

Proposed Innovation for 'WACA Call for Innovation: Impacts of Port Development on West Africa's Coastal Areas'



WAC-App is an open-access, easy-to-use, interactive online application that gives insight into the effects of coastal interventions. It combines the predictions of the new coastline evolution model **ShorelineS** with the computational and data options of **Google Earth Engine**. WAC-App allows for easy impact assessments of coastal measures and supports decision making at different spatial and temporal scales. WAC-App allows users to get more insight in long-term coastal development and thereby facilitates communication between decision makers, technical experts and other stakeholders.

Key features of WAC-App

Easy-to-use

WAC-App provides clear visualizations of impact of coastal interventions, and it can be applied by users without technical background in flow dynamics or coastal morphology.

Innovative

WAC-App combines the new coastal evolution model ShorelineS, which has been thoroughly tested and validated, with an online graphical user interface that allows easy operation and interpretation of results.

Practical

WAC-App gives insight into the impacts of coastal interventions and allows users to compare coastal intervention options. Thereby, WAC-App can help in public engagement and decision-making processes related to coastal erosion, development and planning.

Flexible

The application will be set up in a flexible way such that future expansions can be easily implemented. These extensions could include additional intervention types (including Nature Based Solutions), other geographical areas, climate scenarios and socio-economic impacts.

Implementation

Key components of WAC-App are already available. A version of WAC-App with basic functionalities requires 3 months of development and costs around \$50.000. A further investment of \$160.000 allows development of expanded functionalities, which can be ready after another 9 months.

Open Course Ware

WAC-App will be accompanied by an online Open Course Ware, demonstrating its use for a case in Nigeria or Senegal.

Adaptable to local expertise

WAC-App makes use of predefined coastal conditions for the entire WACA-region. However, local adjustment of the baseline conditions are possible.

Cloud computing and open access

WAC-App is open-access, has no licensing costs and operates entirely in the cloud.

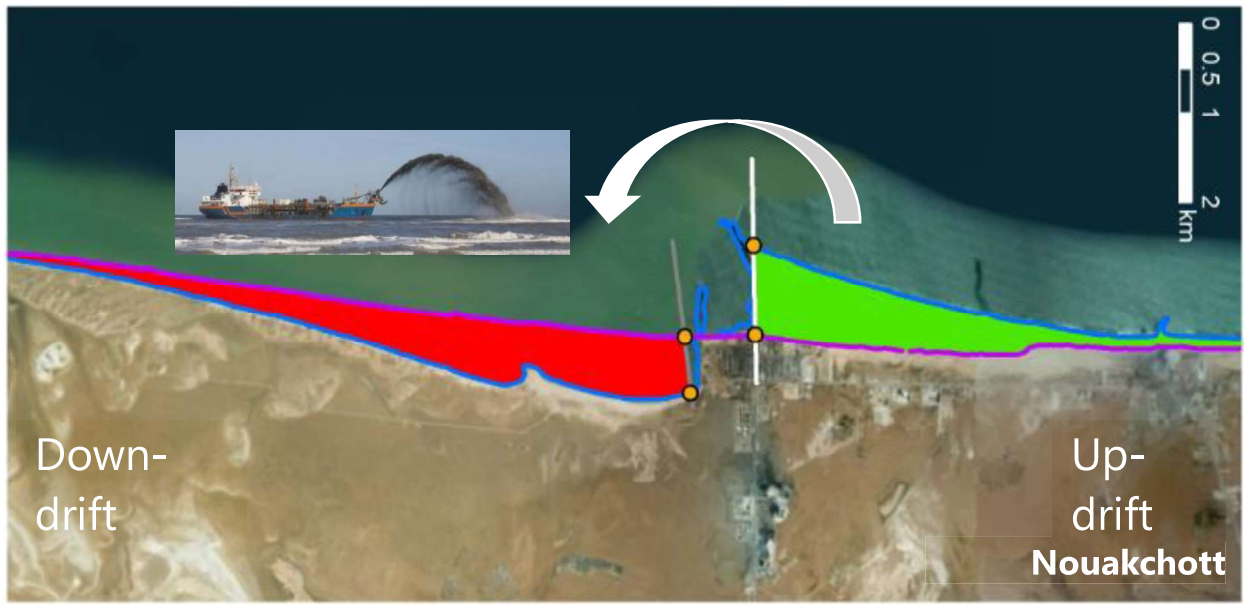
TRANS-SAND: A TRANSNATIONAL BY-PASSING SCHEME FUNDED BY A PUBLIC-PRIVATE DREDGING FUND

In order to tackle coastal erosion adjacent to seaports in West Africa, we propose to **restore the sand balance** through the implementation of a **sand bypassing scheme**. This solution, based on proven technology, will have direct benefits for the ports (less sedimentation) and coastal communities (less erosion). The solution is scalable to multiple West African seaports, experiencing erosion problems. The innovative aspect of this solution is to capture scale benefits by means of a **regional cooperation** between countries and ports by operating combined dredging capacity in a **public-private dredging consortium**. This operation will be principally funded through a **public-private pooled dredging fund** financed by port operators/authorities and other stakeholders. Reduced maintenance dredging costs for the ports will be used to finance sand nourishments to mitigate coastal erosion. If additional funding is required to complete a bypassing scheme, a compensation mechanism will be applied, following the “polluter pays principle” to the amount that the erosion mitigation cannot be funded by other beneficiaries. Key for the success of the solution is the setting up of a robust, independent and regularly evaluated governance regulated by an international institution.

We estimate the preliminary costs of the solution between 63-66.8 M€ compared to 81.1 M€ if nothing is done (due to erosion damage) and 125 M€ for a conventional dredging and sand nourishment approach for each port individually. Our solution becomes more attractive when more ports/countries participate and with growing sediment volumes that are expected in the future for climate change adaptation. As a pilot it seems logical to select 2-3 ports that are relatively close to each other, for example Lomé, Cotonou and Lagos.

The highlights of our solution are:

- **Innovation:** a transnational sand bypass and the proposed governance/financial setup is unprecedented as it aims at applying the “polluter pays principle” for coastal erosion in a mitigated and acceptable way thanks to dredging costs mutualization and optimized coastal erosion management.
- **Feasibility:** sand bypass is a robust, proven technology. Although setting up the transnational dredging consortium is more challenging, successful national benchmarks confirm its expediency: expected cost savings will create the necessary interest to attract local partners.
- **Impact:** sand bypass will have direct results through reduced erosion and port sedimentation. By taking the morphological system as a starting point instead of local ad-hoc ‘fixes’, we believe that our solution will also have a **long-term positive impact** on coastal dynamics with the restoration of the natural sediment budget.
- **Co-benefits:** cost savings will be achieved through a shared interest between ports and easier access to state-of-the-art dredging technology. Additional co-benefits are involvement of local communities in the implementation of the project, natural habitat restoration and sustainable knowledge transfer.
- **Implementation Readiness:** being based on robust and proven technology with a track record in other countries, the solution is implementation ready. It is scalable in time for upscaling to climate change and in space for including gradually more ports and/or increasing the size of the sand nourishments, which allows the governance structure to be gradually developed within 3-5 years.



SA-PoD Systems Approach for Port Development

Port developments around the world, West Africa included, often impact the coastal environment, posing challenges like erosion and degradation of environment with negative socio-economic implications. To develop sustainable ports solutions which are adaptable to climate change and have net positive value a paradigm shift is required from a conventional, economic and engineering oriented approach to a stakeholder inclusive and environmental, social and economic integrated approach.

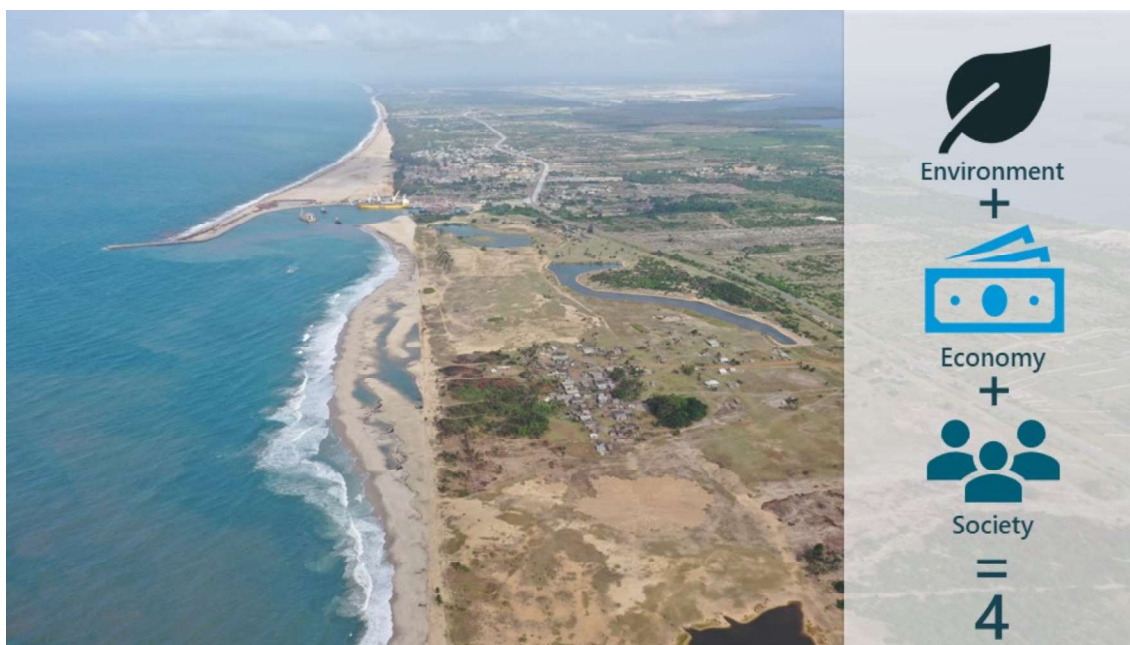
Port developments are complex and require a holistic approach based on thorough system understanding and active participation by all stakeholders. Our approach consists of a systematic five steps process that integrates the systems: **environment**, **society** and **economy**.

Each step capitalizes on the results from the previous one. They are iterative, achieving a higher degree of detail after every cycle. The focus is different per step:

1. **Problems** and plans (needs and values) are identified for the port project and the larger area surrounding the port.
2. **Processes** in the three systems mentioned above are investigated and the root causes of the problems are determined. Focus on the specific West African context and identify opportunities.
3. **Values** and benefits are investigated, those that are under threat, lost and to be developed.
4. **Solutions** are developed, that are on different scales and are technical as well as non-technical.
5. **Assessment** of the different solutions with existing methods to come to viable, bearable and equitable solutions that are widely supported.

In this process relevant stakeholders are brought together to develop solutions as well as innovative finance instruments to allow for a bankable development which takes into account additional benefits for nature and society.

Figure 1 Systems Approach for Port Development - Sandbar Breakwater (Lekki, Nigeria)



The [Sandbar Breakwater](#)¹ at Lekki, Nigeria is an example of a port development where this approach is applied. The actuation is based on the understanding of the natural system and in particular the coastal processes along the Gulf of Guinea. Given the strong sedimentation at the western updrift side of existing port infrastructure along this coast, sand as construction material seemed very obvious. The large longshore sand transport is used beneficially and formed the basis of the breakwater. This minimised the use of rock and significantly reduced costs and transportation of rock. This resulted in less congestion, traffic accidents and nuisance. The sand nourishment that protrudes from the coast to the east of the port is an integral part of the concept as it prevents erosion and minimises the negative impacts. Through its flexible design it is easy adaptable and can anticipate climate change implications.

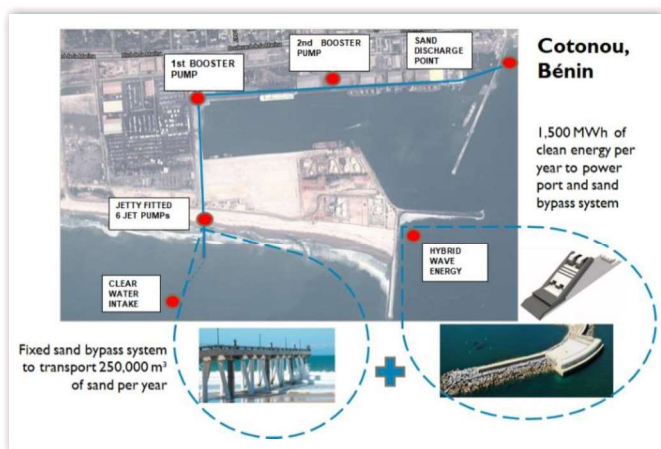
Applying this approach results in inclusive integrated port designs from the beginning where negative impacts are minimised and benefits are co-created. It will also lead to a reduction of the cost, hidden social costs included, during the lifetime for everybody.

¹ <https://www.mdpi.com/2073-4441/12/5/1446>

BESand - The Blue Energy Sand-Bypass System

With BESand, the Blue Energy Sand-Bypass System, IMDC offers a **UNIQUE, INNOVATIVE and FEASIBLE** solution to fight coastal erosion associated with the ongoing development of large commercial ports. In many cases port infrastructure intersects the littoral drift, which leads to erosion downdrift.

BESand's groundbreaking innovation is transferring wave energy back into sediment transport movement. This is achieved by an **integrated concept** consisting of a **multi-purpose breakwater**, a novel **hybrid Wave Energy Converter (h-WEC)** and a **sand-bypass system powered by blue energy**. Port infrastructure becomes thus part of the solution by creating strategic sediment reservoirs and by restoring the natural sediment supply.



The system is **FEASIBLE**, since the sand bypass system builds on existing concepts. The h-WEC concept addresses main barriers and obstacles in the wave energy sector, and is **LOW RISK**:

- Technology: builds on two well understood technologies, a water and an air turbine, which have been around for over a century
- Performance: the h-WEC allows energy harnessing over a wider range of metocean conditions
- Operations: the breakwater offers a solid foundation and access for maintenance and repairs

BESand will be **ADAPTED** and tailored to the site-specific context, to select the most durable and sustainable option. The scale of the port infrastructure, the site conditions, and the client's preference influence the choice of the system. BESand can be **SCALED** up to numerous ports in West Africa or even worldwide.

The main **IMPACT** of BESand is **limiting erosion impacts** of port infrastructure, while **limiting energy requirements, and related operating costs**. The figures in the tables show that based on typical, average numbers the BESand will generate 42 million USD **savings** for the sand bypassing over a 30 years lifetime compared to traditional dredging. Moreover, clean electricity production of three hybrid energy modules of 1,500 MWh per year at 0.20 USD per 1 kWh could result in another saving of 9.0 million USD and preventing 10,000 ton of CO₂ emissions in 30 years.

| Period of operation | Total Volume Bypassed (m ³) | Cost (million USD) | Unit Cost (USD/m ³) |
|-----------------------|---|-------------------------------------|---------------------------------|
| 2025-2055 30 years | 250,000 x 30 =7,500,000 | CAPEX: 12 OPEX: 1,2 x 30 = 36 | 7.2 |

| Beach Nourishment | Fill Volume (m ³ /30 years) | Unit cost (USD/m ³) | Total cost (million USD) |
|-------------------|--|---------------------------------|--------------------------|
| Dredge and fill | 7,500,000 | 12.0 | 90 |
| BESand bypass | 7,500,000 | 7.2 | 48 |

Next many social, economic and environmental **COBENEFITS** are associated with this solution, also reducing the COCED.

Several **FINANCING** instruments can be used such as PPP (involving port operators, government, donors), but also DBFM or other performance-based contracts, so that not only the construction, but also the operation and maintenance is taken care of.

BESand has a **HIGH LEVEL OF IMPLEMENTATION READINESS** as it blends already existing and proven concepts. The timeline for field studies, site conditions, feasibility studies (incl. CBA & SEIA), detailed design with numerical and physical modelling, EIA and permitting till tendering and construction is about 2 to 3 years, which means BESand could be operational in about 3 to 4 years.



***CoastalProtect Africa* – Multi-purpose technology for an integrated solution to coastal erosion and sediment management for West Africa**

Integral Consulting Inc. (Integral) is a leading environmental and engineering consultancy company based in Seattle, WA USA, with a global reputation for delivering successful, high value, multi-partner projects. We have formed a consortium of companies and individuals with a high level of integrity, and the technical and scientific expertise capable of executing the projects in our response to this Call for Innovation. Consortium members are from the United States, Senegal, Tunisia, and the Netherlands. Our Senegalese partners have been involved at all stages of our proposal, and through them we have received valuable feedback from Senegalese stakeholders.

No single remedy can sustainably resolve coastal erosion and sediment management issues in W. Africa – only an integrated combination of innovative infrastructure and management techniques can deliver much-needed coastal resiliency in the region. When our proposed projects are combined, their synergy greatly increases benefits for the entire region in terms of erosion mitigation and enhanced coastal resiliency. In responding to this Call for Innovation, we have provided a number of innovative and sustainable solutions and, for initial implementation, we focus on one **innovative green infrastructure** project, *CoastalProtect Africa*, as a keystone for our integrated solution.

In our *CoastalProtect Africa* project, we provide **a new and disruptive method of extracting wave energy to reduce erosion at the coast, while simultaneously providing much-needed desalinated water and electricity to nearby coastal communities.** *CoastalProtect Africa's* multi-purpose technology will have a clear and measurable reduction in coastal erosion, and is implementable within a 2-3 year timeframe. Highly scalable to other coasts in WACA countries of interest and beyond, *CoastalProtect Africa* will deliver much needed socio-economic and environmental co-benefits. The technology is proven and has undergone extensive testing over several years.

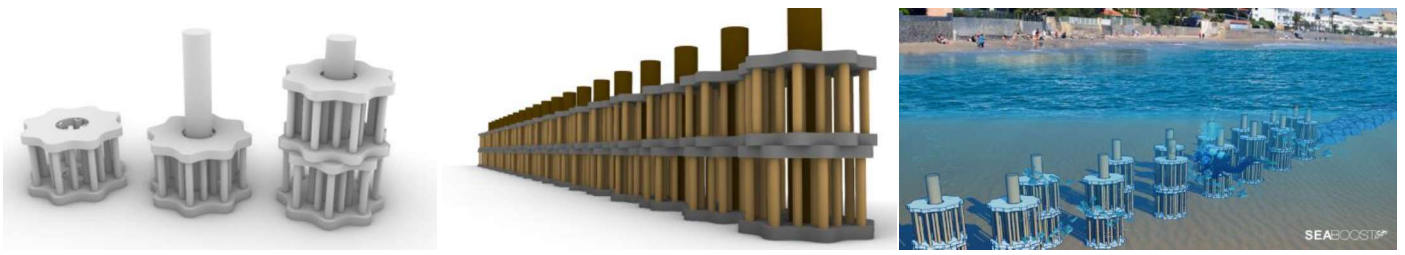
We have selected a site for possible implementation of our *CoastalProtect Africa* project, south of the proposed Port du Futur, Dakar Région, Senegal. We propose installation of a 26-module system that will mitigate coastal erosion down drift of the port development, while supplying 4000 m³ water per day (enough for 48,000 homes) at an estimated levelized cost of \$1.25/m³. Implementation will be in three stages: 1) Feasibility studies and capacity building; 2) Pilot plant deployment; 3) Commercial-scale deployment. Total Project costs are estimated at \$31MM. We envisage Development Funds and Public-Private partnerships (e.g. Green Bonds) as main funding mechanisms. Our partners, Resolute Marine, have already succeeded in raising AfDB funding for a pilot plant, leading to a full-scale development, where the main purpose is desalinated water production in Cape Verde. Further information including detailed cost estimates are provided in our Detailed Proposal.

See: <https://www.youtube.com/watch?v=bXEIFPHMGHU> for a brief overview of how the technology works.



Figure 1. (Left) Pilot *CoastalProtect Africa* module testing in United States; (Right) Schematic of installed *CoastalProtect Africa* system at Ndyane, Senegal

ROOT – NATURE-BASED SOLUTION TO PROTECT COASTLINE, RESTORE MANGROVES, AND GENERATE LOCAL ACTIVITIES AND ECOSYSTEM SERVICES

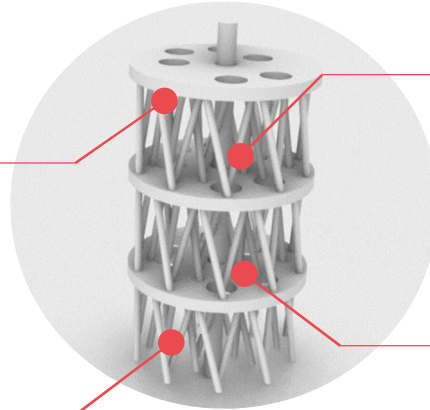


ROOT IS AN INNOVATIVE NATURE-BASED-SOLUTION THAT SUPPORTS MANGROVE RESTORATION THROUGH THE RESTORATION OF SUITABLE HYDRO-SEDIMENTARY CONDITIONS FOR SPONTANEOUS MANGROVE RECOVERY AND REPRODUCES MANGROVE PERFORMANCES FOR COASTLINE PROTECTION.

A solution to mitigate coastal erosion



- An optimal roots density to mitigate waves and currents action.
- A biomimetic structure of mangrove root trees
- A pile of units allowing to reach the desired water column occupancy



A functional solution on an ecological level



- A suitable rugosity for the colonization by the biodiversity
- Creation of a substrate, of habitats and nursery areas for numerous species



- Inexpensive, affordable and locally produced materials (wood, bamboo, concrete)
- Management and exploitation of the infrastructure by local communities

A solution supporting ecosystem services

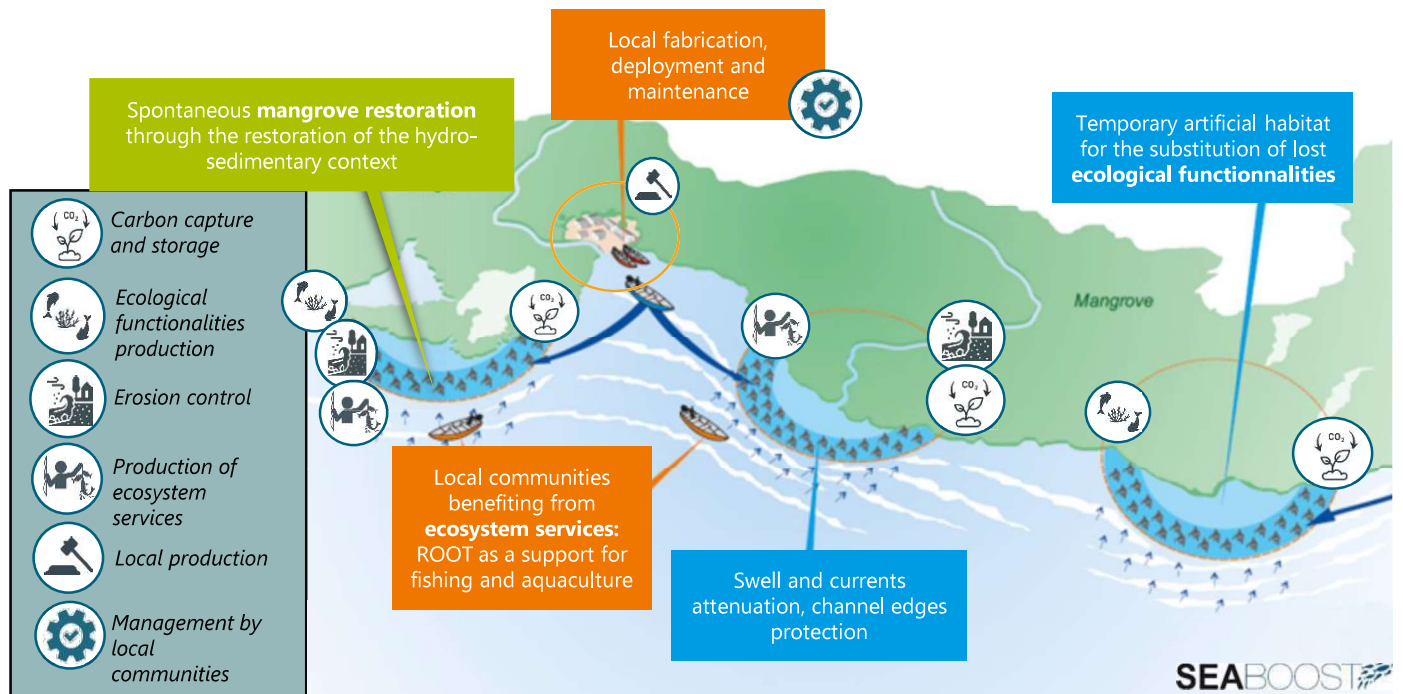


- Reefs supporting shellfish farming
- Reefs creating habitats and nursery areas for commercially important fish and shellfish species



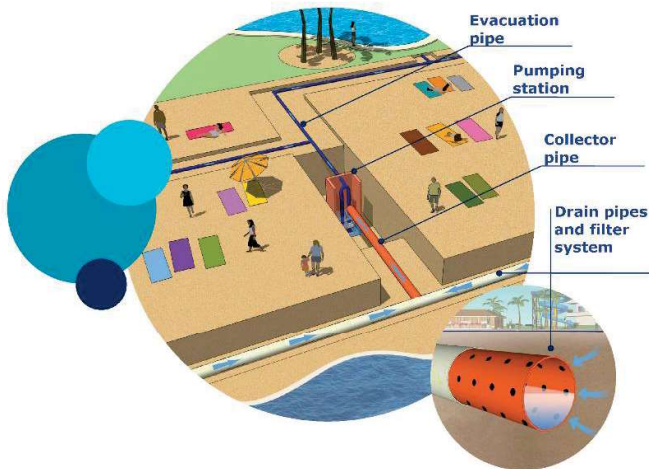
Module complexification with simple, lightweight and potentially versatile add-ons

ROOT RELIES ON THE WORLD BEST PRACTICES TO UNDERSTAND AND MODEL DYNAMICS IN ORDER TO MITIGATE COASTAL EROSION. IT IS A POROUS MODULAR STRUCTURE, WHOSE SETTLEMENT PATTERN AND DIMENSIONS ARE CUSTOM-MADE AND ADAPTABLE TO BEST FIT AND EVOLVE WITH THE LOCAL CONTEXT.



ROOT IS A LOW TECH APPROACH, THAT EMPOWERS LOCAL COMMUNITIES TO PRODUCE, MAINTAIN ,MANAGE AND EXPLOIT THE DEVICES. ROOT DESIGN ALLOWS THE PRODUCTION OF VALUABLE ECOSYSTEM SERVICES FOR COASTAL COMMUNITIES AS WELL AS KEY ECOLOGICAL FUNCTIONALITIES FOR LOCAL SPECIES.

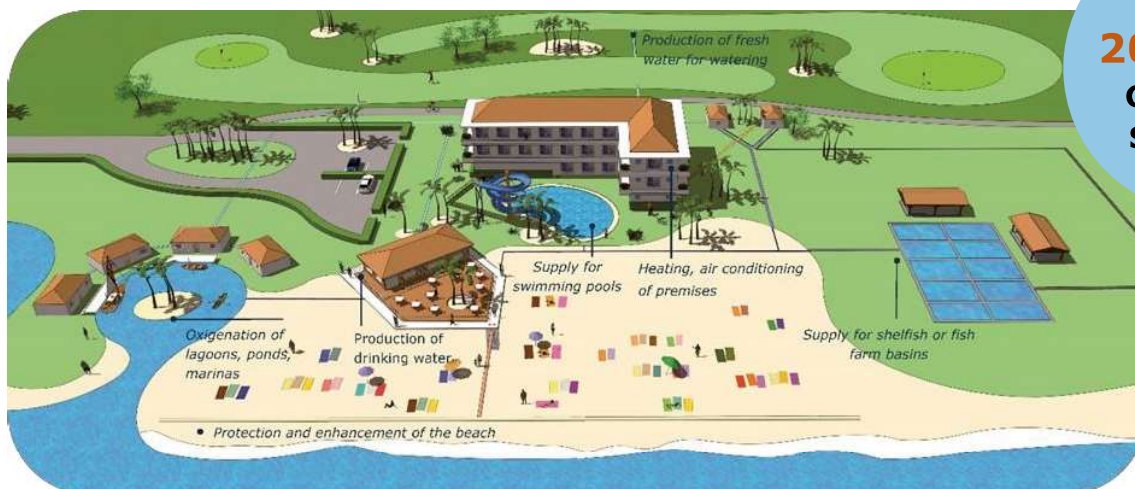
THE PRINCIPLE



The Ecoplage® System consists of:

- ~ **One or several drains buried under the beach**, parallel to the coastline. The seawater infiltrates the drains by depression, insuring the desaturation of the sand
- ~ **Collector pipes and transport pipes** ensure that seawater inside the drains goes to the pump station by gravity
- ~ The **pumping station** is aimed to evacuate the filtered seawater
- ~ **Each system is unique** and adapted to the beach, the environment and the needs
- ~ **Zero negative impact** on the fauna and flora, nor on the neighbouring shorelines

BENEFITS



Up to
2000m³/h
Of Filtered
Seawater

Because of the dewatering of the beach, Ecoplage® can **reduce, or even, stop coastline erosion** and facilitates a natural accretion of the beach.

The combination of both filters, the drains, the beaches natural sand and their own filtration, produces a significant quantity of **highly filtered seawater**. It is a sustainable system that works and helps reduce energy consumption and therefore costs. Numerous applications are possible, depending upon local needs:

- **Oxygenation of lagoons, harbours, marinas...**
- **Water supply of water for swimming pools, sea spas, thalassotherapy...**
- **Provide water for basins for fish/shellfish farms and marine centres**
- **Provide a heat pump to produce heat and/or cool infrastructures (AC)**
- **Provide a desalination plant to produce drinking water**
- **Etc.**

Apart from the known environmental degradation, the core issue addressed by the local population is the absence of multidisciplinary cooperation between the stakeholders in-charge. The objective of the current proposal is to suggest different methodologies to manage WA's ongoing challenges.

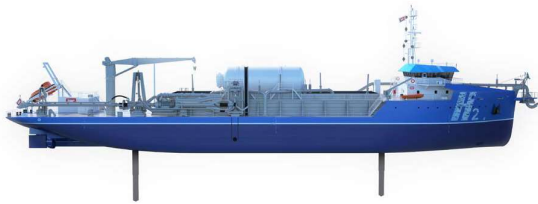
- **Tools for stakeholder engagement:** A holistic stakeholder mapping as the primary step of the management plan. DAPSI(w)R(m) framework would be applied such that, fundamental human needs associated with fisheries, agriculture and trading of goods (drivers) that lead to population migration towards the coast (activities), adding extra pressure to the system, can be clearly identified with a bottom-up method. Hence, gamification is suggested as a game structuring approach, used to effectively manage non-gaming issues. Such an approach would be applied in awareness workshops in the form of role-playing with the different actors in order to understand each other's priorities.
- **Tools for water quality:** In response to the ongoing water contamination, the use of zeolites can be useful to prevent or limit significant ecological damages of coastal lagoons and coastal areas in relation to the discharge of lagoons to the ocean. Zeolite structure allows high ion-exchange and reversible dehydration properties, absorbing and capturing contaminants from the water into their pores. Therefore, it is aimed to test their effectiveness for the purification of domestic water creating wells filled with gravel and zeolite in order to monitor the suitability of the system for reducing the concentration of heavy metals and ammonia in the water, before its discharge into the lagoon.
- **Tools to monitor shoreline changes:** Further involvement of the local population will be achieved with the use of the already developed technology of CoastSnap by UNSW Sydney, which allows the collection of snaps from the public. CoastSnap requires the installation of cradles at a fixed place overlooking the sea, where beach users can deploy their smartphones and take the desired snaps. With the use of these assigned hashtags, they share them through social media platforms where the experts will be able to collect, analyse the footage and thus, obtain a sufficient amount of data.
- **Tools to efficiently manage a potential port expansion:** Taking advantage of the ongoing smartPORT project in Hamburg, Germany, operations regarding land-sea interactions can be optimised using the power of Internet of Things. An application would allow the truck-drivers to track port traffic, suggesting them alternative routes and possible parking areas. Warning sensors through a cloud-based platform, would send information in case of potential incident, as well as, at a further stage the sensors would collect climate data. On the other hand, learning from the project of Clean Port Barcelona, an eco-calculator would be created, to quantify cargo's environmental footprint, calculating various emissions factors, analysing cargo routes and, thus, re-evaluate port's demand.

Securing a multidisciplinary stakeholder participation from all the interested actors is the key for the successiveness of each project. The aforementioned suggestions give light towards the effective inclusion of the local population, either by providing employment opportunities or by involving them in the decision-making process.

SUSTAINABLE LOCAL DREDGING CAPACITY



West Africa relies on international contractors and an aging fleet for the execution of dredging works. The vessels owned by the local contractors and port authorities are on average well over 30 years old and range amongst the most polluting vessels in operation. The only other alternative is to contract international Dredging Contractors, which means no local employment. We believe dredging required to counter the consequences of climate change can only be executed with the most environmentally friendly equipment operated by locals.



THE LEAF-HOPPER CONCEPT

Royal IHC is a leader in the design and build of trailing suction hopper dredgers. In the research & development program for trailing suction hopper dredgers optimizing cost-efficiency and minimizing environmental impact has been the focus for many years. In 2017 Royal IHC delivered the world's first LNG fuelled trailing suction hopper dredgers. At this moment the concept of Low Energy Adaptive Fuel (LEAF) hoppers is being developed. These dredging vessels are specifically designed for minimal energy consumption and are adaptable to clean types of fuel.

The ultimate goal is to sail, dredge and offload using hydrogen. Hydrogen is (at the moment) still very expensive, but it is expected that the price will decrease in the (near) future due to technical and infrastructural developments. With actual bunker infrastructure in West Africa being set for a general overhaul, we foresee that West Africa can leapfrog into the transition to green fuels. The adaptability of the LEAF-Hopper means that it can be operated using MDO, biodiesel, LNG or hydrogen as the region transitions to greener fuels. Every option has its own contribution to the reduction of CO₂ and other harmful emissions, like SO_x, NO_x and particulate matter. Every option has its own adaptive measures and development.

FINANCED AND OPERATED LOCALLY

A consortium of public private parties invest in the acquisition of new equipment through a Special Purpose Vehicle. This way several Investors such as Operators or Equipment Suppliers can join forces and share the capital investment.

Ports and authorities will then lease the LEAF-hopper for their development or maintenance project, supplying their own (or local) crew. This lease operate model relieves public parties from CAPEX heavy investments and offer an OPEX rate that is more in line with their cash flow.

An additional benefit is the boost for local involvement and local content created this way. Jobs are created, as crews are made available by the ports, authorities or local crewing agencies. Crews will be trained as part of the lease operate model, allowing for local expertise building. IHC Dredging Consultants can play a role in training of management, remote control and supervision of a project and coaching.



**THE TECHNOLOGY
INNOVATOR.**

ROYALIHC.COM



A joint
venture



World Bank Group – WACA
Call for Innovation

'Coastal.Retrofit 2.0™'
Mangrove trees & man-made Barrier Reef in key role

Introduction

'Coastal.Retrofit 2.0™' - Mangrove trees planted on a man-made offshore Barrier Reef for Climate Proof Coastal Protection. An innovative design from The Netherlands for a sustainable **Nature Based Solution** to enhance the resilience of coastal communities in West Africa for many decades to come. These countries are at present being adversely affected by Climate Change, Sea level Rise, Coastal Erosion & Flooding.

Technical design

For easy reference please see the illustration in the enclosed pdf. The **Van den Herik Sliedrecht & Nautilus Coastal-Solutions innovation** is unique, but based on natural-processes developed by ocean-nature itself, e.g. the coastal situation around the Islandstate of Mauritius in the Indian Ocean is our prime example and inspiration: mimicking the superb wave-breaking capabilities & coastline protection services of coral reefs in tropical waters.

Eco-socio benefits

A unique feature of our design is the planting of massive, new offshore wetland areas with the versatile **Mangrove tree**, (50.000 m². to 200.000 m². of new mangrove forest for every kilometre of shore-length) communal owned and managed not only able to reduce and dissipate wave attacks, but also a very effective method to achieve eco-socio benefits including: carbon sequestration (up to 400% faster than land-based tropical rain-forests), earn carbon-credits, re-establish lost coastal-ecosystem and biodiversity, both above and below water, generate nature-based economic benefits and services for coastal dwellers, including: seafoods, building materials, herbal medicines, nutrient recycling, pollution filtering, reducing social injustice and bringing new and rewarding employment, requiring new skills, substantially improving their resilience. In addition our innovation will make a major contribution to lift a large number of the most vulnerable coastal-citizens, women and adolescent girls in particular, out of poverty and 'last-but-not-least' fully climate proof and climate adaptable for decades.

Integrated Coastal Zone Management & Adaptation utilising mangrove trees in a prime role

According to the recent publicly available report (12-2020) from Earth Security Group (ESG) – London, titled: *"Financing the Earth Assets"*, *'The Case for Mangrove as a Nature-Based Climate Solution'*: **Mangroves** are a vital and indispensable asset for countries and coastal managers to achieve true integrated coastal zone management and **adaptation** and for companies and investors a tool to deliver 'net-zero' carbon commitments, besides being incombustible for wildfires, while halting the runaway extinction of biodiversity, (<https://earthsecurity.org/report>).

Despite all the above described superb properties mangroves have been disappearing worldwide in an alarming rate due to unsustainable urban pressure and investment models in: agriculture, aquaculture and infrastructure that do not recognise their value. The ESG Report[®] provides the evidence to guide investment decision-makers to embed these values in their investments to achieve greater resilience.

During January 2021 the UNEP organised the worldwide, online **Climate Adaptation Summit 2021 (CAS 2021)** from The Hague – The Netherlands. Thirtytwo worldleaders participated, there were 25 high level program elements, 300 speakers and 18.000 worldwide participants attended the conference platform. The majority of worldleaders, speakers and participants, including institutions such as The World Bank Group, IMF, African Development Bank, UN Global Center on Adaptation (GCA) called for urgent climate action and climate adaptation. The recently published UNEP **'Adaptation Gap Report 2020'**, in part. Chapter 6, *'Nature-Based Solutions for Adaptation'* is an other wake-up call!

CALL for Urgent ACTION & ADAPTATION along your vulnerable coast:

Do not postpone a decision, but immediately involve our Jointventure to design & construct your **'Coastal.Retrofit 2.0™' - Nature Based Mangrove planted Barrier Reef Solution** for a Climate Proof, sustainable Coastal Protection!

For further details please contact: jan.huijbers@herik.nl and/or Jan H. de Jager at: nautilus.coastal.solutions@gmail.com

January 2021

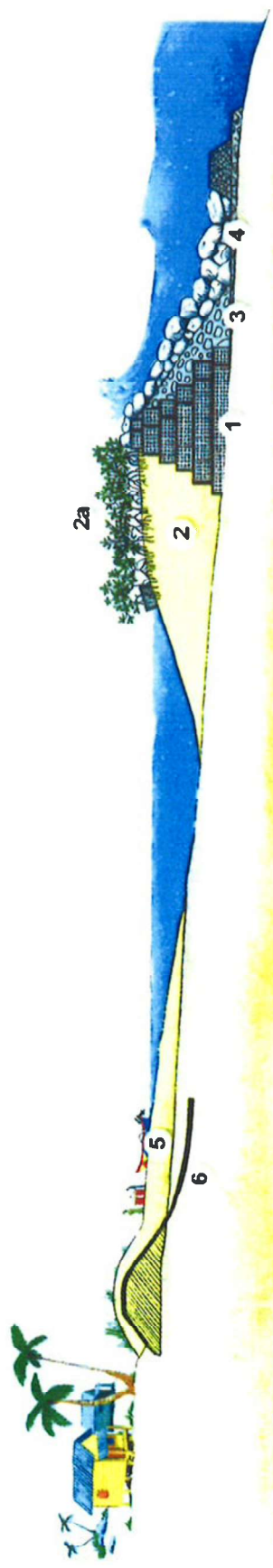
Coastal.Retrofit 2.0™, a six phase Nature Based Solution

West Africa sediment-coast

a man-made 'Barrier Reef', build with pre-fabricated Reef-elements, strengthened with seasand on the coastside & with rock and armour-rocks on the seaside, planted with Mangrove trees (tropical area's), Beachnourishment & a Hidden Coastline Protection with endless coupled Gabion-mattresses



PRESENT Situation at West Africa sediment-coast



SITUATION after completion of Coastal.Retrofit 2.0™

(Final design to be optimized with testing in the Delta Flume in Delft {NL})

LEGEND

- 1) Placing pre-fabricated Barrier-Reef-elements
- 2) Placing of seasand sediments at landside of Barrier-Reef-elements
- 2a) Placing of Aqua-Flora® Mangrove Gabions & planting mangrove trees
- 3) Placing of first rocklayer along seaside of Barrier-Reef-elements
- 4) Placing of armour rocklayer along seaside of Barrier-Reef-elements
- 5) Placing of seasand sediments on existing beach
- 6) Installation of hidden Coastline Protection with endless-coupled Gabion-mattresses



Nautilus

Nautilus Coastal-Solutions b.v. & Van den Herik Stiedrecht

Scale : none

Date : January 2020

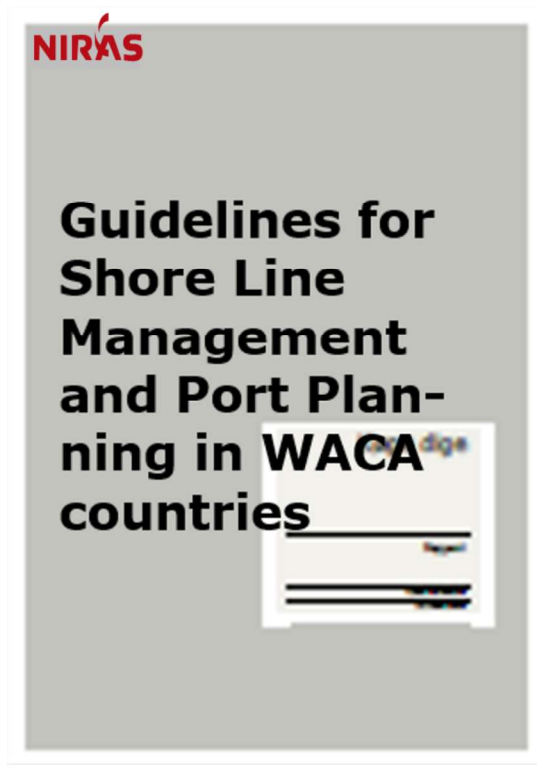
Proposal :

Mannmade Barrier-Reef-elements, build with a pre-fab Gabion-core, covered with rock on the seaside and dredged seasand on the coast-face of the reef. Aqua-Flora® Mangrove-Gabions and Mangrove saplings placed & planted atop of the nourished seasand along the coast-face of the reef: a solution available to protect sediment-coasts anywhere!

Designer : Ing. Jan H. de Jager, Helico / Stiedrecht - The Netherlands

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Networking and knowledge sharing process to elaborate integrated SHORELINE MANAGEMENT PLANNING



NIRAS has prepared an innovative idea and a well-defined programme with a clear purpose of elaborating Shoreline Management Planning (SMP) Guidelines for each member state engaging all key stakeholders in a participatory SMP process.

NIRAS' role is to facilitate the process of networking and knowledge sharing and

With a proper SMP Guideline the country will be well prepared to continue the elaboration of SMP for each of the coastal cells defined in the Guideline using the methodology and approached specified in the SMP Guideline.

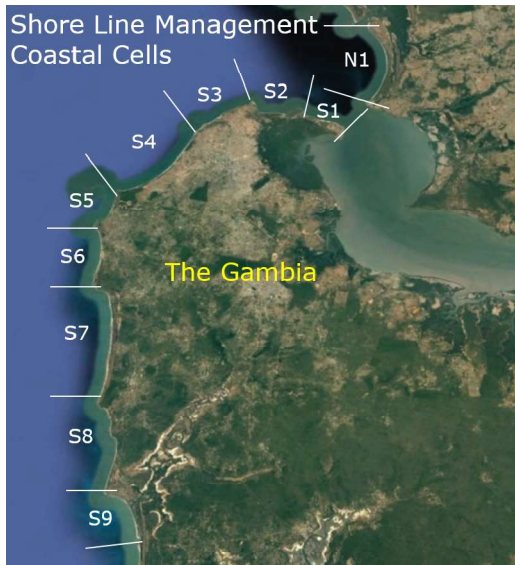
present feedbacks supporting the preparation of SMP Guidelines specifically designed to each WACA member state. The innovative idea is built on a believe that:

the key obstacles in designing sustainable ports are deficient planning of the coastal zones due to lack of knowledge and understanding of the physical and ecological environment in the coastal areas, rather than lack of specific expertise and knowhow in port and lagoon design and operation.

We strongly believe that SMP is a powerful tool to meet above challenges.

We acknowledge that many WACA countries are studying the morphology of the coast along their shores and are carrying out a number of Climate Vulnerability and Risk Assessment (CVRA). We believe that the results of these studies can be used as very valuable baseline information for elaborating a **Shoreline Management Plan (SMP)**.

Our **innovative idea** concentrates on initiating a SMP process in each of the member states resulting in elaborating a country specific **SMP Guidelines** for each country.



Coastal planning is a complicated process involving many stakeholders and many

complicated physical and ecological processes. The SMP is a powerful tool to guide and facilitate this planning process.

The impact of this **innovative idea** is implicit lying in the SMP process as results of clarity, understanding, and awareness raising, showing how all the parameters involved are playing together giving a direction, which will ensure prosperity and long-term sustainable development.

The SMP strategy proposed is generally feasible in the context of shoreline management and particularly feasible for port and lagoon operations and may demonstrate clear value proposition of solving the identified problem/s, with a real likelihood to succeed.

Is technology the only way for a new future? Social capital is vital for new value creation.

Exploring engineering and social coherence, vitalizing coastal societies by the establishment of an information sharing platform and incentive system and utilizing cutting edge technologies such as the latest space technology.



Social implementation in coastal management

We believe that technology should work together with society to solve any individual issue, even when it seems more specified to the engineering field. Coastal areas are technically facing geomorphological and hydrological variations at different time scales. Simultaneously, coastal communities face various social challenges, such as population and assets concentration, community degradation due to coastal erosion, and so on. Therefore to manage this complex system, the inclusion and integration of technology into society is essential.

Applying the latest technology with consideration of social inclusion offers the potential to utilize social capital more effectively. Not only blockchain and satellite technology are introduced, but we are also seeking for more innovative solutions for a better integrated coastal management.

Bringing out “leapfrogging” in coastal development

Our approach aims to establish a resilient and sustainable society by empowering humanware, hardware, and software. Many developing countries, where policy, regulatory, and institutional frameworks are not sufficiently developed to manage coastal areas and conserve environmental assets, have the potential for leapfrogging development using today’s technology.

Platforming and its process

It is important to set and share common goals that satisfy both engineering and social aspects to create sustainable and lively coastal areas. Besides, coastal values and generated benefits should be adequately evaluated, recognized, and shared among the whole stakeholders. To realize leapfrogging development and formulate a well-designed ecosystem in a coastal community, a platform for sharing and collaboration among various stakeholders is essential.

The platform is prepared for collecting and accumulating the information and data related to coastal management. **It also can incentivize a participant’s actions and contributions based on blockchain technology.** Community profiling such as baseline survey, gap analysis, etc., is one of the core activities for coastal management. Furthermore, **satellite imagery has become a powerful tool for enhancing macro-scale understanding.**

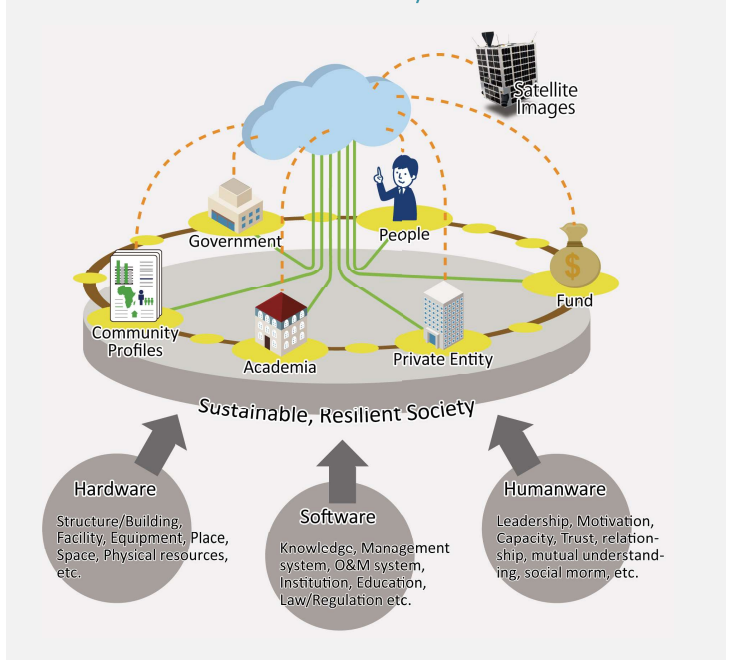
Our Technology

Blockchain technology enables information sharing, while

the ownership of the information remains with the original provider. Blockchain also provides a database where the record of contribution to reach a solution can be secured against any attempts of tampering. Furthermore, blockchain can mint some “token”, similar to Bitcoin, to measure and visualize the contribution for the solution. The token can be traded among the participants across the globe. Thus, it works on formulating a so-called “Token Economy”, creating economic values and responsibilities, and promoting sustainable coastal management. In the future, it may also be possible to cover some of the project and survey costs using tokens, together with other budgets and funds.

AxelGlobe is the new era for earth observation infrastructure consisting of a satellite monitoring system that is at a low cost, can capture imagery daily, and has a wide coverage. AxelGlobe can radically improve coastal monitoring. It has the ability to capture the whole civilized world with 2.5 m resolution every day. Such resolution is enough to distinguish container size objects. The satellite provides daily-fresh information and a collection of past data. Comparing older images and studying their evolution can lead to invaluable insights and predictions for the future. We can build a scheme of satellite image provision that monitors coastlines, lagoon conditions, community activities, and conducts construction monitoring and disaster monitoring.

Figure The platform can integrate information/data and work as an incentive system



SLAMDAM by Zephyr Consulting

A Rapidly Deployable Water-Filled Flood Barrier

The SLAMDAM-technology, developed in The Netherlands, is an innovative and low-cost technological solution to enhance resilience against floods. The product is a mobile emergency barrier, which can easily be deployed when there is a threat of flooding. The same technology can also be used to store water and other fluids vapor tight to improve access to water in times of drought.

SLAMDAM's unique design and material enable an exceptionally flexible solution for the emergency dam and water retention market. The product is made out of EPDM, a synthetic rubber having unique properties related to heat, ozone and weather resistance. These properties allow for the product to be used in many different conditions as an effective flood defense system. The flood barrier can be customized to meet local specific requirements. A video on how SLAMDAM works can be found [here](#).

Unique Benefits

- Patented design
- UV-resistant and vapor tight material
- Flexible design to withstand high pressure
- The only mobile barrier that is TÜV-certified
- Lifespan of 40+ years
- 100% recyclable
- Award “Most effective solution against flooding”
- Finalist TechEmerge program of the World Bank



Proposal

The mobile flood barrier can be deployed at coastal and non-coastal areas to prevent climate-induced flooding. Simultaneously, fresh water can be stored in the dams to be used in times of drought. We build climate change adaptive capacities and manage knowledge of institutions, flood response teams and local communities. Complementary products and services include consulting services related to flood risk and complete Flood Early Warning Systems (FEWS).

Members of the Consortium

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SharIn@SEA

Sharing Innovation for Sea and Littoral by an e-learning portal

United Nations forecasted in 2017 that 80% of world population will live in a 75 km wide band of littoral by 2050. West Africa is facing this challenge more than other countries.

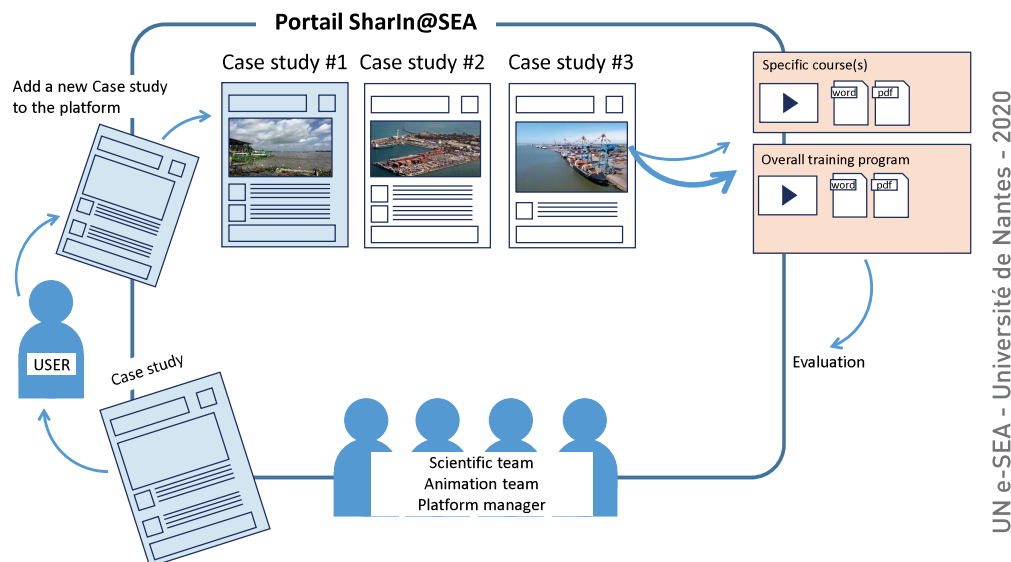
Littoral areas in West Africa are facing contradictory challenges: increase tourism capacity, develop housing constructions and increase port installations capacity to support the economic development. Good practices are required for limiting reducing pollution, limit the pollution due to new infrastructures and limit the use of natural wild areas.

These constraints need for an interdisciplinary view and analysis: spatial planning, infrastructure management, logistic and economics, bio-chemical analysis and legal issues. For instance, increase port installations capacity requires an optimization of maintenance and an adaptation of existing structures and building infrastructures knowing that that have to be flexible to face evolution of trade and impact of climate change (sea level rise).

In this context, the objective of **SharIn@SEA** is to share interdisciplinary good practices towards an international community of specialists by providing case studies based on real situations, and analyzed through a common foundation of interdisciplinary knowledge.

The project aims at developing a collaborative e-learning portal funded on four pillars:

- Offer a series of existing good practices and a method to create, evaluate, and transfer new ones.
- Teach people on an existing e-learning platform UN-e-SEA how to understand the interdisciplinary context.
- Guide experts through individual programs based on individual past experience and the assessment of cases transferability.
- Propose interactive tools in order to increase professional interactions towards the users community.



SharIn@SEA expect to provide several levels of online contents and learning pathways, from free resources to mentoring trainings.

The interdisciplinary common core of knowledge will be structured through three topics: The harbour zone and its environment, Coastal risks, and Forward-looking indicators to evaluate climate change's impacts on harbour zones and coastal zones. It will be based on a systemic approach of harbour environment, and focused on the concepts of risks, and land-sea continuum. It will pay attention to properly identify key concepts and build a common language. It should especially clearly differentiate the concept of *coastal erosion management* requiring soft solutions from *coastline management*, which most widely pushes towards hard solutions.

<https://www.univ-nantes.fr>



UNIVERSITÉ DE NANTES



CENTRE TRAINMAR DE DAKAR



COLLECTE LOCALISATION SATELLITES

WARPS

WESTERN AFRICA REAL-TIME PORTS SYSTEM

COASTAL ENVIRONMENTAL ASSESSMENT

Combining technologies and environmental expertise to transform data into information over the time

WARPS is a coastal environmental assessment system that combines several technologies and expertise for achieving a comprehensive knowledge of the coastal environment of the Western African Ports and infrastructures.

The combination of in situ measurements, remote sensing and numerical modeling makes possible to represent environmental conditions in the past, present and assess the future at different time and space scales. The visualizing tool is the entry point that allows the users to benefit from the combination of the processed data.

WARPS aim to provide an assessment of the impact of ports operations, infrastructure development and environmental policies on the coastal surroundings. It also allows to have a real time knowledge of environmental parameters and to anticipate and prevent accidents. The project is being developed to monitor the coastal environment in the context of monitoring the impacts of climate change and human activities.

Applications:

Infrastructure monitoring - Coastal erosion - Environmental mapping - Environmental risk analysis - Oil spill simulation - Navigation support - Flood monitoring - Sediment transportation - Floating garbage management - Water quality - Climate change - Ground displacement - Dredging disposal



Satellite Data



MONITORING & ANALYSIS



In-situ measurement



Numerical Modeling



Visualisation tool

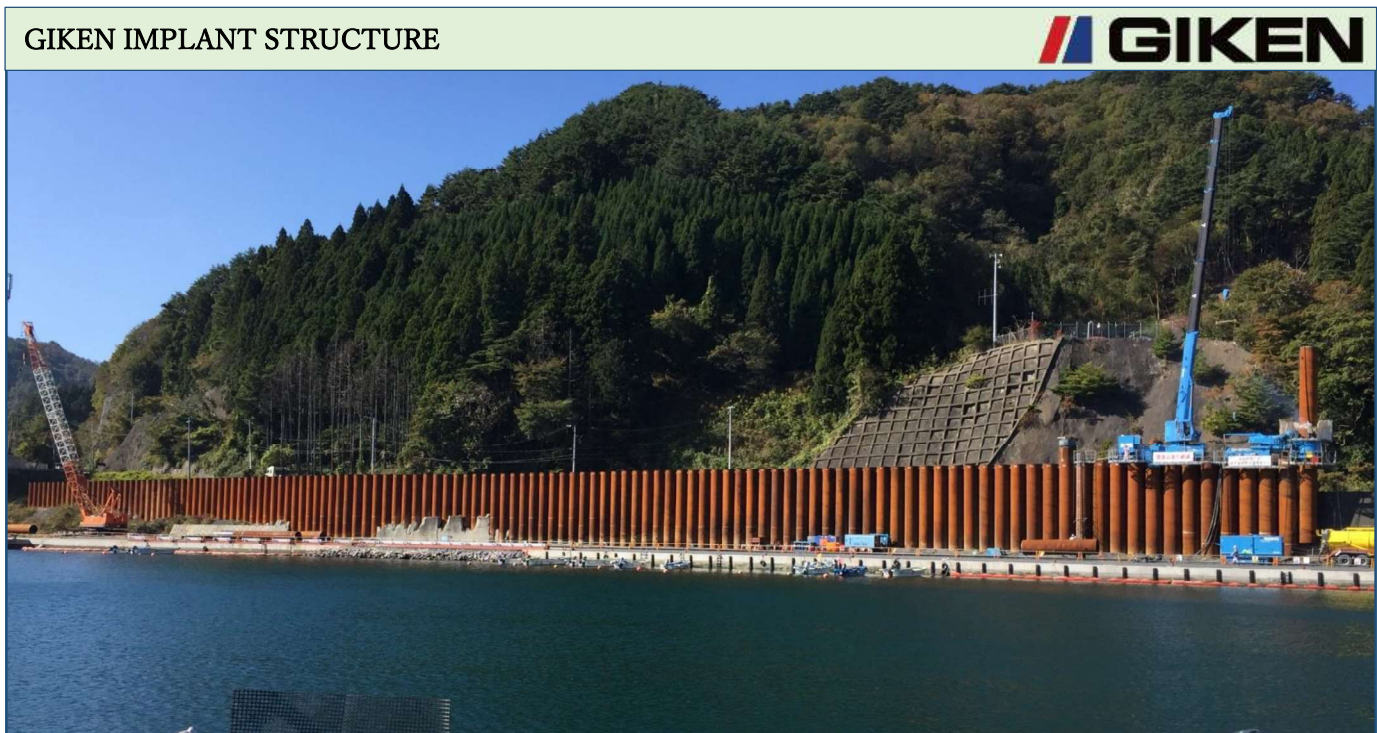
www.energyoffshore-cls.com

CLS – 11 rue Hermès – Parc Technologique du Canal – 31620 Ramonville Saint-Agne

Contact: bmavoungou@groupcls.com

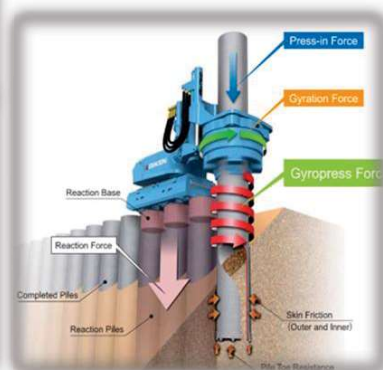
GIKEN IMPLANT STRUCTURE

The Implant Structure consists of robust and durable structural members which are firmly embedded into the ground by the Press-in Method. The structural members are selected from a wide variety of piling materials in accordance with design requirement, thus, the Implant Structure can cover a wide range of foundation designs required in today’s construction industry. Also, being embedded into the ground, the Implant Structure is extremely resilient and maintains its serviceability even in extreme events, such as natural disasters. Traditional gravity structures are commonly used worldwide as they are simply constructed by “seating” on firm ground. However, they are quite vulnerable to dynamic loads caused by floods, wave actions, earthquakes and tsunamis.



Tsunami Testing

- Base Reaction System
- Free of Temporary Works
- Piling on Existing Structures
- No Noise & No Vibration



Contact: project@giken.com



Mr. Funahara



Mr. Ndoye



Mr. Kitano



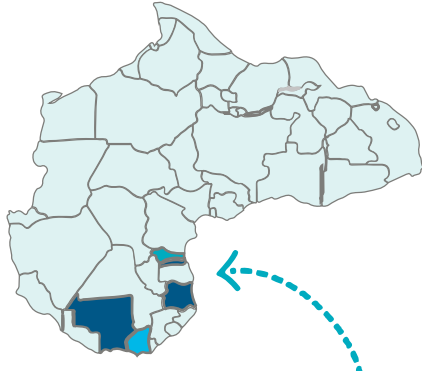
Ms. Komiya

A soft solution to the hard issue of coastal erosion

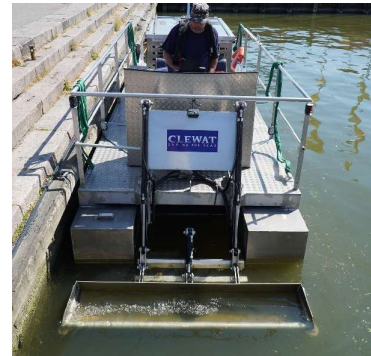


In order to limit unwanted coastal erosion, **BRL Ingénierie** has developed a unique know-how in **design and supervision of works of sand filled geotainers.**

Our company has 2 experiences in France (Sète) & Israël (Tel Aviv) and is seeking to develop this innovation **in West Africa.**



CLEWAT



Collection of harmful plants quickly and efficiently

Clewat's innovation enables concrete measures to clean waterways of plastic, oil and plants.

Thanks to our new technology, collection can also be carried out effectively on difficult plants. The technology is based on the flow of water and does not cause mechanical stress.

As an example, the city of Kokkola, where 7 different technologies have been tested and only the Clewat solution achieved impressive results in removing Eurasian Watermilfoil.

Get in touch now for more information

marko.karkkainen@clewat.com