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Storm recovery on two Italian coarse-grained beaches: a comparison between a mixed sand and gravel and a pebble beach

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High energy events emphasize beach erosion processes, sometimes leading to huge volume deficits not balanced by recovery under fair-weather conditions. In this scenario, artificial replenishments are frequently used as a form of coastal protection with large volumes of sediments re-injected in the system without strongly altering the environment as it happens with hard structures. Since climate change is expected to accentuate in the near future erosion effects, the need to artificially feed beaches is likely to increase. Gravel and pebbles are more and more often used as beach fill, on some occasions replacing sandy sediments. That was the case for two beaches located at either sides of the Italian Peninsula (Portonovo, Adriatic Sea; Marina di Pisa, Ligurian Sea), which constitute the study area of the present research. Portonovo is a 500 m-long mixed sand and gravel beach with a significant pebble-sized content (about 40%), unloaded on the beach during multiple replenishments. Marina di Pisa is an artificial, 180 m-long beach, mainly composed of 40-to-90 mm pebbles; it was built in 2008 as a part of a larger protection scheme. Groins or headlands that prevent any sediment exchange with adjacent areas bound both beaches. Periodic topographic surveys were carried out to evaluate the response of these human-altered beaches to high-energy events. The topographic surveys, undertaken with a DGPS-RTK instrument along cross-shore transects (from the landward end of the backshore to about 1.5 m depth seaward), were done following intense storm events occurred during the time period of the research. Transects were done out every 10 m along the entire length of the beaches. Prior to the first topographic survey, a sediment tracing experiment was set up as a form of control of the results provided by the geomorphologic analysis. Pebbles directly sampled from the beaches were marked by means of the RFID technology and injected back all along the beachface. As expected, considerable beach profile changes after the storms were identified, in particular at Portonovo (mixed beach), where huge sediment volumes were displaced longshore according to the incident wave direction as opposed to Marina di Pisa (gravel dominated), where the main beach changes developed along the cross-shore direction. In terms of resilience, results showed a better response of the Portonovo beach rather than the Marina di Pisa beach. The different response might be ascribed to the grain-size that constitutes the beaches: no physical process can rework the pebbles at Marina di Pisa once they are moved during the storms towards the back-end of the backshore or seaward of the step, thus preventing any beach recovery process to take place. Since the awareness on storm impacts is more critical than in the past, the understanding of beach recovery to extreme events needs new insights to combine the preservation of natural beach evolution as well as maintenance for end-users. That is particularly pressing on coarse-grained beaches, where the need to predict storm impact and recovery is much more vital considering that finding suitable sediment to refill the beach is never an easy task.