers any more and, as an example, we have read only *one* paper that was interesting and informative in the last four years' journals. We have, in fact, already cancelled our subscription; none of its papers hold any relevance to what happens on our prototype. Frankly, we find it useless for field work.

### ASCE Journal of Waterway, Port, Coastal and Ocean Engineering

Contrary to the appreciations of the Editors of "Coastal Engineering" we believe that this journal has always been the world leader in coastal engineering and by far the most useful, probably because most of the most useful coastal engineering has been conducted in U.S.A. For most of its life, this journal published a very fruitful

blend of practice and theory that made it extremely useful, or as field engineers we certainly found it so.

Unfortunately, however, the creeping pure science syndrome is gradually taking over this journal too. Whereas ten years ago we would read 90% of the papers in a year, it is now barely 10%. The academics and research scientists are now the dominant input. The latest edition on our desk, that of May/June 1993 has no authors other than academics or scientists, and it will go out in the trash can next weekend, completely un-read, where its last few recent brothers have likewise gone! To us—a great pity.

### The I.C.E. Proceedings

Over the last thirty years or so, the proceedings of the Institution of Civil Engineers (London) have had a fair sprinkling of coastal process and coastal defence papers. We have found these papers absolutely fascinating stuff, because the papers have usually dealt with the Eastern coast of the U.K. This has generally been so, because their coastline is so dramatically different from ours, and nearly all the U.S.A. coastlines as well. Things like Chesil beach, constructed entirely from cobbles are generally outside all of our coastal experience, but they must face the same hydraulic processes, even though the blend is very different.

We note for example that the Eastern beaches of the U.K. are in the lee of weather systems incoming from the deep Atlantic, so they are thus very different from the Dutch and German beaches which are on the windward side, but the gap in between is not a deep ocean, but the shallow very fetch limited North Sea. After thirty years, we are still pondering upon these profound differences. Unfortunately at the moment, however, the I.C.E. is changing its publication and publishing arrangements, so we do not currently know if this flow of informative papers will continue into the future.

### The Journal of Coastal Research

This journal is a comparatively recent newcomer to the discipline of coastal processes, but it is certainly making itself felt. It is not restricted to coastal engineering or physical processes alone, but it covers the complete spectrum of factors that occur on our coastlines through biology, change, climate, geology and through coastal processes and human response. To the field engineer, the

issues continue to be quite delightful, and present an up to the present wonderful overview of *all* the sorts of things that happen on our coastlines and *not* for a change, *only* those theoretical things, that we read about so often elsewhere.

We thus find this journal to be highly educational and its diversity enchanting. It, at least, does give us a feeling about the whole background of our coastline—and it is all very much world-wide at that. The editors of “Coastal Engineering” might be quite surprised, that there are lots of us people out there that *are* interested in the overall and not just strings of differential equations, however pure they may be. If at times we feel that we would like to see more papers on engineering field conditions and natural processes in *JCR*, and we do, at least from this Journal, we may stand back a little, and really appreciate that coastal engineering is only a part, and perhaps only a small part, of the total picture. In the event, we might conclude with the observation, that we in fact *do* read 90% of all the papers in each edition of *JCR*.

#### ***Shore and Beach***

We have left this journal last in our discussion through simple malice. It is by far the most educational, informative and practical publication of all (by far) to the practical field coastal engineer. This is the one journal that we read from cover to cover for every edition. Most of our confrères in academia and research institutes tend to turn up their noses and sneer, when we mention the name, but that is perhaps only because they can only equate to a journal that is based upon “pure rational science”. The more fools they are,

since pure rational science is very seldom indeed capable of addressing and solving real-time, real-thing conditions and problems, but maybe these things are too grubby and mundane for those “pure” scientists to even consider. At least that is how we have found it.

Yet we find the *Shore and Beach* papers highly pertinent and we can apply much that we read in them to our local environment. All papers published do get peer review so there is nothing second class about them at all. In fact, we rate *Shore and Beach* now as the full equivalent of the ASCE coastal journal as it was some years back in its heyday in the USA and of equal value. An added advantage that is nearly unique to *Shore and Beach* is the large (relatively) clear photographs that are included, because you can learn a great deal about coastal processes from good photographs of “legible” size.

#### **CONCLUSIONS**

In a survey like this, that is self explanatory along the way, there is little need to summarise the matters to present them as conclusions. However if anybody outside the Gold Coast ever reads this, they would most certainly charge that we are being un-necessarily alarmist. This would be fair comment, but as very frustrated engineers we are perhaps pleading a case. Yet, as we see it, it remains that the study of coastal processes is barely making advances at all right now and we think that the pure science approach and the lack of practical field-based papers being published does have a major impact upon why this is so.