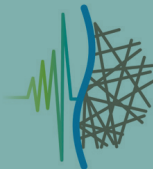




**GOOD PRACTICE GUIDE FOR THE MANAGEMENT,
COLLECTION AND TREATMENT OF ALGAE AND
MARINE PLANT DEBRIS ON BEACHES**



seamatter

© Authors

© Fundación Instituto de Ecología Litoral

Coordinating partner: Instituto Tecnológico del Textil (AITEX).

Financing partner: LIFE+.

Beneficiaries: Fundación Instituto de Ecología Litoral (IEL); Asociación de Empresarios Textiles de la Comunidad Valenciana (ATEVAL); Università degli Studi di Perugia (UNIPG).

Texts: Juan E. Guillén Nieto; Joaquín Martínez Vidal; Alejandro Triviño Pérez; Gabriel Soler Capdepón; Eduardo Fages Santana; Sagrario Girones Bernabé; Miriam Martínez Carbonell, Laura Santos, Luigi Torre, Debora Puglia, Roberto Petrucci & Elena Fortunati.

Edition: Fundación Instituto de Ecología Litoral. C. Santa Teresa, 50, 03560, El Campello, Alicante (Spagna)

This publication must be referenced as: Guillén, J., Martínez-Vidal, J., Triviño, A., Soler, G., Fages, E., Torre, L., et al., 2014. Guida di buone prassi per la gestione, rimozione e trattamento delle banquette di alghe e piante marine lungo le coste. Progetto Seamatter LIFE11 ENV/ES/000600. Ed. Instituto de Ecología Litoral, El Campello, 24 pp.

Legal Deposit (Spanish Edition): A-192-2014

1st Edition; April, 2014.

TABLE OF CONTENTS

1
WHY THIS GUIDE?

2
THE IMPORTANCE OF
ALGAE AND MARINE
PLANT DEBRIS.

3
REGULATIONS AND
MANAGEMENT EXAMPLES.

4
WHY COLLECT ALGAE AND
MARINE PLANT DEBRIS?

5
WHEN AND HOW SHOULD
ALGAE AND MARINE PLANT
DEBRIS BE COLLECTED?

6
WHAT ARE THE POTENCIAL
USES OF ALGAE AND MARINE
PLANT DEBRIS?

7
HOW CAN POSIDONIA
OCEÁNICA DEBRIS BE USED IN
MATERIALS MANUFACTURE?

1

WHY THIS GUIDE ?

This guide has been produced as part of the Seamatter project "*Revalorization of coastal algae wastes in textile nonwoven industry with applications in building noise isolation*" (LIFE11 ENV/E/000600), funded by the European Commission's LIFE programme.

The aim of this document is to serve as a best practice manual that provides information about the nature of algae and marine plant accumulations on beaches, their ecological and protective functions and when, where and how these accumulations can be removed to achieve sustainable tourism.

The guide is primarily aimed at municipal services personnel who manage the collection of the plant debris that accumulates on beaches. It can also be used to inform residents and beach users in general about the advisability of not removing these accumulations in certain circumstances because of the environmental damage that this can cause.

LIFE's Seamatter project has the ultimate goal of assessing the possible use of plant debris as a material in the manufacture of soundproofing panels. This guide, therefore, also contains recommendations on how plant debris can be used as a material to preclude the need to dispose of it in landfills.



2

THE IMPORTANCE OF ALGAE AND MARINE PLANTS DEBRIS

The accumulation of plant debris on beaches is closely associated with the action of the waves. There is an initial stage in which it is deposited, followed by a process of enlargement that can see it grow to a height of 3 m. After the algae and plant debris is deposited, erosion phenomena are produced by the action of the waves at the base of the accumulations, forming scarps that eventually collapse. These banks of algae and plant debris reach their maximum dimensions in the winter as a result of maritime storms.

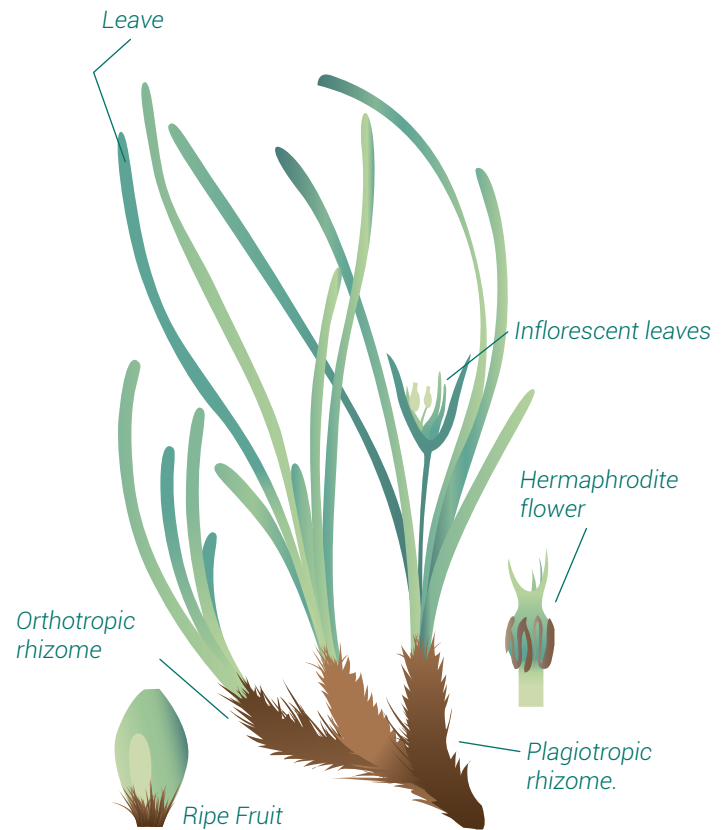
Plant debris and sediment is deposited when the power of the waves begins to diminish. The landward limit of the debris marks the reach of the maximum wave and deposits occur seawards as a result of decreased acceleration. The heaviest material in this debris is made up of rhizomes, which are mainly found on high-energy beaches.

In the Mediterranean, most plant debris is made up of the species *Posidonia oceanica* (L.) Delile, a superior plant that is endemic to this sea. It forms extensive meadows from the shallowest areas of the coast to variable depths, depending on how deep light can

penetrate the water to enable photosynthesis to take place. Similar to other phanerogam plants, it has leaves, roots, a subterranean stem or rhizome, flowers and fruit. The leaves are ribbon-like and distichous, forming a fascicle in each of the rhizomes, and grow from a basal meristem over a period of time that varies between four and eleven months. After this time, the leaves lose their function and, after removing the essential nutrients for the plant, they break off, although they can remain attached to the plant for some time. The intensity with which these processes occur has a certain seasonality; renewal of the leaves occurs in late summer and early autumn.

Posidonia oceanica meadows are important because they are the most productive marine ecosystems on the planet; they are a direct or indirect source of food for a large variety of organisms that grow on the leaves of the plant (Battiato *et al.*, 1982). For many sea creatures, it also provides shelter and a hatchery for their young. The meadows are also a major element in the nutrient cycle of coastal ecosystems and coastal sediment dynamics, and they contribute to fixing carbon in the sediment.

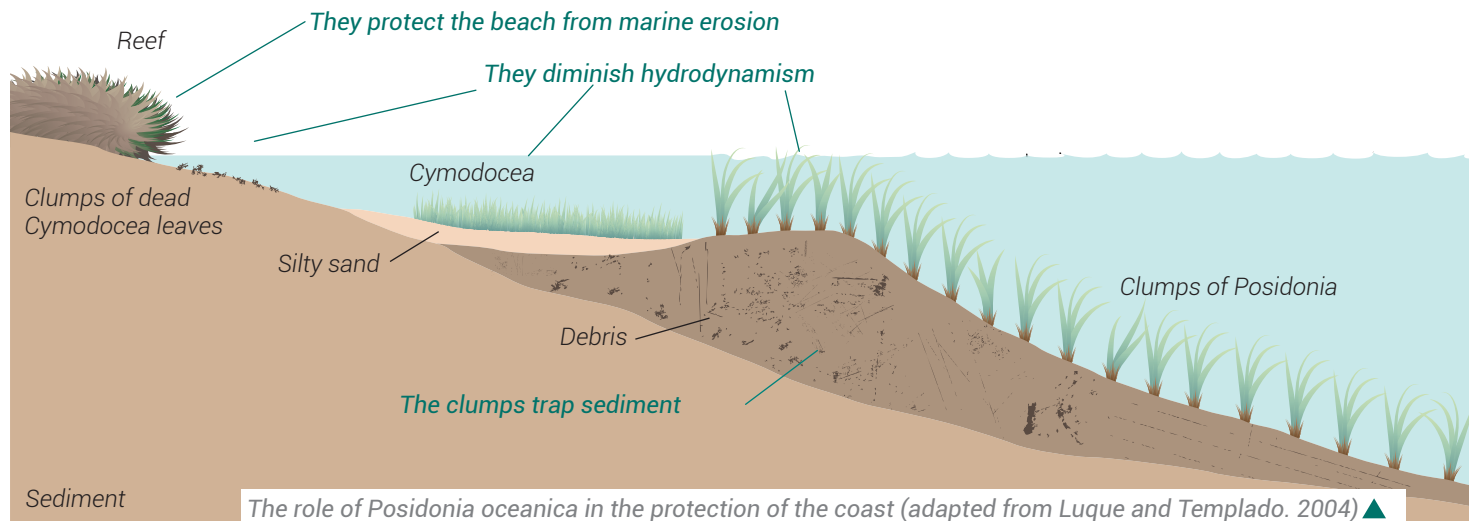
This high production is manifested in its leaf development, one of the highest in the world, which, due to extensive colonisation by algae and small creatures, must be replenished continuously. Some of the leaves that detach from *Posidonia oceanica* plants are recycled in the meadow's own community, while others drift out to deeper waters or towards the coast and end up on the shore. Accumulations of leaves and debris composed of rhizomes and sediment are commonly found along the Mediterranean coast, forming drifts that range in depth from a few centimetres to several metres. The leaves and debris often form structures known as "*Posidonia balls*" or egagropili, which are commonly seen on beaches. These clusters are composed of fibres from rhizome fascicles and grains of sand. Their spherical shape is formed as a result of the constant circular motion of the waves as they break on the beach.



Posidonia oceanica plant ▲



Although this debris has an important role to play in protecting beaches from erosion, on the Mediterranean coast, they are usually removed from beaches and coves for tourism purposes. Removal can negatively affect both the morphology of the beach and the functioning of coastal ecosystems due to the permanent loss of the nutrients and sediments that are accidentally eliminated when algae is removed.





Algae and marine plant debris ▲



Leaf ▲



Rhizomes ▲



Fruit ▲



Rhizome balls ▲

3

REGULATIONS AND MANAGEMENT EXAMPLES

Under Spanish law, there are no specific regulations on the removal of plant debris from beaches. In the European Union, except in Italy, where regulations on the removal of drifts of *Posidonia oceanica* are yet to be introduced, the specific regulations of each country in relation to the collection of municipal solid waste are implemented. It should not be forgotten, however, that algae and marine plant debris have an important ecological role to play in coastal ecosystems, especially in the sedimentary balance of beaches and coves. This role is clearly set out in the criteria under which beaches can obtain Blue Flag status, which establishes that it is imperative that algae and plant debris should not be collected unless the extent of the accumulation and state of decay are evidently unpleasant and unhealthy, thus recognising that marine algae and plant debris are natural components of the marine ecosystem.

According to this imperative, coastal areas should be considered natural and living environments, not just an “asset” in the local leisure industry that only needs to be kept clean. Because of this, the management of algae and other plant debris on beaches should be carried out in a manner that is sensitive both to visitor needs and the maintenance of biodiversity.

It is important to inform or remind users and tourists that algae and plant debris are deposited on the sand naturally by currents and waves. It is inevitable and should be accepted, unless it clearly becomes harmful to beach users, a question which, conversely, has no scientific justification.

Ensuring that debris is not moved is the best solution from an ecological point of view, and should be carried out when there is no conflict with users' bathing requirements and the beaches are subject to erosion processes. Algae should be removed without harming the environment and put to use in ways that preclude its transportation to landfills.

In countries like the U.S. and Australia, specific regulations exist regarding when and how to clean beaches. In the U.S., these rules are needed, for example, to protect the eggs laid by turtles on the beaches of Florida and prevent cleaning machinery from destroying them. The regulations also recommend not removing algae and other plant debris from beaches as they are considered important for the marine ecosystem.

Australia, by far, has the most comprehensive legislation in this area, especially in South Australia where the use of heavy machinery for cleaning beaches is restricted and cleaning cannot be carried out within a distance of 4 m from the foot of a dune or at low tide. The collected debris has to be allowed to dry and is then reused.

TO CONSIDER

ENVIRONMENTAL ANALYSIS



Sedimentary dynamic
Sandy shores
Pebble and gravel shores



Morphological changes
On the free surfaces of the
beach



**Impact due to reduced
organic material**

4

WHY COLLECT ALGAE AND MARINE PLANT DEBRIS?

Algae and marine plant debris is removed from beaches mainly for aesthetic reasons and usually from beaches considered as urban, i.e. beaches with infrastructures such as promenades, where the urban infrastructure and associated services take precedence over the natural concept of a beach.

These beaches, of course, are often precisely where human intervention has caused the biggest problems in terms of stability, resulting in the need for corrective measures such as the construction of seawalls and breakwaters in order to retain sediment and prevent coastal erosion. These barriers can have unanticipated effects such as promoting the accumulation of algae and plant debris on urban beaches as a result of interrupting natural sedimentary dynamics and causing sedimentary erosion. The removal of 1000 m³ of debris represents a loss of 19-44 m³ of sediment. This is mainly carried out by heavy machinery without the use of grid systems. The loss of significant volumes of sediment on beaches over several years can substantially disturb the sediment balance, especially on beaches that are characterised by low sedimentary input.



Loss of sand, due to the non selective cleaning beaches ▲

Most of the economic costs of removing debris are incurred precisely on these types of beaches and the reasons for removal are mainly aesthetic for tourism purposes or a result of complaints from residents when properties are close to the sea.

Morphological transformation of an urban beach due to cleaning services ▼



5

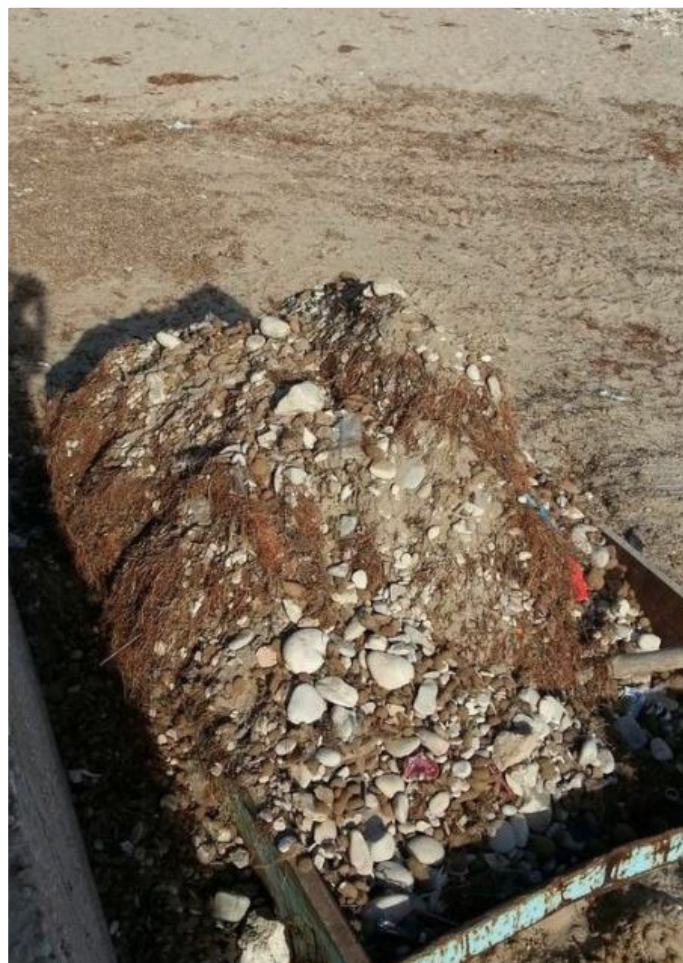
WHEN AND HOW SHOULD ALGAE AND MARINE PLANT DEBRIS BE COLLECTED?

The practice of cleaning beaches has extended from urban beaches to those that are less frequented by people in an attempt by councils to provide more service to users with beaches where the build-up of algae is not such a nuisance. The immediate consequence of this is a considerable increase in the economic cost of cleaning and the collection of greater volumes of rubbish generated and its transportation to landfills. Paradoxically, these kinds of initiative create a considerable environmental impact by causing the removal of large amounts of sand, compacting sediment and leaving them in situations of greater vulnerability to coastal erosion phenomena.

Coastal councils need to find reasonable ways of cleaning beaches that reconcile economic exploitation with environmental conservation. Whenever possible, the first option should always be to allow the debris to remain, precisely because of its important environmental and beach protection role.

The effectiveness of this option can be enhanced through information/ awareness-raising campaigns that highlight the fact that, in terms of hygiene and

A container with a significant amount of sand and pebbles ready for transportation to the landfill. ▼



health, the scientific data shows that plant biomass accumulated on beaches does not pose a hazard to human health. On the contrary, in certain areas, these build-ups are exploited as a resource in thalassotherapy.

The removal of debris can be carried out exclusively on beaches that no longer fulfil an ecological function, such as those with an absence of dunes or whose morphology has been affected by human intervention (artificial beaches), or urbanised beaches that are intensively used by tourists. Cleaning operations should, however, still strictly follow recommendations to prevent loss of sand in the removal process. In these cases, removal should be limited to the summer season, from May to October, although it is recommended that this be shortened from June to September for Spain's Mediterranean coast. Removal should be avoided during the winter and spring when storms are more likely to occur and the presence of debris is necessary to reduce the effect of waves on the beach.

In terms of removal and storage, the following recommendations are made:

- The impact of cleaning operations can be reduced by using machinery with claws to enable the sediment contained in the debris to percolate through and ensure that most of the sand can be returned to the beach.
- The use of heavy machinery should be limited and

regulated in order to minimise the impact on the morphology of the beach.

- Mechanical cleaning should only be performed if the surface is dry, about 7-10 cm.
- It is recommended that the material removed is sifted. Similarly, a 10 cm-thick layer of *Posidonia oceanica* should be left on the beach to limit sand loss.
- On beaches with dunes, areas near the dunes (3-5 m) should be set aside for manual and selective cleaning.

TO CONSIDER

WHEN SHOULD ALGAE AND MARINE PLANT DEBRIS BE REMOVED?



- On beaches with pebbles and coarse sand, debris should not be accumulated arbitrarily; the waves should perform this role. In the event of alteration of these materials, the pebble base of the beach should be restored to increase its thickness so that the bottom of cliffs and coastal plains are protected.
- It is recommended to implement control systems for cleaning operations to prevent fraudulent activity and systematic extraction of sand for unauthorised uses.
- Regarding the removal of *Posidonia oceanica* debris, it is preferable to create temporary storage sites for the leaves to enable decomposition until it is suitable for use as a soil improver. The recycling of *Posidonia oceanica* debris should partly offset transport costs and avoid landfill charges at MSW plants.
- It is also recommended that drivers of cleaning vehicles should undergo training courses as their level of skill has a decisive effect on reducing the amount of sand removed.
- Management measures could include the requirement of assessing environmental impact before the debris removal process is permitted.
- On beaches with severe erosion that are inaccessible or less frequented by bathers, the biomass could be transported to remote areas of the beach. This could even be carried out seasonally with debris moved during the summer and returned during the winter.

- The final recommendation is that there should be an increase in environmental education activities, as user behaviour directly affects the amount of waste generated on beaches.



Storage and transport of *P. oceanica* beds ▲

WHAT ARE THE POTENTIAL USES OF ALGAE AND MARINE PLANT DEBRIS?

In the Mediterranean, there is evidence of various traditional uses of *Posidonia oceanica* debris, mainly the leaves. This raw material was not treated or manipulated in any particular way; it was just collected from the beach and used. Such was the case with the use of the leaves for packing glass and ceramics, and even fresh fish in markets.

In North Africa, it was used for roofing, in Tunisia, its fruit was consumed by livestock, while in Egypt, the leaves were used to cure skin and throat conditions.

Nowadays, most of these traditional uses have died out, except for its use as bedding for livestock due to its antifungal and bug repellent properties. In some places, marine algae and other plant elements are dried and subsequently used as fertiliser.

Several reutilisation initiatives exist for *Posidonia oceanica*, in which no industrial processing is carried out. Such is the case with the town of Santa Pola in Alicante, where *Posidonia* and algae are used for sealing landfills and recovering green areas. In various places (e.g. the Balearic Islands and Albufera in Valencia), it

is used to stabilise dunes. Feasibility studies are also being carried out to determine whether it can be used for the reforestation of native species found in salt water environments and forest species that can exist in areas with high levels of salinity, due to the high silicon content of this marine plant.

This debris has been widely used to make compost, as is the case with a recycling plant in Denia (Alicante), and even commercialised in countries like Greece since 1999. Before it can be used, it has to undergo a number of preliminary steps (washing with fresh water, storage and drying through natural aeration, etc.) in order to remove sand, salt and humidity.

Research is currently being carried out into processing techniques for converting it into materials with various industrial applications. These include studies of its properties as a building material undertaken in Germany by the Fraunhofer Institute for Chemical Technology (ICT). *Posidonia oceanica* from Tunisia is used to obtain materials for the manufacture of building panels and other architectural uses. One of the main properties of *Posidonia* fibre is its ability to



Interior panels made of *posidonia oceanica* ▲

store 20% more energy than wood or wooden products. Also noteworthy are its insulating properties, since it is practically fire-resistant, low in salt (2%) and highly resistant to processes of microbial degradation due to its structure being practically free of proteins. Its very consistency makes it easily malleable and it does not require chemical processes to ensure its effectiveness.

In industrial applications, its health properties are also valued because it does not contain toxic or waste materials, making it particularly suitable for people with allergies.

The Fraunhofer research centre in Germany currently has projects to develop solid sheets made from this material with the aim of creating complete insulation systems for roofs, facades, interior walls and basement ceilings.

Various European research centres are studying the physicochemical properties of *Posidonia oceanica* for industrial, pharmaceutical and environmental applications. Below are some of the potential applications:

- From the leaves of *P. oceanica*, an extract with good antioxidant, anti-diabetic and vasoprotective properties can be obtained (Gokce & Heznedaroglu, 2008).
- *P. oceanica* fibres can be used as an activated carbon precursor for environmental purposes (Ncibi *et al.*, 2008).

- *P. oceanica* fibres have a significant capacity for adsorption and removal of dissolved phosphorus, thus making it suitable for agricultural applications (Wahab *et al.*, 2011).

These current applications and potential uses that are still in experimental phases therefore show that the disposal of these materials in landfills should be the last resort.

TO CONSIDER



7

HOW CAN POSIDONIA OCEANICA DEBRIS BE USED IN MATERIALS MANUFACTURED?

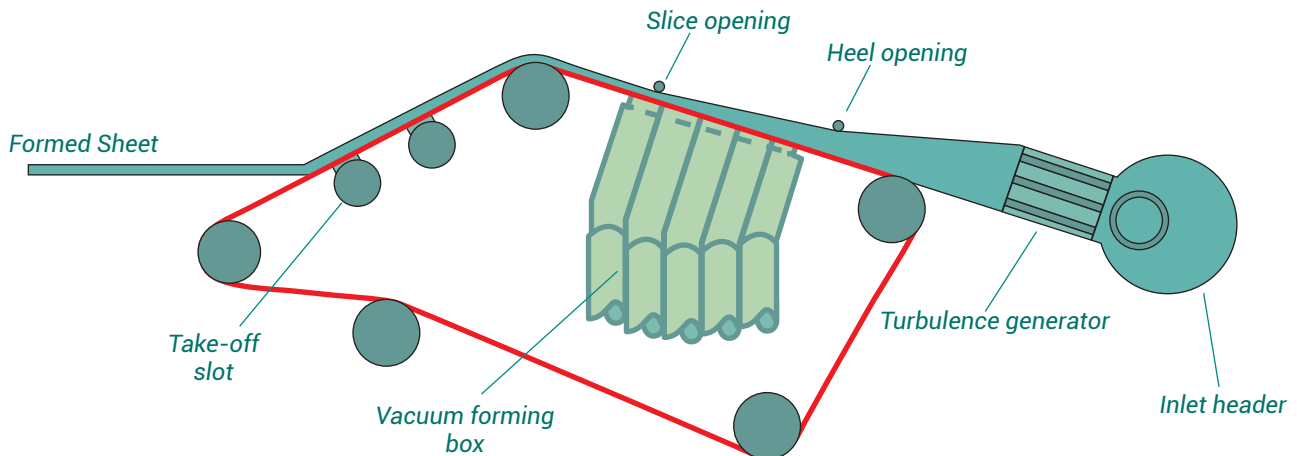
In recent years, there has been a growing interest in the development and use of materials from renewable resources. This interest has also reached technological sectors that are closely involved in sustainable development, such as construction, automotive, transportation, etc. *Posidonia oceanica* debris can be used to manufacture materials that respect the environment while adding ecological value to the final articles made from this raw material. Specifically, in the development of soundproofing panels made from renewable sources, marine plants and biopolymers can be transformed, by means of wet-laid technology, into nonwoven structures that are used as a textile reinforcement for composite materials.

The *Posidonia* directly collected from beaches contains large amounts of salt, sand and stones of different sizes, making it difficult to process. Its size is also excessive for processing in the wet-laid pilot plant. For correct processing, it needs to be cleaned to remove the accumulated sediment, dried and shredded to obtain a suitable material that can be correctly processed in the pilot plant and used to manufacture perfectly functional nonwoven material.



As soon as the *Posidonia* is in the appropriate state, it can be used to manufacture nonwoven material by means of wet-laid technology. This is a widely used process in the paper industry to consolidate the leaves or sheets. This technology can also be transferred to other sectors with the use of a wide variety of basic materials for web formation. This technology is based on a process in which textile fibres are suspended in an aqueous solution, and then deposited on a conveyor

belt that carries the sheet to a station that consolidates the nonwoven fabric. The sheet of randomly orientated fibres leaves the conveyor belt where it is formed to reach a pressing system by means of rollers which removes and recovers some of the excess water contained in the sheet. The material is then dried and spooled.



▼ AITEX wet laid pilot plant ▼

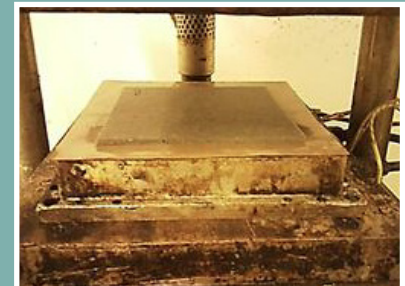


The concentration of residue and thermoplastic fibres should enable handling of the nonwoven fabric used as reinforcement for obtaining soundproofing panels by means of thermocompression processes. This process enables the consolidation of the web layers obtained until the formation of panels of composite material with high rigidity and excellent acoustic insulation properties. The consolidation process requires moderate pressure and temperatures above the melting point of the binder fibre. Thus, the thermoplastic fibres melt and flow into the cavity of the metal mould absorbing all of the natural fibres. The pressure enables the panel to be compacted. After a while, it is cooled to enable the thermoplastic matrix

that has absorbed all of the fibres to solidify and the panel to be removed.

Biocomposites, developed from marine plant debris, have exceptional soundproofing properties and are more environmentally friendly than existing materials on the market, thereby providing added value to the final product.

COMPRESSION MOULDINT PROCESS



REFERENCES

- Battiato, A., Cinelli, F., Cormaci, M., Furnari, G. & Mazzella, L., 1982.** *Studio preliminare della macroflora epifita della Posidonia oceanica (L.)* Delile di una prateria di Ischia (Golfo di Napoli). *Nat. Sicil.*, 1: 15-27.
- Gokce, G. & Haznedaroglu, M.Z., 2008.** *Evaluation of antidiabetic, antioxidant and vasoprotective effects of Posidonia oceanica extract.* *Journal of Ethnopharmacology* 115 (2008) 122-130 pp.
- Luque, A. A. & Templado, J. (Coords.), 2004.** *Praderas y bosques marinos de Andalucía.* Consejería de Medio Ambiente, Junta de Andalucía.
- Ncibi, M.C., Jeanne-Rose, V., Mahjoub, B., Ehrhardt, J.J., Bercion, Y., Seffen, M. & Gaspard, S., 2009.** *Preparation and characterization of raw chars and physically activated carbons derived from marine Posidonia oceanica fibres.* *Journal of Hazardous Materials* 165 (2009) 240-249 pp.
- Wahab, M., Rafik, B. H. & Salah, J., 2011.** *Removal of phosphorus from aqueous solution by Posidonia oceanica fibers using continuous stirring tank reactor.* University of Carthage, Water Research and Technologies Centre (CERTE), Wastewater Treatment and Recycling Laboratory, B.P. 273, 8020 Soliman, Tunisia b International Environmental Green Technology (IGET), Tunisia. *Journal of Hazardous Materials* 189, 577–585 pp.



seamatter

SEAMATTER: The exploitation of algae and marine plant debris by the textile industry with applications in products such as soundproofing panels for buildings.

The main objective of Seamatter is to demonstrate and validate the exploitation of algae and marine plant debris that builds up on beaches for industrial purposes. This natural debris, derived from marine biomass, can be used as a nonwoven structure by the textile sector and converted into a sustainable textile reinforcement that is suitable for use by the composite materials industry, specifically as soundproofing panels for buildings.

The project is coordinated by the Textile Technology Institute (AITEX) with head office in Alcoy, Alicante in collaboration with Spanish partners Fundación Instituto de Ecología Litoral (IEL), the Asociación de Empresarios Textiles de la Comunidad Valenciana (ATEVAL), and the Italian partner Università degli Studi di Perugia (UNIPG).



www.aitex.es



www.ecologiailitoral.com

ATEVAL

www.atevalinforma.com



www.unipg.it

