What on Earth?!

Damien Sous, Samuel Meulé, Frederic Bouchette

What on Earth?!

Damien Sous[1,2*], Samuel Meulé[3], and Frédéric Bouchette[4]

[1]Université de Toulon, Aix Marseille Université, CNRS, IRD,
Mediterranean Institute of Oceanography (MIO), La Garde, France

[2]Université de Pau et des Pays de l'Adour, E2S UPPA, SIAME, Anglet, France

[3]CEREGE, Aix-Marseille Université, CNRS UMR 6635, Aix en Provence, France

[4]GEOSCIENCES-Montpellier, Université de Montpellier II, Montpellier, France

A fundamental issue of long-term surveys in sandy nearshore areas is to maintain instruments at fixed positions and, incidentally, recording reliable data. This becomes an enduring challenge when trying to track storms. Recording storms is always a very gratifying job, as soon as instruments have been safely retrieved and the recovered data is processed in a warm, stable and cozy desk. A bit more depressing is the number of lost instruments, buried under meters of sand accumulation, destroyed by rocks, sliced by boat propellers, snatched by stainless frame lovers or just disappeared without a trace...

GLADYS, a research group on nearshore hydro-morphodynamics in the South of France (Le Grau du Roi, www.gladys-littoral.org) has long been involved in such nearshore *in-situ* deployments. After years spent deploying supporting frames weighted by hundreds of kilos of concrete or lead, our strategy is to bury long (3 to 6 m) tubes or thick angle irons. The basic procedure is that the metal profile is first buried using a motorpump to fluidize the sand bed, either underwater or on the dry beach (Figure 1a), such that a sufficient portion remains outside the sand (typically 1 to 2 m) and then the instruments are bolted onto it. This type of structure prevents the occurrence of most issues mentioned above.

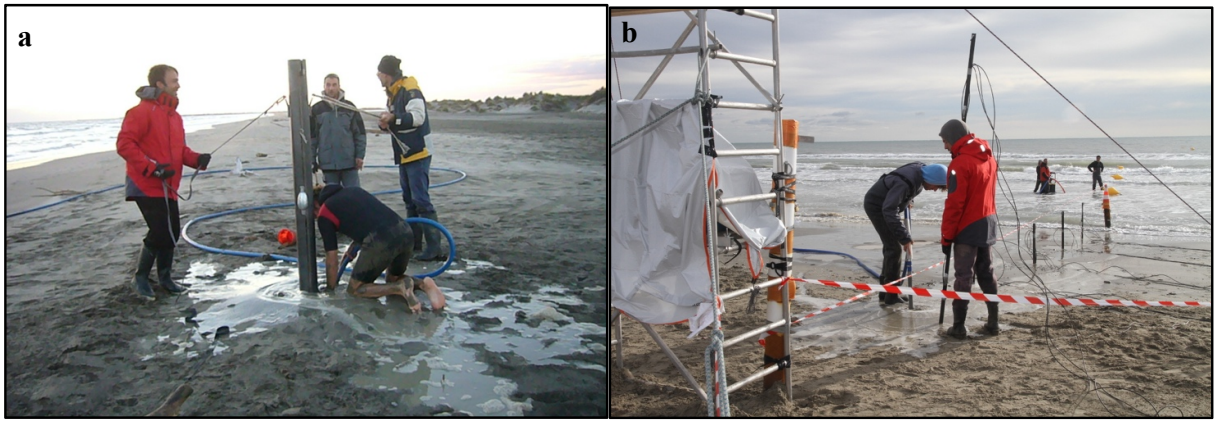

Figure 1. (a) Illustration of burying of instrument-supporting poles by sand fluidization using motorpump at Rousty Beach, France, in December 2014. (b) Experimental setup deployed at Rousty Beach. A cross-shore network of instrumented poles was deployed across the swash zone using sand fluidization, including light angle irons (3 m long) for short-term cabled sensors and heavier (10 cm diameter, 4 to 6 m long, with white and orange stripes) tubes for long term autonomous sensors. (Photos: D. Sous.)

This nice outcome is true in most cases. A rare exception is when the sand accumulation is so great that the whole metal profile totally disappears. This is precisely what occurred on Rousty Beach during a 2014-2015 three-month winter survey. Rousty Beach is located in the Beauduc Gulf in the national park of Camargue, about 5 km east of the Saintes Maries de la Mer, France. The studied area (43.456589° N, 4.493034 °W) is a nearly alongshore uniform sandy beach. The beach is micro-tidal (tidal range about 0.3 m) with a typical two-bar and gently sloping profile (average slope about 0.01). Wind can be strong in the Rousty area, frequently reaching more than 15 m/s, both from the south-east and north to north-west sectors. Wind events driving significant fluctuations of the mean water level can be observed, ranging from a setup of 1 m during south-easterly winds and low atmospheric pressure storm conditions to a setdown about 0.5 m during strong offshore winds and associated high pressure conditions. The wave climate is mainly bimodal, with moderate (0.5-1 m) and short (peak periods lower than 6 s) south-western swells and more energetic storm waves (larger than 2 m for 40% of the events) from the south-east associated with onshore winds. A cross-shore network of 12 tubes were deployed from the shoaling zone up to the dune (Figure 1b), to record wave transformation across the foreshore together with groundwater dynamics inside the beach (Petitjean *et al*., 2016; Sous *et al*., 2016, 2017).

After a sudden seaward shift of the berm, the 4 m long tube deployed in the swash zone totally disappeared under the sand. Its position was precisely known by DGPS-RTK measurements, so we knew that the top of the tube was somewhere under 1.5 m of sand. The first part of the search procedure was to dig with a shovel, and then to use the motorpump to try to fluidize enough sand to detect the top of the tube. It is like creating a little pool of shifting sand.

While Samuel Meulé was permanently injecting pressurised water into the sand, Damien Sous was trying to find the tube top, first with the shovel, then with one foot, then two feet, and finally he just went down little by little in this boiling pool of fluidized sand until he had to use his snorkel to breathe. To get a better picture of the conditions: this was winter, we were in wetsuits from the early morning in water about 12°C. The expected miracle finally occurred – Damien was just able to touch the top of the tube with one of his toes. After mutual and understandably warm congratulations, the team started to think a bit deeper. The main issue was to catch the big hole drilled at the top of the tube with a rope and a shackle. Damien spent nearly half an hour trying to perform this operation only with two feet – a lost cause. Without really considering what he was going to do, mindful of the setting sun and losing energy and patience, he decided to dive head first into the fluidized sand pool, just to be able to use his hand to fix the shackle – a question of seconds for sure.

Upside down, holding his breath, his head nearly one meter and a half under the sand bed, trying to re-find this stupid tube in a totally dark, thick and moving fluid, a series of questions suddenly hit his brain. What will happen if the motorpump stops (as it usually stops without any reason several times a day)? Who filled up the gas the last time? And when? A frightening memory came to his mind: when the pump stops in the Rousty swash zone (which is not the same for all kind of sands), only a few seconds are necessary before the sand quickly becomes compact again, as a nice beach sand to build sand castles. Damien could feel some parts of his body experiencing the partial re-compaction of the sand when Samuel pulled a bit away the hose to avoid hurting him. This is precisely the point where he said to himself, '*What on Earth?!*' The slightest mishap and he would stay preserved in the sand for quite a while...

But the story has a happy ending (Figure 2). After a few seconds more, the shackle was finally caught and Damien escaped from the sandy hell by twisting and wriggling his body. And, of course, he remained smiling when shaking his head totally glued by the sand: '*Just a nice walk in the park for a guy like me*,' he said. However, a stiff drink was necessary a bit later to recover a normal state.

Damien still tells this story from time to time, particularly when he sees students and colleagues a bit too confident when using motorpumps.

Figure 2. The day after the '*What on Earth*' event. Thanks to the efforts deployed the day before, the tube has been lifted up to the sand surface, *i.e.* nearly 1.5 m above its initial position. The game was almost won. (Photo: D. Sous.)

LITERATURE CITED

Petitjean, L.; Sous, D.; Rey, V.; Bouchette, F.; Sabatier, F., and Meulé, S., 2016. The structure of nearshore currents driven by changes in meteo-marine forcings. *In*: Lynett, P. (ed.), *Proceedings of the 3th International Conference on Coastal Engineering* (Antalya, Turkey), pp. 405-414.

Sous, D.; Petitjean, L.; Bouchette, F.; Rey, V.; Meulé, S., and Sabatier, F., 2017. Groundwater fluxes within sandy beaches: Swash-driven flow vs cross-barrier gradients. *In*: Aagaard, T. ; Deigaard, R., and Fuhrman, D. (eds.), *Proceedings of Coastal Dynamics 2017* (Helsingør, Denmark), pp. 226-236.

Sous, D.; Petitjean, L.; Bouchette, F.; Rey, V.; Meulé, S.; Sabatier, F., and Martins, K., 2016. Field evidence of swash groundwater circulation in the microtidal Rousty Beach, France. *Advances in Water Resources*, 97, 144-155.