WACA Resilience Investment Project

Call for Innovation

The issue of coastal degradation in West Africa

Aerial view of Bargny, Senegal. Photo: Vincent Tremeau/World Bank

It appears that some beaches of West Africa suffer coastal degradation. This Call for Innovation launched by the World Bank Group under the West Africa Coastal Areas Management Program (WACA) aims to collect innovative solutions to reduce the impact of large commercial ports on sediment movement and coastal erosion.

ECOPLAGE.SA is fights against beach erosion around the world since 1996 with an innovative solution: the beach dewatering system. In addition, the seawater from drainage can be used for many applications.

1) A fortuits discovery

The North Sea Research Center was constructed at Hirtshals on the west coast of Denmark in 1981. The center included aseawater aquarium. These facilities required large volumes of filtered sea water as did the Center's 'heat pump' heating system (total: 400m^3/hour).

The Geotechnical Danish institute GEO was challenged with finding a suitable solution to fulfil the requirement for clean sea water in the necessary quantity. The GEO's engineers thought of draining the beach and use the filtering properties of the sand. The following sea water intake design was finalised: a 'horizontal' well, with slotted well pipe surrounded by filter gravel complying with the filter criteria for the natural beach deposits.

The sea water drain was installed in August-September 1981. The system produced crystal clean sea water in a quantity of 460m_3/hour and a quality that could fit with the standard requirements for drinking water (except from the salinity).

A reduction of the drain flow was registered by March 1992. Investigation indicated that the drain itself functioned as intended and, that a significant accretion of sand had taken place over and seawards of the system. It was also shown that the coastline had moved 20 to 30 metres further seaward in front of the drain.

Consequently, it was decided to lengthen the existing system. This new section was activated by November 1982. Monitoring surveys showed significant accretion of sand over and seaward of the total drain length and that the shoreline had apparently stabilized some 25 metres in front of the drain position. This system provided for a sufficient amount of clean sea water to the North Sea Center.

By then it had become obvious that that the pumping of water from the beach deposits was the primary process behind the registered changes and that a relocation of the drain structure would not solve the problem.

After this discovery in Denmark, some beach drainage systems have been implanted in Denmark, USA, Japan, Spain, Germany, Italy, Malaysia and Sweden.

2) The ECOPLAGE company

In 1996, Carl Linderoth created the ECOPLAGE company in France. His goal was to install three experimental beach drainage systems: one on each coasts with their own environments:

- Channel and North Sea coast (macro to megatidal environment, from reflective to dissipative beaches)
- Atlantic coast (meso to macrotidal environment, more or less dissipative with or without ridge beaches)
- Mediterranean coast (microtidal environment and reflective beaches).

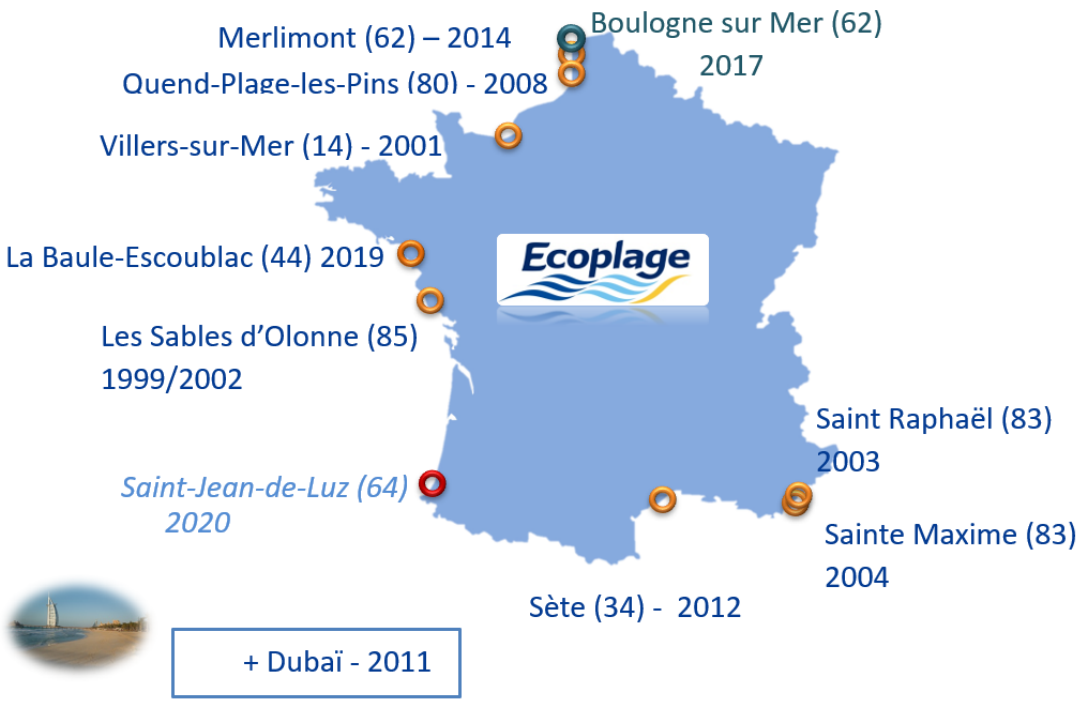
The three pilots' installations realized by ECOPLAGE were:

- "Les Sables d'Olonne" on the Atlantic Coast in 1999,
- "Villers-sur-Mer" along the Channel Coast in 2003
- "Saint Raphael" for the Mediterranean system in 2003

Theses beaches have been monitored during 3 years by local university. The results was successful.

Since 1996, ECOPLAGE study and design projects on the five continents, France, Portugal, United Arab Emirates, Egypt, Cape Verde etc. These projects mainly focus on coastal erosion problems and therefore beach reclamation and stabilization. On the other hand, ECOPLAGE also study the valuation of seawater collected by the dewatering process as a source for fresh water, heat or cooling, as a source of seawater for aquariums, pools.

Since 1996, ECOPLAGE has implemented 11 beach drainage systems: 10 in France and 1 in Dubai: 7 only with the beach stabilisation goal, 2 only as a seawater intake and 2 that combine the fight against erosion and the use of the seawater.



ECOPLAGE develops and registers patents related to beach drainage for these various uses mentioned above.

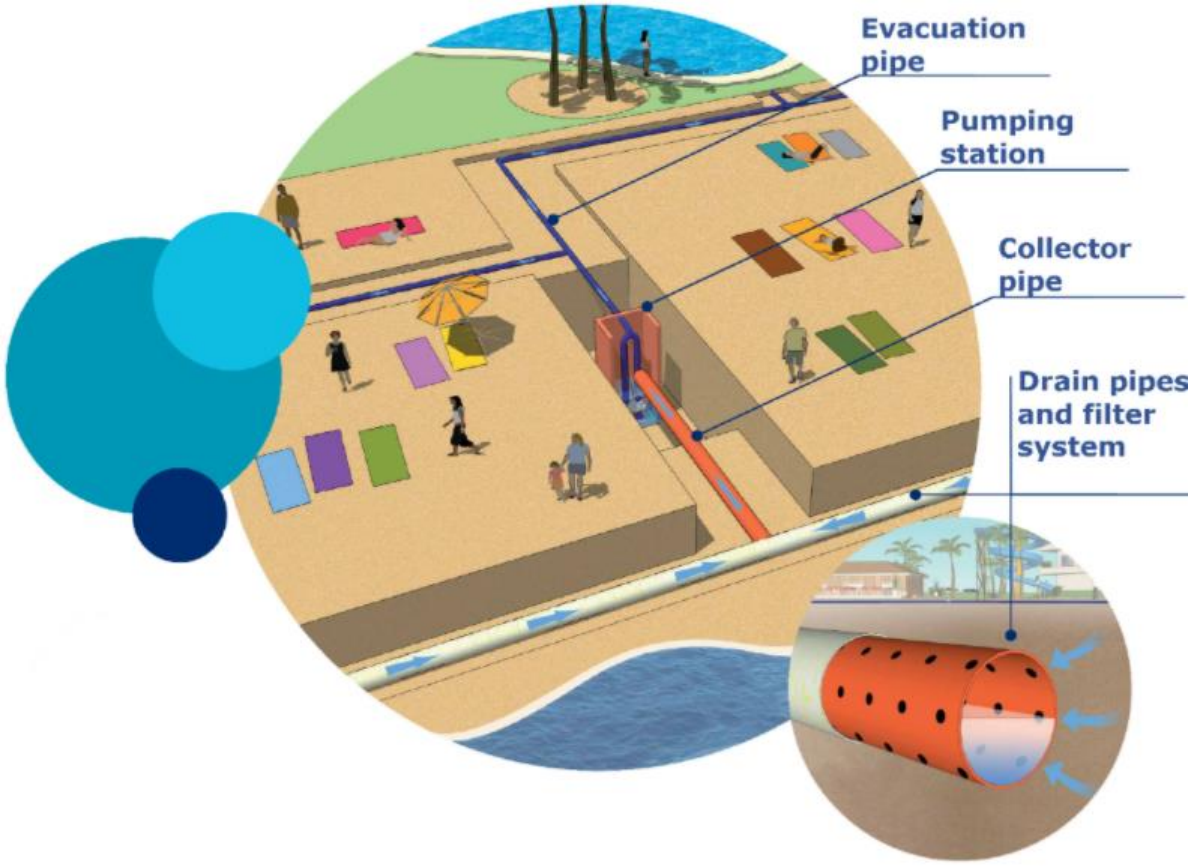
ECOPLAGE works with the public sector (municipalities, inter-communal bodies..) and the private sector (hotels, industries..).

ECOPLAGE usually offers an ecologically friendly turnkey solution project: we perform feasibility and design studies on site and then install the systems with the support of local companies when we work out of France.

3) Ecoplage®

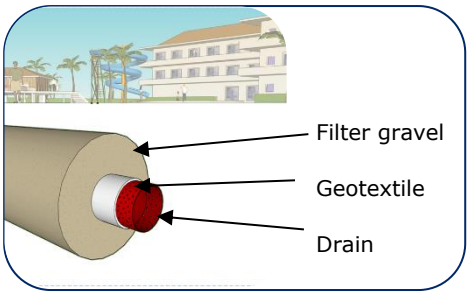
The Ecoplage® system consists of :

- **One or several drains** installed beneath the beach, parallel to the coastline. The sea water infiltrates the drains by depression, insuring the desaturation of the sand and therefore a good attraction of the sediments on the upper part of the beach.
- **Collector pipes and transport pipes** which ensure that the sea water coming from the drains flows by gravity to the pump station.
- **A pumping station** aimed to evacuate the filtered sea water. This water, perfectly clean, can be rejected to the sea or used for neighboring structures in need for filtered sea water supply (desalination units, pools, aquariums, Thalassa, pisciculture …).



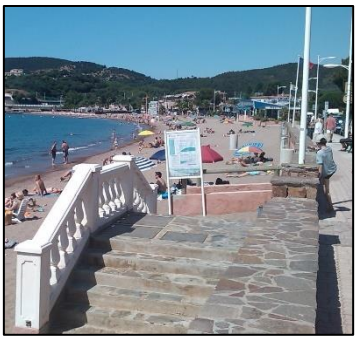
The drains are positioned parallel to the coastline at an optimised depth to ensure their safety according to the morphological variations of the beach over time and during storm conditions, and to allow sufficiently efficient drainage.

The drains are surrounded by a layer of geotextile and a layer of filter sand to ensure filtration and prevent clogging. All the parameters of the drain (frequency and size of the openings), the geotextile and the filter sand are adapted to the granulometry of the beach in the area to be protected and to the possible need for water.



The combination of both filters, the natural sand of the beach and the drains and their own filtration system, produces very **high filtered seawater**.

Like the drains, the collectors are also buried under the beach.



In order to make the system as less visible as possible, and not to denature the landscape, **the pumping station** is as much as possible integrated into existing infrastructures: stairs (St Raphael – photo on the left), old pumping station (La Baule), seawall (Merlimont)... or is buried (Dubai, Sète).

From the pumping station, the seawater can be evacuated to infrastructures with need (oxygenation of a lagoon, desalination plant...). If there are no needs or if those needs do not use all the water, an discharge outlet must be installed. This outlet is also integrated in existing infrastructures as much as possible: groynes (Sète), dyke ... If this is not possible, an **outlet** is created at the bottom of the foreshore as descreet as possible. It is configured so that the water can drain homogeneously around it without creating disorder on the foreshore. On the picture on the right, you can see the outlet of the Merlimont system (France).

Each system is unique and adapted to the beach, the environment and the needs (fight against erosion, need for sea water...) .

Following the installation of a system, the pumping station must be monitored and maintained. The beach must also be monitored to verify that there is sufficient sand cover above the system.

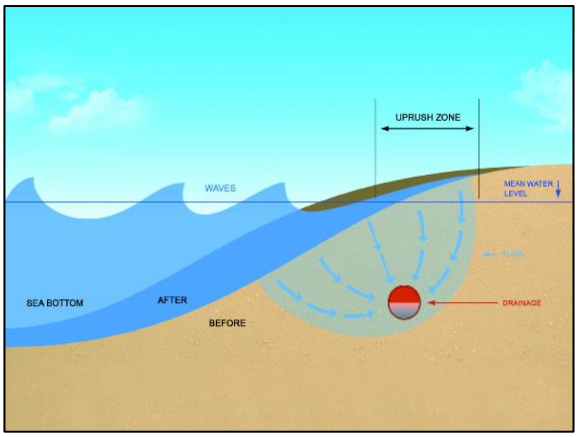
4) A large field of applications

a. Fight against erosion

Ecoplage® can considerably reduce, or even, stop coastline and facilitates a natural accretion of the beach.

How does the beach drainage stop erosion? It lowers the level of the water table under the beach and it promotes the flow of the sea water toward the drains. These phenomena lead to beneficial effects for the beach:

- It stabilizes the sediments on the beach
- It increases the deposit of sediment transported by the waves thus promoting infiltration
- It decreases the export of sediment caused by the flow of the water from the grounds (land to sea)
- It decreases the strength of back wash of the waves
- It promotes a rapid recovery after storms
- It increases the effect of the wind promoting the accumulation of the sand at the feet of the dunes and the sea wall. This formation of sand reserves that can serve as e buffer stock for future storms



In a nutshell, Ecoplage® increase the resilience of beaches.

Environmental Benefits	Social Benefits
- It stabilizes the coastline and protects beaches - It is invisible and silent - It respects the fauna and flora - It promotes natural mechanisms - It has no negative impact on neighbouring shorelines	- It protects the infrastructures, houses, and lands - It optimizes the surface area of the beach that can develop tourist accommodation capacity

b. Using sea water

The Ecoplage® process produces a significant quantity of filtered sea-water, of which its impurities are removed by the sand. Numerous applications are possible, according to the business located near the installation site and local needs.

Using Ecoplage® as a water intake:

- Reduce the investment because there are no submarine works
- Remove the costs related to seawater prefiltration steps thanks to the natural filtration of the sand of the beach and the drains and their own filtration system. It provides a high filtration seawater

i. Sea water

The high filtered sea water recovered by the drains can be for various applications:

- Oxygenation of lagoons, harbour, marina, … It has been done in Dubai
- Supplying swimming pools, sea spa, thalassotherapy…
- Feeding the basins for **fish / shellfish farms** and **marine centers**

Environmental Benefits	Economical Benefits
- No negative impact of the water intake on the fauna and flora - No negative impact on the neighbouring shorelines - Invisible and silent	- Removal of the costs related to seawater prefiltration steps - using this water for tourism projects or professional activities related to sea farms

ii. Air conditioning

This high filtered sea water can also be use to feed a heat pump to produce heat or cool.

Using the seawater heating technology consist in using the sea heating capacity to heat or cool coastal infrastructures.

Combined with a heat pump, the Enerplage® is a **positive energy** beach protection system: the system allows the **recovery of 10 times the energy** needed for drainage while protecting the beach against erosion. It participates in **reducing the GHG emissions**.

Thanks to the dewatering system, it removes the risk of exchanger filter plugging.

Environmental Benefits	Economical Benefits
- No negative impact of the water intake on the fauna and flora - No negative impact on the neighbouring shorelines - Invisible and silent - Reduction of GHG emissions - Using local resource for energy	- Heating and/or Cooling coastal infrastructures - Meeting growing energy needs enhance by demographic pressure

iii. Drinking water

This high filtered sea water can also be used to feed a desalination plant. Desalination is a process that takes away mineral components from saline water.

Environmental Benefits	Social Benefits
- No negative impact of the water intake on the fauna and flora - No negative impact on the neighbouring shorelines - Invisible and silent - Using local resource for drinkable water	- Feed the population with drinkable water

5) Studies and Works

Before any work, studies are necessary to know the feasibility and to design the project.

As a first step, a feasibility study must be carried out to determine whether the installation of a drainage system is possible and whether it will be able to meet the needs (erosion control and/or seawater requirements). This study is carried out in three stages:

- On-site investigation to know the site, the permeability of the sediments, the problems, the variations of the water table, seawater analysis...

- The analysis of the elements collected during the on-site study allows to determine the feasibility or not of a system on this beach.

- The results are presented in a report and can be explained during a presentation.

If the feasibility study is positive, the next step is the design-build phase. A new on-site study may be necessary to deepen some aspects and will be used to establish the final technical specifications of the installation. Then report and plans are delivered to the client.

Prior to the start of work, applications for permits from local authorities for the installation of systems may be necessary. This depends on the legislation of each country.

The duration of the works depends on the length of the drains to be put in place.

The installation of the drains is carried out either with an adapted ploughing machine, or by making a trench with excavators. The choice of the technique depends on the length of the system and the geographical possibilities.

In order to install the drains at a sufficient depth, and for an effective drainage in the fight against erosion, the beach must be a sandy beach. The thickness of sand below the surface must be at least 2m. Pre-engineering studies can identify limiting layers in the lower layers of the beach.

The pumping station is installed as far as possible in existing infrastructures so as not to distort the landscape.

To allow the work to be carried out, the beach must be at least 10m wide for the movement of machinery. The beach must also be closed to the public for the duration of the work, for safety reasons.

About the cost of an Ecoplage® system, it depends of the beach and the size of the system. We can't give you a price range. Instead, we'll give you some examples:

- 2020 – St jean de Luz – France : 300m of drains to nourish a thalassotherapy for pools and cool – 405 530€
- 2019 – La Baule-Escoublac – France : 950 m of drains to fight against erosion and nourish the swimming pool for pools and cool - 1 500 000€
- 2014 – Merlimont – France : 900m to fight against erosion - 1 400 000€

6) A scientifically validated system

The scientific monitoring provided on the 3 pilot installations by regional Universities showed without ambiguity that the system is an efficient method for the control of erosion, stabilisation and even sandy beaches reconstruction.

Each beach and each situation are different. That’s why each system is different. The next two examples will show two different possibilities to fight against erosion and using dewatered water.

a) Madinat Jumeirah – Dubai

The Jumeirah beach is 1400m long and 80m wide. It suffered from severe erosion on a 1000m long section south of the beach. There was a negative sediment budget of 30 000m3/year and the retreat of the beach was from 5 to 10m/year locally. The beach was regularly nourished of approximately 60 000m^3 every 2 years with external materials.

In 2011, there was a 56 000m^3 of sand recharging and installation of a 950m long Ecoplage® system.

Since, the beach appears to be stable. The accumulating part north of the beach compensate the eroding southern beach with a simple back pass. There is no need of external sand nourishment. There the beach has a gentle slope and there is no more erosion cliff.

Moreover, the produced water is used to oxygenate the lagoon.

b) La Baule-Escoublac – France

La Baule-Escoublac is a famous french seaside town. The center of the beach suffered from erosion.

During the winter 2018/2019, they have set up a 950m long Ecoplage® system on the section concerned by erosion. Moreover, they were in the process of completely rebuilding the city's aquatic complex.

Therefore, the aim of the project was to fight against erosion on 1000m long beach section and to supply the aquatic centre with sea water for the pools, the spa, but also to heat and/or cool the water and the buildings.

Over the 1000 linear metres to be protected, the drying out is visible. A topographical monitoring of the beach is in progress and should bring these results soon. The system recovers up to 900m^3/h of drained seawater. The La Baule swimming pool uses a maximum of 100m^3/h.

7) Ecoplage® in West Africa

West Africa is a region of the world in which ECOPLAGE is certain to have its place. Indeed, we have already carried out a study on the erosion of certain beaches in Cape Verde, we are in contact with private clubs in Senegal ...

Coastal areas are home to 31% of west Africa's population and generate 56% of the GDP [WACA]. These values will tend to increase in the coming years despite the problems of coastal erosion, of sea-level rise, …

ECOPLAGE could fight against erosion and thanks' to drained sea-water meeting the increasing needs for energy, drinking water ... on the coast. This seawater could also be used by the fishing industry with the creation of fish farms, or could be useful for tourism development…

Example:

A harbour creates erosion on the shoreline and suffers from silting. The harbour sediment can be dredged and used to recharge the eroding beach. This nourishment can be stabilized by draining the beach. Seawater can be used to cool a fish market, for desalination, or to create water circulation in the harbour or lagoon. If the harbour is blocking the sediment too intensely, a back-pass should be considered.

Financially, the system can be ordered by a community to limit erosion, and the seawater can be resold for private uses: resort, harbour, desalination company, etc. A resort could command a system to protect the beach in front of its hotel and use the seawater to feed its pools and cool the hotel. …

Ecoplage could respond to an environmental problem while reducing societal pressure, and increasing the economic opportunities thanks to the seawater from the dewatering system.