

Deposition Dynamics of *Posidonia oceanica* “Banquettes” on Calabrian Sandy Beaches (Southern Italy)

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Abstract: The deposition of *Posidonia oceanica* leaves on the sandy beaches of the Calabrian region could be one of the most important defence mechanisms against erosion processes. The management of *Posidonia oceanica* leaf litter in Italy has been realised through the mechanical removal and transport in dumping areas of the beach-cast material. This solution, apparently simple and fast, produces a net loss of sediments from sandy beaches and, therefore, a deficit in the sedimentary budget of the coastline, leading the coastal system to possible shore erosions. Instead, it could be better to keep these vegetable deposits in place to warrant a positive sedimentary budget and to increase the tourist value of regional beaches, improving coastal tourism in seaside resorts with opportunities for bathing.

Keywords: *Posidonia oceanica*; “banquettes”; Calabria; seaside tourism



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Introduction

Posidonia oceanica (Linnaeus) Delile, an endemic species of the Mediterranean Sea, forms extensive beds in the infra-littoral bottom of the basin, according to favourable environmental conditions. Along Mediterranean coasts, *Posidonia* beds provide a great variety of ecosystem services, amongst which the power of entrapping marine plastics [1] and the protection of sandy beaches against erosional processes are some of the most important [2]. A long time ago, the meadows of *Posidonia oceanica* surrounded a large part of the Mediterranean coastline, forming an almost continuous belt along the coasts of the basin. However, in recent decades, there is a widespread regression of these natural barriers along the Mediterranean coast with a declining trend in the global area extent, variable from 13% to 50% [3]. So, the meadows have been replaced, in the damaged areas, with deserts of dead “mattes” or have been colonised again by some algal species such as *Caulerpa prolifera* (Forsskål) J.V. Lamouroux or *Cymodocea nodosa* (Ucria) Ascherson. This negative trend has been reported in many areas of the Italian coastline where 72% of prairies have deteriorated, as shown by the “National Program of characterization and development of *Posidonia oceanica*” started in 1989 and finished in 2009 [4]. More generally, these critical conditions of the Mediterranean meadows have also been reported in other Mediterranean countries by the scientific literature [5–12]. The widespread deterioration of coastal environments in the Mediterranean basin implies a global vision of the problem. The critical state of the Italian coast has become a serious problem in recent years along its coastal boundary, where 42% is in erosion [13]. These negative conditions are particularly severe in the Calabrian coastline, where 43% of beaches are in erosion [14]. The particular position of this region, surrounded by the Tyrrhenian and the Ionian seas, for a coastal boundary of 715.7 km, as 9.7% of the national coastal outline, suggests the solution of some problems linked to the protection of its coastline—the transition area between the terrestrial and the marine environments. So, coastal defence must become the main appointment for national and regional authorities.

The balance of sandy beaches is made by three basic elements: the shore-face, the shoreline and the coastal dune, amongst which sediment exchanges take place to grant the littoral sedimentary equilibrium and the correct working of the coastal system. The loop of organic and inorganic materials between the water and the terrestrial shore begins at the end of the vegetative period of the plants when leaves senesce and detach off the rhizomes [15]. This leaf loss may reach values of 10–20 tons of vegetable fragments per hectare of meadow (Medina et al. 2001), of which 5% is exported outside, 70% remains in the meadow and 25% is washed away by wave action on adjacent shorelines, forming deposits known as “banquettes” [12,16–21]. Indeed, during their life, the plants lose a lot of leaves that are carried by hydrodynamic pressure onto the beach in clumps and are accumulated on sandy beaches, where they form very conspicuous wedge-shaped deposits up to 2 m in height (Figure 1).



Figure 1. “Banquette” surveyed on a sandy beach of the Calabrian coast.

The “banquettes” also play a leading role in trapping high amounts of sediment inside the overlapping layers of the deposits [22]. The leaf piles and their sediment store carry out an important functional and structural role by attenuating wave energy and limiting coastal erosion [23]. The wedge-shaped deposits of *Posidonia oceanica* leaf litter that pile up on the sandy beaches of the Mediterranean basin are a temporary sink of organic matter made up of detached leaves of the plants, but also include inorganic materials such as marine plastics, sands and water. The amount of sediments in the “banquettes” depends on their grain size. The quantity of sand trapped in the “banquettes” is very high in beaches of coarse-grained sand, while it decreases in those of medium- and thin-grained sand. Anyway, the “banquettes” represent the “sand factory” of the coastal system, producing and exporting towards the coastline a great amount of sand [24]. In Italy, some regional and local trials have been realised to test the importance of “banquettes” against the erosion process, and are actually ongoing on Italian sandy beaches. The results of the Arena Project, carried out along the Sardinian coast, prove that the removal of 100 m³ of “banquettes” from beaches of coarse texture causes a loss of sediment of 11.2 tons from the beach [25]. These conditions produce a negative beach sediment budget and, consequently, possible shore erosions following storm events. Therefore, it is necessary to value the percent in weight and in volume of the organic and inorganic fractions contained in these deposits to establish the physical role of “banquettes” in coastal dynamics. The first results of this

method, held by the Environmental Department of Livorno Province [26], prove that the sandy fraction of the deposits is very high, ranging from 37% (percent in volume) to 56% (percent in weight), and, consequently, these wedge-shaped deposits of *Posidonia oceanica* leaf litter can be considered basic for the hydrodynamic equilibrium of littorals. For a long time until the seventies, the presence of “banquettes” was accepted by coastal users [19,27]. From then on, just at the beginning of seaside tourism, most tourist operators, stakeholders and coastal municipalities regarded “banquettes” as a useless waste with negative impacts on coastal tourism. So, the dead leaves of *Posidonia oceanica*, with their large amounts of sand, were removed from sandy beaches, often using mechanical earth movers, and transported to landfills. The cleaning operations of the beaches and the whole removal of this beach-cast litter produce a subtraction of sediments from the beaches and may lead to possible shore erosions. These conditions also produce the deterioration of the coastline and the loss of dune vegetation. The desertification of sandy beaches gives rise, long-term, to substantial changes in beach morphology. From a biological point of view, the “banquettes” are an important and potential sink of biogenic elements for sea-grass ecosystems [17]. These vegetable biomasses accumulate, indeed, a large amount of organic carbon valuable from 18 to 500 kg. of dry wt m⁻¹ of shoreline [28]. The complete removal of the “banquettes” causes a nutrient depletion for the trophic chain of the coastal ecosystem and, in particular, a permanent loss of C, N and P. The N and P losses are, respectively, 5.4% and 1.2% of the annual requirement of the plant [15,29,30]. Removal operations, made by coastal municipalities, using heavy machinery such as bulldozers and excavators, are carried out to keep the tourist value of sandy beaches. The following loss of sediments from the shoreline impacts upon littoral stability and may support erosive processes on the beaches exposed to high hydrodynamic pressure. So, Calabrian beaches, unprotected by “banquettes” and exposed to a growing withdrawal trend, were steadily eroded and, afterwards, many human attempts were made to compensate this increasing erosion process by unsuccessful hard structures and/or costly sand replenishment. Therefore, it is hoped to avoid this kind of procedure or to carry out late actions of displacement in the months of May or June, at the beginning of the summer season, to minimise the impacts of removal. So, it is necessary to avoid the mechanical handling of the deposits while it is right to work manually to avoid the direct removal of sandy materials. The solution to the problem should be to leave these vegetable deposits to their natural process of maturation, keeping the “banquettes” in place, or to stock them on the ground in tourist areas, moving them inside the coastal dune or in retired belts close to the point of maximum wave expansion. These kinds of operations may contribute to the protection of the coastline against erosion processes and to the stability of substrates behind the fore-dunes, allowing, at last, a real saving of financial resources. These suggestions have been ratified by a ministerial memorandum issued by the Ministry of Environment dated 17 March 2006 (DPN/VD/2006/08123) concerning the management of beach-cast litter found in coastal areas. This provision states three alternative solutions: the removing and dumping of beach-cast litter, the moving of the deposits or the maintenance of the “banquettes”. This last one is the ideal solution to the problem, and in this event the coastal municipalities have to inform the public and, particularly, tourists through posters, placards and information boards (Figure 2) explaining the ecological issues of the species so as to improve the presence of *Posidonia oceanica* meadows in those areas as a pattern of ecological shores like the “bio-beaches” of French coasts [31].

Additionally, in Italian coastal waters, the meadows of *Posidonia oceanica* are very widespread, representing one of the most important endemic species of the Mediterranean basin. In particular, along Calabrian coasts thirty prairies of *Posidonia oceanica* were located, including thirteen meadows mapped on the Tyrrhenian coast and seventeen on the Ionian seaside, resulting from the “SINPOFACC” project founded by the Italian Ministry of Environment [4].



Figure 2. Tourist advertising on *Posidonia oceanica*.

In this sense, the joint presence of meadows and “banquettes” could become the main factor of wildness in coastal areas. The final result will be tourists visiting the beaches and a favourable perception of “banquettes” by the public, which could support this kind of ecological approach to improve the leisure enjoyment of sandy beaches.

The vegetable biomasses known as “banquettes” are an excellent indicator of the quality of marine coastal environments for the presence of extensive *Posidonia oceanica* meadows on the marine sea-beds. Therefore, the presence of these massive supra-littoral deposits of leaf litter along coastal areas is a clear sign of a sea in good environmental health. The wedge-shaped deposits, placed on some stretches of the protected coastline, perform an important mechanical and biological role in the trophic and sedimentary budget of the coastal system and cannot be considered a simple waste material but, instead, a natural resource for the sensitive balance of coastal ecosystems.

In this way, in Italian coastal regions exposed to a rapid increase in the rate of urbanisation but also to an increasing trend in erosion processes, it is necessary to construct a global approach to establish a structured framework based on information and collaborations between various stakeholders to solve such coastal issues. So, the decision-making process must be addressed towards a more integrated approach improving access to environmental data at regional and national levels, both in governmental instances as well as in public knowledge. Finally, it is hoped that broader outreach planning including a widespread campaign at the national level will be implemented in various media, in social networks and in the national press for effective media coverage, increasing the public knowledge of coastal problems at local and global levels.

The actual technologies and the current management practices regarding “banquettes” must change from simple beach litter removal to their maintenance to reduce wave energy, providing protection to the foreshore and reducing erosion processes. At last, it is necessary to revalue the ecological role of *Posidonia oceanica* “banquettes”—natural elements of some Calabrian coasts that could become the “bio-beaches” of the coastal regional boundary—to improve tourism in seaside resorts.

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