Reçu de Nic Flemming le 21/5/2014.

Objet: Publication submerged breakwaters

Dear Arthur,

My apologies for the delay in reply to your draft papers on erosion of rubble breakwaters.  I have read both the shortened version, and the PDF with more details.  The basic work and the logic is excellent, and will provide the basis for a paper of value to people working on classical ports.

The material you have sent me is interesting, but still a considerable distance away from the logical sequence that is needed for archaeologists.

The following suggestions are not complete, but I hope you can see how the addition of these data go a long way to answering the questions that archaeologist will have.

1. What is the earliest date of construction of a rubble breakwater, how many do you have in your catalogue, and when does the construction of rubble breakwaters die down as the Roman Empire collapses?  (Rubble breakwaters are built today, so there is no firm end date.  But presumably harbour construction more or less  stops around 300-500 AD?)
2. What are typical water depths, block sizes of the main rubble mound, size of armour blocks near the surface, and do most ancient rubble moles have a road, dock surface, or wall built on top?  Gradient of the BW slopes?
3. Brief summary of Mediterranean wave climate, showing a simplified map of winter Hs, or Hmax.  Where are the biggest storms.
4. How many BWs have survived completely intact (e.g. Kiassamou, Cnidos, and others), and how many just a bit damaged, and how many flattened almost completely, )e.g. Thapsus, Caesarea, Apollonia, etc.)?
5. Then the experiments that you have done fall into context.  What is the process that determines the extent of flattening?   How do the hydraulic models scale up?  Everything is shown as ratios or parameters, so that it is not immediately apparent how one translates the tank model to a real-world BW.  That is, examples could be quoted, … this is equivalent to a water depth of X… and an Hs of…. Etc.
6. The running of models with 1500 waves of the worst case is intriguing, but what is the cumulative effect of less severe storms?  Is 1500 waves the duration of a typical severe storm?  Is the cross-section of the submerged breakwater after 1500 severe wave impacts really a final equilibrium profile.  What is the effect of 1 million waves of 80% of the biggest Hs?  Do the blocks really not move at all?  What if the severe storm is estimated to return every 50 years, that is still 40 storms in 2000 years.  Will the stone pile get a bit flatter each time, or not?  Would the damaged or half-submerged breakwaters have been any use to sailors in the “Dark Ages?” after the Roman Empire?

From the Kissamou photographs can one work out the block size and slope.  It does not seem to have been pillaged at all.

These comments don’t go so far as to suggest the outline of the argument of the paper, but I hope it gives you some ideas as to a way ahead.  I will have much more time towards the end of the year.  Hectic now.

Thank you for letting me see this work.  It is very promising.

Best regards,

Nic.