



Deltares

**SMAART
FINANCE**

ROADMAP

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

29 October 2021



MANAGED BY

WORLD BANK GROUP



Document information

GENERAL INFORMATION

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Document volume	Road Map
Version	01
Reference	PRT0041-ESQ-ENV-RAP-001

HISTORY OF CHANGES

Version	Date	Drafted by	Checked by	Changes
00	29/09/2021	Authors	Eric FERNAGU	1 st issue
01	29/10/2021	Authors	Eric FERNAGU	Incorporation of WB comments and questionnaires results from PMAWCA

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TABLE OF CONTENTS

1 - INTRODUCTION	5
1.1 - Context	5
1.2 - Understanding of the problem	5
1.2.1 - Erosion induced by port infrastructure	5
1.2.2 - A transnational issue	6
1.3 - Our proposed solution: Trans-Sand	7
1.4 - Why Trans-Sand is the solution	7
2 - THE MAIN PRINCIPLES OF TRANS-SAND	9
2.1 - Restoration of the sediment budget by implementing a transnational bypassing scheme	9
2.1.1 - Bypassing scheme for existing ports	9
2.1.2 - Implications for new port developments	10
2.1.3 - Preliminary analysis of the incentives and barriers for the implementation of the solution	10
2.1.3.1 - Enablers	10
2.1.3.2 - Barriers	11
2.2 - Design a public-private financing mechanism to finance the sand bypassing strategy	11
2.2.1 - The creation of a regional Public-Private dredging Consortium	11
2.2.2 - A public-private pooled dredging fund	12
2.2.3 - Fund Rationale	14
2.2.4 - Preliminary analysis of the incentives and barriers for the implementation of the solution	14
2.2.4.1 - Enablers	14
2.2.4.2 - Barriers	14
2.3 - Cost estimate	15
3 - IMPLEMENTATION TIMELINE & METHODOLOGY	17
3.1 - Timeline	17
3.2 - Methodological approach	17
4 - THE ROADMAP FOR SUCCESSFUL IMPLEMENTATION	18
4.1 - Feasibility Study	18
4.1.1 - Objectives	18
4.1.2 - Step 1 – Pre-feasibility study / Identify front-runners for case studies	19
4.1.2.1 - Step 1.1 – Awareness and capacity building	19
4.1.2.2 - Step 1.2 – Quick scan - Screening of potential case studies and involved parties	19
4.1.2.3 - Step 1.3 - Select case studies to form the pilot project	20
4.1.3 - Step 2 – Feasibility study	20
4.1.3.1 - Step 2.1 - Technical feasibility	21
4.1.3.2 - Step 2.2 - Governance feasibility	22

4.1.3.3 - Step 2.3 - Financial feasibility.....	23
4.1.3.4 - Step 2.4 - Upscaling feasibility	23
4.1.4 - Step 3 – Overall feasibility study closing	23
4.1.4.1 - Go/no-go investment decision from partners and WB to do a pilot.....	23
4.2 - Implementation of the pilot project.....	24
4.2.1 - Set-up of the governance and funding.....	24
4.2.2 - Detailed technical studies	25
4.2.3 - Implementation	26
4.2.4 - Monitoring and evaluation of the pilot project	26
4.3 - Upscaling	26
4.4 - Required level of support	27

TABLE OF FIGURES

Figure 1 : Beach changes around 130 African seaports (Ref: De Boer et al., 2019).....	6
Figure 2: Proposed high level structure.....	12
Figure 3: Proposed Governance and financing scheme.....	13
Figure 4: Preliminary cost estimate of our solution	16
Figure 5: Proposed timeline	17

1 - INTRODUCTION

1.1 - Context

West African Coastal Areas have experienced severe coastal erosion (up to 23 – 30 m/year²) for many years that has resulted in significant social and economic impacts. One third of the population of West African countries lives in coastal areas and is highly dependent on beaches and coastal habitats for their livelihoods (e.g., ports, fishing and tourism). The West African coast is a critical part of the region's economy that accounts for 50% of its GDP. The costs of coastal erosion for the WACA countries (Benin, Côte d'Ivoire, Senegal and Togo) have been estimated to be \$3.8 billion or 5.3% of the four countries' GDP according to a World Bank study in 2017¹. Coastal degradation is responsible for the death of 13,000 people/year, mainly because of flooding events, air and water pollution. The ports located on the West coast of Africa play a part in this coastal degradation as described hereafter.

Considering the above, strengthening the resilience of the coastline is a financial and social urgency to avoid further impacts. Investing in coastal adaptation now will reduce the damage, save billions of dollars in the future and protect the livelihoods of the coastal population. Past studies have estimated the costs for coastal protection in the region to be \$1.5 billion dollars. The goal of this call for innovation is to address this issue for port-induced erosion.

1.2 - Understanding of the problem

1.2.1 - Erosion induced by port infrastructure

West Africa's coastal dynamics are governed by persistent wind and swell waves that induce a strong littoral drift that transports the sediments along the coast from west to east². West African countries have seaports along the coast, and several new port developments are currently planned to accommodate for the growth in population and economy of these countries. A recent study of the coastline changes adjacent to 130 African seaports has demonstrated that the construction of the seaports (see Figure 1) induces significant coastline changes: breakwater structures and access channels interrupt the alongshore sediment transport and the littoral drift leading to major accretion up-drift and erosion down-drift of the breakwaters.

For most ports, the adjacent coastline changes result into two major problems:

- On the one hand, the up-drift coastline accretion can induce increased sand bypassing along the breakwaters leading to **sedimentation of the port access channels and basins**. This results in increased maintenance dredging costs to maintain the navigable depth. Often, the present strategy to deal with this problem is to extend the up-drift breakwater, which postpones the sedimentation issues to the future (such as in Nouakchott and Lomé).
- On the other hand, coastal erosion puts the communities' down-drift of the ports and their livelihoods at risk in terms of land loss and increased probability of flooding. These risks are amplified by the present practice of extending the port breakwaters. Moreover, the erosion often leads to **expensive coastal protection projects**. The port-induced erosion is complemented by persistent erosion along the WACA coastline due to reduced sediment supply from rivers (e.g., damming) and sand mining activities (amongst others.³).

¹ The Cost of Coastal Zone Degradation in West Africa

² Giardino, A., Schrijvershof, R., Nederhoff, C.M., de Vroeg, J.H., Brière, C., Tonnon, P-K., Caires, S., Walstra, D.J., Sosa, J., van Verseveld, W., Schellekens, J., Sloff, C.J., 2018. A quantitative assessment of human interventions and climate change on the West African sediment budget. *Ocean and Coastal management* 156 (2018) 249-264

³ UNEP, 1985. *Coastal erosion in West and Central Africa. Regional Seas Reports and Studies No.67*

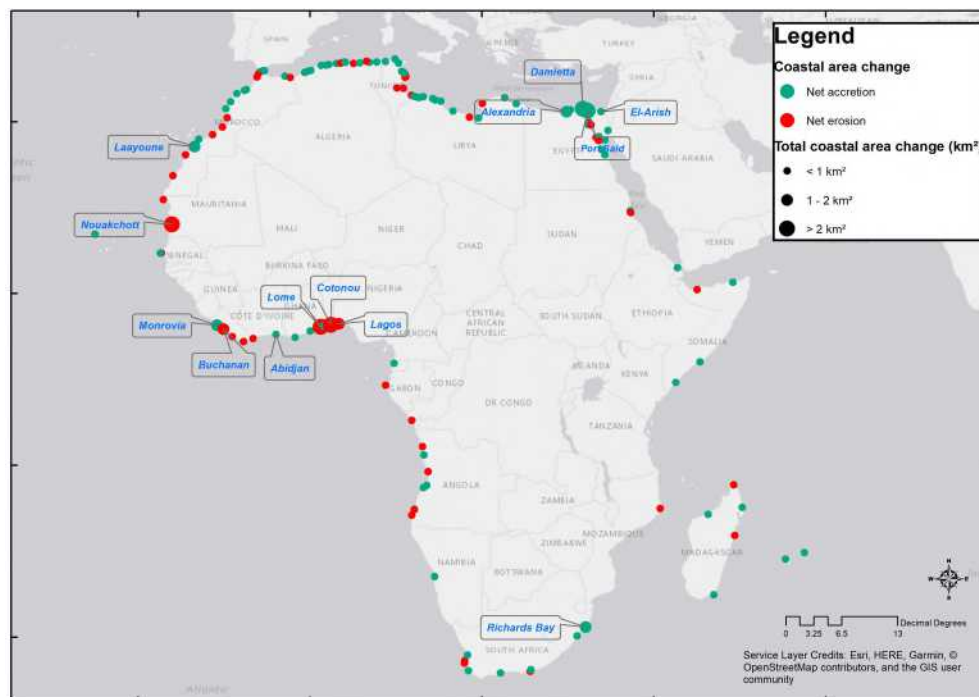


FIGURE 1 : BEACH CHANGES AROUND 130 AFRICAN SEAPORTS (REF: DE BOER ET AL., 2019)

The coastal erosion mitigation strategies that have been implemented individually in West African countries have proven limited results to date and will not be sufficient to tackle the damages related to coastal erosion at a regional scale in the future. We therefore believe that the definition of an integrated coastal management plan developed in cooperation between the impacted countries and ports is the best solution to prevent further coastal degradation.

1.2.2 - A transnational issue

A specific challenge of the coastal management in the WACA region is that the port structures in one country can affect the coastline in the adjacent countries. Hence, coastal erosion is an issue that cannot be solved by one country alone but that has to be dealt with regionally. This complicates the issue: cooperation between the countries is required to implement integral (transnational) coastal zone management. Ideally integrated coastal zone management should be linked also to integrated river basin management, when this last one is known to impact the sustainability of the sediment management.

Since 2000, investment efforts and policy changes have led to a changing port management landscape. Most West African ports have undergone institutional reforms with increasing public-private partnerships (PPPs) dominated by multinational operators, resulting in an improved operational efficiency of the terminals. This increased share of PPP has also shifted the governance of the ports from state to non-state actors. Multinational operators have brought along their global environmental practices so that ports' environmental policies can be aligned to international best practices⁴. Moreover, port authorities are now beginning to harmonize their practices through participation of the work streams of various organizations (e.g., PMAWCA, RCU, and PENAF).

⁴ Barnes-Dabban H., van Koppen C.S.A, van Tatenhove J., 2018, *Regional convergence in environmental policy arrangements: A transformation towards regional environmental governance for West and Central African ports?* Ocean and Coastal management 163 (2018), 151-161

Still, a lack of cooperation and coordination persists to tackle the problem of sand sedimentation and erosion, a problem leading to increased maintenance dredging costs, flooding risks and other negative impacts for coastal populations and ecology, in particular the most vulnerable ones.

Sustainable coastal erosion management can only be achieved through cooperation between West African countries and public and private stakeholders.

1.3 - Our proposed solution: Trans-Sand

In the framework of the Call for Innovation for the WACA program (launched by the World Bank in 2020), thanks to the extensive experience on the ground of Deltares and Egis in all WACA countries, a team was formed (including Deltares, Egis, and Smaart Finance, hereafter the *Team*) and developed the idea of restoring the regional sand balance - which is disturbed by the ports - through the implementation of a transnational sand bypassing scheme at a regional level. Through a cooperation between countries and ports, a public-private pooled dredging fund financed by port operators/authorities and other stakeholders is proposed to be set-up to operate a combined dredging capacity. This regional cooperative approach will allow optimising the integrated costs of maintenance dredging required to ensure safe port operations and sand nourishments required to preserve the coastal areas. **This concept has been called Trans-Sand**, which is further described in Section 2 (below).

The purpose of this document is to establish a roadmap for the development and implementation of the Trans-Sand innovation in the context of the West Africa Coastal Areas High-Level Platform project (P166218), as the project is clearly about supporting partner countries in achieving coastal resilience in Western Africa by scaling-up finance with knowledge, expertise and dialogue as enabling conditions. In other words, the project is fully aligned with the objective of the WACA Platform to mobilize public, private and civil society partners to support sustainable development and reduce climate risk for millions of people living in West African coastal areas.

For that purpose, the following information will be provided in the next sections:

- Section 2 describes the main principles of the concept Trans-Sand and why the *Team* strongly believes Trans-Sand is a solution to address the matter of coastal erosion within West Africa.
- Section 3 details the implementation timeline associated to the proposed stepped approach.
- Section 4 explains the details of the road map for the successful implementation of Trans-Sand concept.

1.4 - Why Trans-Sand is the solution

The *Team* strongly believes that **Trans-Sand being “a transnational By-Passing scheme funded by a Public-Private Dredging Fund” is the solution to transcend the port and national boundaries**. Among the advantages and added-values of the concept, the following shall be listed:

- A regional approach to a regional problem: this integrated turnkey solution financed by the proposed organisation will involve all the impacted public and private partners and therefore stimulate increased exchange between all stakeholders
- An innovative approach: a transnational solution that proposes to solve the coastal erosion issue at a regional level
- But also feasible: technical solution based on robust and proven technology that can be implemented quickly with fast results
- With long-term positive impacts on coastal dynamics

- Adapted to national context: solution replicable for multiple ports in WACA countries
- Benefiting to all: a solution with direct benefits for ports and coastal communities and potential co-benefits with natural habitat restoration, increased knowledge of coastal erosion dynamics, etc.
- Readily implementable: a solution that is scalable in time (to take into account climate change) and in space (to involve several countries, as from two only)
- Compatible with other interventions: a solution that can be linked and leverage to/from Nature-based Solutions (i.e., mangroves and dunes restoration) and integration of green and grey infrastructures (i.e., artificial reefs and coastal wetlands).

2 - THE MAIN PRINCIPLES OF TRANS-SAND

2.1 - Restoration of the sediment budget by implementing a transnational bypassing scheme

In short, most of the WACA countries suffer from the same problem: a disbalance in the sediment budget due to an interruption of the littoral drift by the ports, and of the river sediment by the dams. The proposal focuses on the former aspect. The sediment balance of the eroding sections can only be restored by adding new sand to the coastal system or by bypassing the currently available sand along the ports.

The proposed solution is based on restoration of the sand balance by means of sand bypass or by supplying sand from offshore sources. The elegance of this concept is that it strives to restore nature, in the sense that the alongshore sediment transport is artificially restored as much as possible to the situation present before construction of the ports. This is in strong contrast with “hard” grey solutions (e.g., groins, seawalls, and detached breakwaters), which do not restore the sediment balance but merely further expand the disruption of the natural system. If coastal protection structures are built down-drift of a port, these tend to shift the erosion problem further along the coast, in the direction of down-drift countries. As a result, hard measures may increase the risk of transnational issues rather than diminish it.

This proposed “soft” solution requires regular sand dredging and disposal operations. It should be realised that this is already the case in the present situation, where regular maintenance dredging of the ports is required. In the proposed plan these dredging operations are optimized for both the ports and the coastal communities living nearby, in the sense that sand can be dredged before it enters the ports (instead of after), and the dredged sand can be placed in the active coastal zone down-drift to mitigate erosion. This is in contrast with the present practices where sand is often disposed at an offshore location where it is lost for the active coastal system.

To benefit from the transnational character of the problem (i.e., scale benefits), the *Team* proposes a shared solution where the WACA countries join forces in the form of a cooperative transnational sand bypassing scheme. This sand bypassing scheme is inspired by other examples of restoring the sediment budget, such as the Tweed River sediment bypass in Australia (a pumping system that resulted from the cooperation between the New South Wales and Queensland states) and the pro-active nourishment scheme in the Netherlands (bringing sand from offshore to nearshore). The idea is that the proposed sand bypassing scheme will lead to mutual benefits such as reduced transnational coastal erosion problems, cost savings for sediment dredging and nourishments (economics of scale), reduced sediment loss from the active coastal system, reduced environmental impacts of dredging activities and pro-active knowledge exchange and capacity building between the partner countries.

2.1.1 - Bypassing scheme for existing ports

For existing ports, the basic principle is that sediments that accumulate up-drift of the port breakwaters are bypassed to the down-drift side to reduce coastal erosion. This could be in the form of an automated sand pumping system (such as in the Tweed River example) or in the form of a dredging scheme (such as in the Netherlands). The *Team* believes that, given the local context, a cooperative dredging scheme is the most robust solution, since it is based on proven technology and could be scaled up for possible larger sand bypassing volumes in the future to adapt to sea level rise. An innovative part of this solution is not only the transnational cooperation, but also explicitly accounting for the value of sand for people (monetary and non-monetary, in terms of loss of land and livelihoods, but also loss of ecosystem services), value for the planet (in terms of ecological impacts of dredging and loss of habitats), and value for prosperity in present and future port developments (in terms of port and channel sedimentation and damage due to coastal erosion). The partner countries can jointly hire or buy dredging vessels to sail along all associated seaports to implement this bypassing scheme. A significant training would be also required to ensure the dredging skills level is lifted uniformly across all partner countries.

2.1.2 - Implications for new port developments

Transnational cooperation provides opportunities to identify alternatives to avoid or reduce coastal erosion problems from the offset of port developments (following the ecosystem-based port design hierarchy, as proposed by the study “Identifying ecosystem-based alternatives for the design of seaport’s marine infrastructure: the case of Tema port expansion in Ghana”⁵). For new port developments, the *Team* suggests the following in hierarchical order, given their ecological (including coastal) impacts:

- Be critical in assessing the need for new (greenfield) port developments and explicitly consider alternatives in the form of increasing efficiency and capacity of existing ports, and cooperation amongst national and regional ports.. In such cases, a collaborative approach is always recommended by the team, as proposed also through the principles of the SA-POD innovation.
- If a greenfield port development is inevitable, be careful and thorough in the site selection and layout design of new ports. By choosing port locations where the longshore sediment transport rates are small, coastal erosion may be reduced to a substantial extent. Also, avoid as much as possible locations with high biodiversity and conservation value, as this would not only impact livelihoods and habitats, but also region’s economy in terms of reduction ecosystems services and natural capital and ecotourism potential, as well as a reduction of the region’s climate mitigation/adaptation capacity. In that perspective, the WAC-APP innovation could support such assessment.
- Another aspect in the design of new ports is to create space for sand traps up-drift and erosion buffers down-drift of the port at its construction stage. Creating such buffers generates “overcapacity” in terms of up-drift sand storage, which increases the recurrence interval for bypass operations, making it not only more cost-effective, but also reducing ecological impacts, as well as impacts on the port operations.
- If a port development at an unfavourable location is inevitable, initiate a participatory planning process to involve all affected stakeholders and ensure design minimizes the impacts to livelihoods, businesses and environment, and make the port owners/developers responsible for the monitoring and mitigation costs of coastal erosion by joining the transnational sand bypassing scheme.

2.1.3 - Preliminary analysis of the incentives and barriers for the implementation of the solution

2.1.3.1 - Enablers

- Cost savings (i.e., economics of scale):
 - Lower port maintenance dredging costs by reducing up-drift accretion
 - Lower costs for erosion damage (or coastal protection measures)
 - More opportunities to optimize bypassing strategies in terms of cost-effectiveness
 - And even more through cooperation and sharing costs
- Technically **robust and flexible** solution:
 - Simple concept based on proven technology
 - Quickly implementable with relatively fast results
 - Scalable solution in relation to climate change
- Stimulates regional cooperation to **tackle transnational issues**:
 - Less transnational issues due to passing on problems from up-drift to down-drift countries
 - The scale of the scheme allows to reduce environmental and climate change impacts jointly (i.e., optimize dredging in terms of ecological impacts and CO₂ emissions)
 - Build capacity to keep sediments in the coastal system for now and for the future.

⁵ De Boer, W.P., Slinger, H.H., wa Kangeri, A.K., Vreugdenhil, H.S.I., Taneja, P., Addo, K.A., Vellinga, T., 2019. Identifying ecosystem-based alternatives for the design of seaport’s marine infrastructure: the case of Tema port expansion in Ghana. MDPI Sustainability 2019, 11.

2.1.3.2 - Barriers

Potential barriers for the transnational sand bypassing scheme are the (potentially diverging) terms and conditions for the transnational agreements that need to be made, the governance and financing of such a scheme, and the dependency on third parties for the delivery of dredging equipment and/or implementation of the scheme. Therefore, the proposed road map fully integrates the fact that such a scheme needs to be explored and designed in co-creation with the local stakeholders, as developed through section 4.

2.2 - Design a public-private financing mechanism to finance the sand bypassing strategy

2.2.1 - The creation of a regional Public-Private dredging Consortium

The implementation of a **transnational bypassing scheme** will require the operation of dredging equipment in several countries along the West African coast. Port authorities and operators in West Africa currently award dredging contracts on a single-project basis with private companies, few of which are national and most international. This type of procurement often results in:

- High mobilisation and demobilisation costs for the dredging vessels
- High-risk provisions from the dredging companies
- Sometimes inadequate dredging equipment for the Client depending on the dredging means available at the signature of the contract (e.g. high environmental footprint, dredging depths not in line with the Employer's Requirements, complex mobilisation timeframe, etc.).

Low returns of paid dredging costs in terms of jobs and skills development and reinvestment in local economy, in case of services provided by international dredging companies.

To rationalize the dredging costs, the *Team* proposes to mutualize the dredging means between WACA countries with the creation of a **regional dredging consortium**: all countries affected by coastal erosion and sharing the same type of dredging requirements will mutualize their requests and issue a regional dredging contract. On this basis, affected countries will benefit from an internal co-management of the dredging means.

As an illustration, this type of initiative has already been implemented at a national level in France in 1979 with the creation of an Economic Interest Dredging Group, the "GIE dragage", co-owned by the French State and seven port authorities. The ambition of this group, which is still in place, is to optimize the maintenance dredging costs with an internal management of the dredging equipment between all ports. The organisation is responsible for the procurement, the maintenance and operation of a fleet of dredging vessels fitted to the needs of the participating ports. The port authorities act as ship owners, responsible for the recruitment and training of the crews, and the organization of the maintenance dredging operations. Although financed by the state and the port authorities, the Dredging Group has its own organisation, which enables dispatching the dredging vessels when and where they are needed, at reasonable cost, alongside the Atlantic coast of France (more than 1700 km). To date, the Dredging Group is composed of eight dredging vessels

Based on this positive return of experience, the regional dredging consortium the *Team* proposes would be jointly owned by the countries/port authorities along with private operators/investors. This organisation will be managed by a regional organisation that will centralize the needs of the stakeholders and organize the dredging operations accordingly. The procurement of the dredging contracts by the consortium will depend on the dredging needs determined for the sand bypassing scheme and for the maintenance dredging of the ports. At this stage, two types of contracting schemes can be anticipated:

- The **procurement of regional dredging contracts through private companies**: the mutualisation of the dredging needs between several ports will enable the dredging consortium to issue regional dredging contracts. Those dredging contracts, awarded to private dredging companies will have better conditions than the individual contracts currently negotiated between the (individual) port authorities and the

dredging companies, as the dredging volumes will be higher and the mobilisation/demobilisation costs and risks provision will most likely be reduced significantly.

- The creation of a **regional dredging fleet**: if the anticipated dredging volumes justify the investment of the consortium in self-owned dredging vessels, the dredging consortium could act in the same model as the French GIE but at a regional level instead of a national one. In this option, the consortium will own dredging vessels. The planning and operation of the dredging vessels will be decided by the consortium based on the requests of the port authorities, of the countries, and of the sand bypassing scheme. An added value of such scheme will be the development of skills and jobs in the dredging sector directly in the region.

The scope and organisation of the regional dredging consortium will be confirmed as part of the study, based on the outcomes of the interviews with the relevant stakeholders and on the estimated dredging volumes.

2.2.2 - A public-private pooled dredging fund

To implement the regional consortium and to manage the ongoing local needs, the *Team* proposes to establish a public-private dredging fund to be managed at a regional level. The fund will operate under the authority of the dredging Consortium board and its main purpose will be to administer a mechanism for optimal cost allocation between the various stakeholders. This mechanism will operate based on (i) the input received from time to time from consortium members in relation to dredging needs as well as (2) the proposed transnational sand bypassing strategies as per **Steps 1 and 2** – see diagram below.

The diagram in Figure 2 also depicts the 3 high level steps of the public-private dredging fund (design solution, monitoring & impact measurement mechanism, and compensation mechanism), as detailed hereafter.

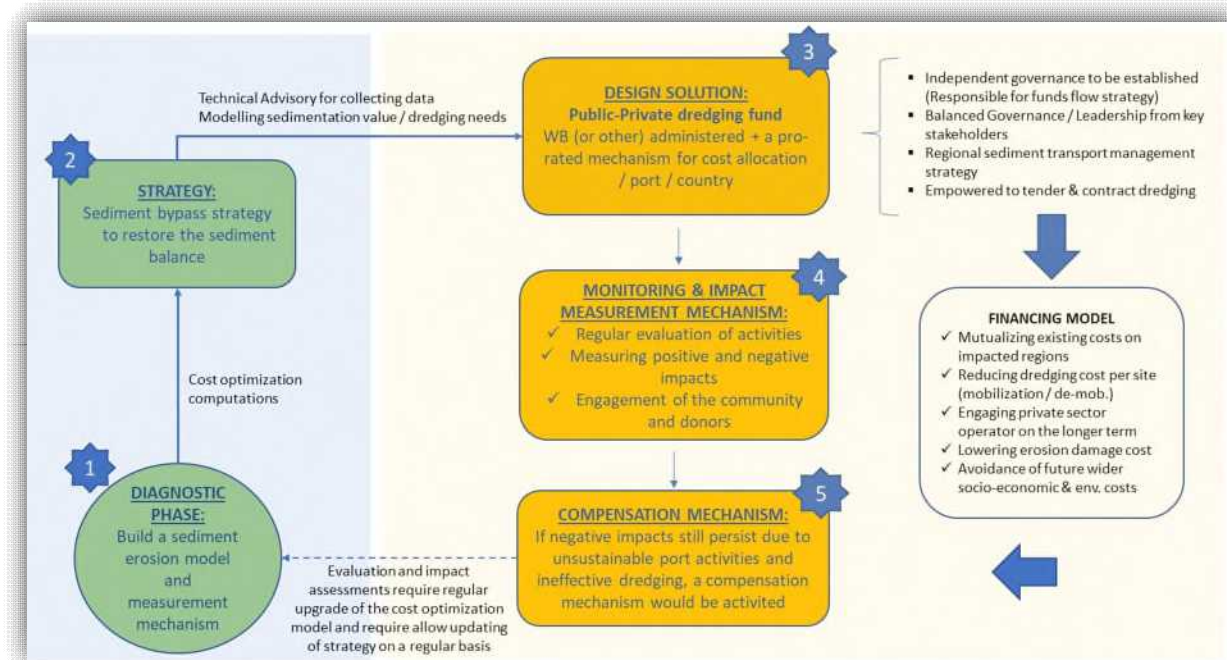


FIGURE 2: PROPOSED HIGH LEVEL STRUCTURE OF TRANS-SAND PLANNING AND FINANCING MECHANISM

2.2.2.1.1 - Pooled Fund design methodological approach

The following approach is proposed for the definition of the public-private dredging fund.

- Agreeing on the Fund's mission. An initial step will consist of reviewing the **Corporate object** of the Fund and its scope of activities, including notably its roles as (i) trusted third party for the collection of data from

port authorities on dredging activities and from local governments on the management of erosion and other related costs and (ii) as processing centre for the financing model and funds flow management at regional level.

- Reviewing the **Governance options** from a regulatory and tax implication standpoint so as to agree its corporate statute. Also defining its membership framework and rules, including annual budgetary contributions, ensuring that (i) a multi-layer committee structure is implemented with a board and/or executive decision making body and an operational / technical forum, (ii) factoring in an appropriate balance between public institutions and private operators, the right level of government representation and (iii) joint leadership from significant stakeholders to guarantee a proactive agenda of activities, involving for instance one of the largest port authority, as well as World Bank Group/ WACA representation.
- Defining the **Finance function** and relating processes, including the process for taking input from members on dredging needs, the process for submitting proposed options for sand by-passing strategies, mobilization / demobilization, and pan-regional scheduling. This function should also be tasked with **Impact evaluation**, including computation of down-drift erosion costs on a transnational basis, but also the assessment of socio-economic & environmental costs of coastal degradations for the local populations, and the socio-economic & environmental benefits of planned dredging interventions. The entire financing / assessment process will be designed based on standardized presentation formats for Members to agree their respective positions with a common outlook on costings – segregated, pro-rata, by type, by geography - presenting monetarized benefits and scenario comparisons (individual cost vs. mutualized).
- Implementing a mutualized **Procurement capacity**, which will be built on individual port authorities' procurement function and experience, with an initial step of defining the roadmap for managing existing supplier relationships and recreate them based on a new shared and peer-reviewed tender practice.
- Implementing a **Funds flow administration** function to (i) undertake funds computations for the respective stakeholders i.e. port authorities, government & public authorities, etc. based on the agreed actions and (ii) process the funds transfers accordingly. This will include the net cost allocation of the mutualized ports' dredging works, the contributions made to implement the sand bypassing strategies and the remaining funds to meet the costs linked to a minimized down-drift erosion.
- Define and implement a **Monitoring / compensation mechanism** which will be tasked with monitoring activities ex post, undertaking yearly evaluations and five-yearly independent evaluations, and effecting compensating actions on an annual basis and under a medium-term perspective to be agreed upon between the parties.

The above is further described in below figure with the creation of a regional dredging board encompassing all involved stakeholders (e.g. Port authorities/operators, States, regional organisations).

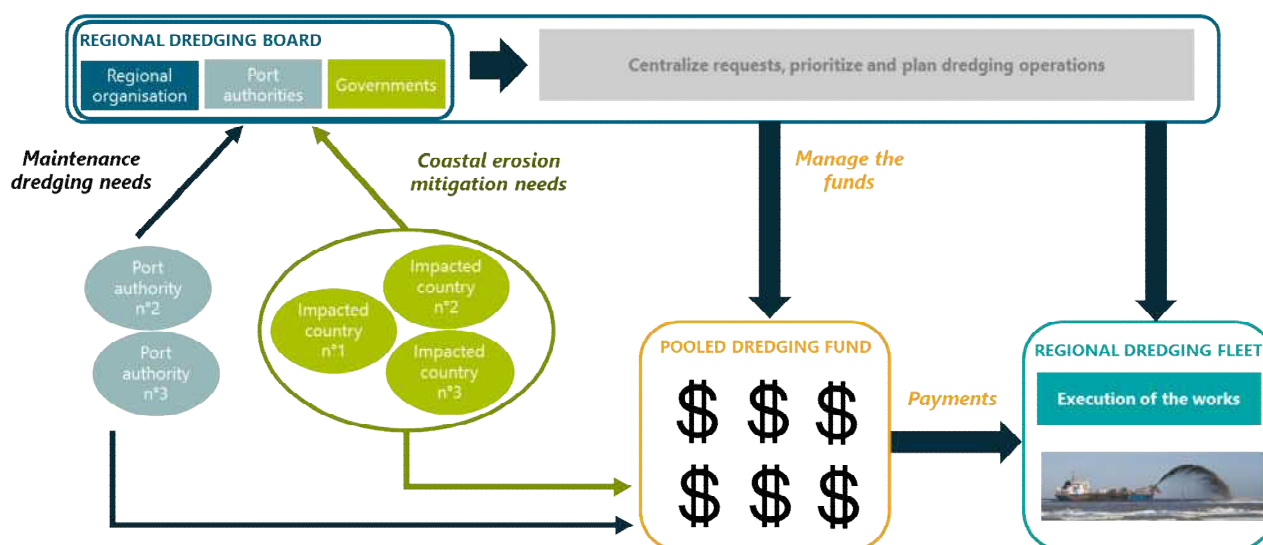


FIGURE 3: PROPOSED GOVERNANCE AND FINANCING SCHEME

2.2.3 - Fund Rationale

The fund would be designed to ensure that the right level of funding is mobilized on the various projects according to specific engagement rules. Such a funding mechanism may be initially administered by the World Bank or any other regional entity having the capacity to house such an arrangement (e.g., ECOWAS, African Union or MOLOA). The *Team* believes that, this shared governance, while it may seem arduous to establish initially, would rapidly prove beneficial, in terms of permitting economies of scale but also as an opportunity to concentrate and develop expertise and share it through training / capacity building at all member authorities.

In practice, it is assumed that the solution to be managed by the Fund would be broadly neutral in terms of maintenance dredging costs, before taking into account the gains to result from the suppression of coastal erosion costs. The proposed hypothesis is that the additional costs to be paid for by port authorities to fund down-drift erosion costs would also be largely compensated by the gains linked to the avoidance of cost for the supply of sand from offshore borrow areas as a result of the bypass strategy.

The balance of costs and benefits will be refined during the proposed **Feasibility study**. Even if these assumptions are not confirmed in full during the feasibility stage, it is the Team's belief that the benefits of creating a pooled Fund would be found in the control of mutualized / transnational dredging costs which will largely outweigh demobilization costs. Noteworthy, the proposed pooled Fund is also a scalable solution (the more members, the more benefits) and a highly sustainable one in the context of sea level rise over the coming 20-year period, as the costs of erosion are expected to increase significantly in the region.

2.2.4 - Preliminary analysis of the incentives and barriers for the implementation of the solution

2.2.4.1 - Enablers

- Cost savings through the reduction of coastal erosion inducing lower erosion damage costs for the communities and the state, and reduction of maintenance dredging costs for the port authority (e.g., important cut on the dredging costs with reduced mobilization/demobilization costs of dredging equipment, important cut on risk and benefit mark-up from contractor's)
- Reduction of the environmental impact through investment in environmentally friendly equipment in line with international best practices. Also, the scale of the scheme allows to reduce environmental and climate change impacts jointly (i.e., optimize dredging in terms of ecological impacts and CO₂ emissions)
- Added value for regional cooperation and the development of a joint approach involving the public and private sectors
- Creation of local employment (for the regional dredging group) and technical benefits for port authorities with increased knowledge in dredging management
- Monitoring of economic, environmental and social impacts of the project (both negative and positive), with a compensation used for mitigation and remediation (in case of persisting negative impacts)
- Positive communication tool for port authorities that will develop ecosystems services with influence on a regional hinterland.

2.2.4.2 - Barriers

- Management of this regional cooperation through an independent organization involving state actors and non-state actors – to define convergence in the transnational cooperation will require a participative approach. Workshops with local stakeholder's engagement will be needed.
- Measurement of impacts is essential and it will require a sound Environmental & Social (E&S) process to be built, with a specific scorecard to be maintained over time.

- The regional cooperation should be based on a strategy involving (a growing number of) partner countries. The strategy defined at a regional level shall nevertheless be tailor-made to address the local needs.
- Uneven scale of drivers across partner countries, e.g. the fact that erosion patterns and port's impacts are uneven between countries.

2.3 - Cost estimate

As a preamble, it is important to note that the high-level cost estimate for the proposed solution will be refined during the feasibility stage. The items and amounts computed represent broad estimates on which the *Team* have based the assessment of the solution.

Clearly, the costs of the solution will depend on:

- The number of stakeholders (states, port authorities and port operators) involved on the project
- The selected form for the regional dredging capacity
- The structure of the pooled dredging fund
- The required sand bypass capacity per port and for all ports involved in the project
- Optimizations that can be achieved in improving the bypass operations

As stated earlier, a complete feasibility study is needed to confirm the costs and benefits of the proposed innovation. To provide a high-level financial package, the *Team* have estimated the costs of the proposed solution based on the following assumptions:

- 6 ports authorities involved in the projects accounting each for a sediment bypass of around 750,000 m³/year to ensure navigability of the access channels⁶, totalling 4.5 million m³/year of sediments to be moved. This figure has been estimated on basis of our Return of Experience in some of the most impacted countries such Senegal, Togo or Benin.
- Cost of environmental treatment, if required, of the dredged sediments, corresponding coastal restoration works spread down-drift each port. At this stage, it is assumed that, with the implementation of the sand bypassing scheme, most of the sand placed during sand-nourishment works will be originated from maintenance dredging but 10% of the volumes will nevertheless have to be procured from sustainable offshore borrow areas. In total, the coastline treated will represent around 15 km, accounting for 5 million m³ of sediments placed in total (but spread evenly between each port).
- A cost of environmental degradation of 3 million USD/Km of coast⁷ per year.

The proposed framework (see table below) is based on the identification of **3 main scenarios**.

- **Scenario A:** 'Do Nothing': this scenario relates to the present operations in terms of classic maintenance dredging of the ports with offshore disposal of the sediments and coastal protection works for the countries to tackle down-drift erosion.
- **Scenario B:** Equivalent to Scenario A, plus implementation of a sand nourishment activity through supply from offshore borrow areas leading to persistent reduction of coastal erosion.
- **Scenario C:** The proposed solution i.e. bypassing strategy implemented either through:
 - A regional dredging capacity - sub-contracted to a third party
 - A regional dredging capacity – via an in-house fleet (procurement and operation of a Trailing Suction Hopper Dredger).

⁶ Giardino, A., Schrijvershof, R., Nederhoff, C.M., de Vroeg, J.H., Brière, C., Tonnon, P-K., Caires, S., Walstra, D.J., Sosa, J., van Verseveld, W., Schellekens, J., Sloff, C.J., 2018. A quantitative assessment of human interventions and climate change on the West African sediment budget. *Ocean and Coastal management* 156 (2018) 249-264

⁷ The Cost of Coastal Zone Degradation in West Africa

Note: The purpose of this cost estimate is to provide a relative comparison between the above scenarios. As a result, the cost estimates should be interpreted as relative figures. In the course of future feasibility study and potential project implementation, the selected number of ports & of coastline protection may vary. Therefore, the absolute costs of the project may change accordingly. However, the *Team* is confident that relative costs reduction between Scenarios A to C will be of the same order of magnitude regardless any project modification.

	Scenario A: do nothing	Scenario B: Conventional Dredging + Sand nourishment	Scenario C: Trans-Sand solution
Description	Total	Total	Total
FEASIBILITY STUDY	0 MUSD	0 MUSD	4,7 MUSD
PROJECT OPERATION COSTS	49 MUSD	145,8 MUSD	61,5 MUSD
GOVERNANCE RELATED COSTS	0,0 MUSD	0,0 MUSD	7,0 MUSD
ADDED COT FOR IN-HOUSE DREDGING FLEET	0,0 MUSD	0,0 MUSD	0,0 – 5 MUSD
TOTAL	49,0 MUSD	145,8 MUSD	69,2 – 74,2 MUSD
COST OF ENVIRONMENTAL DEGRADATION (COED)	45,6 MUSD		
TOTAL INCLUDING COED	94,6 MUSD	145,8 MUSD	63,0 – 66,8 MUSD

FIGURE 4: PRELIMINARY COST ESTIMATE OF TRANS-SAND SOLUTION

Computations based on the above assumptions show that the Trans-Sand solution (Scenario C) comes to an estimate total ranging between 69 MUSD and 74 MUSD which stands clearly below the 94,6 MUSD estimate for Scenario A. This suggests that a **15 to 20% cost savings** can be passed on to the individual port authorities through the proposed solution, after taking into account the annual operating cost of the regional governance, conservatively estimated at 3,5 MUSD for the dredging Consortium and 3,5 MUSD for the pooled dredging fund administration. The cost saving will then exceed 1 MUSD for each port authority, while also reducing significantly the cost for governments to mitigate coastal erosion.

In comparison, such works lead at a local scale by port authorities (for maintenance dredging) and government (for sand nourishment) as depicted in Scenario B would cost around 145,8 MUSD, which represents **almost twice the costs of the proposed solution**. Based on this comparison, the *Team* believes that a transnational solution is the only way to solve the coastal erosion issue at reasonable cost.

In addition, this solution has to be considered in the context of a 20-year project during which the effects of climate change /sea level rise will most likely generate increased costs. In this case, the solution will be even more attractive: the *Team* believes that in the end, **this could reach one-third cost savings for the participating authorities/countries over the life of the project**. These savings are expected to be even more pronounced as additional dams will be built in WA countries, further contributing to sediment deprivation at coastal level.

The above preliminary cost estimate clearly highlights the cost effectiveness of the regional collaborative approach proposed through the implementation of Trans-Sand.

3 - IMPLEMENTATION TIMELINE & METHODOLOGY

3.1 - Timeline

Trans-Sand is aimed to be developed gradually, as from a detailed and reliable feasibility study.

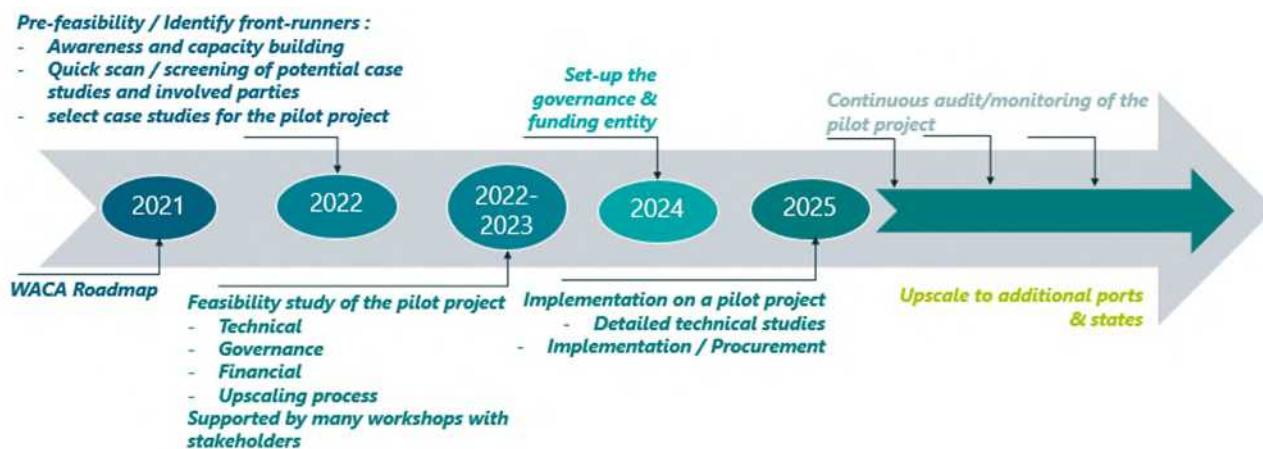


FIGURE 5: PROPOSED TIMELINE

The full process is based on a collaborative approach between responsible stakeholders (i.e., port operators, dam operators), institutional leaders (local, national and regional), and third parties, including all impacted stockholders (i.e., tourism, conservation groups, etc), developed through a stepped approach. The first steps do consist in a feasibility study which will be of paramount importance for the development of the concept:

- During the first months, the pre-feasibility or first step of the feasibility study will aim to identify, and agree in a participatory manner, all required front-runners.
- Once the front runners or best-case studies have been decided, a full feasibility could be initiated for the pilot project, including technical, governance and financial aspects with due consideration of the upscaling capacity from the pilot project to a wider scheme.

This first phase (the pre-feasibility study) could be launched at any time and immediately by the Trans-Sand Team, who is fully committed to move forward towards the development of the project, at an estimated and affordable cost i.e. 10% of the cost of the full feasibility study.

The first phase will also secure the funding for the full feasibility study and as such avoid delaying the implementation of the project, while building up the awareness and capacity as well collecting all required information.

3.2 - Methodological approach

The methodological approach will be of paramount importance and will be proposed in a timely manner with appropriate tools, appropriately selected to ensure that targets of this challenging and innovative project are met.

The backbone of the proposed methodological approach is aimed to be collaborative through an integrated approach with the WACA team and their partners, as well as with all other partners/third parties which may be associated with the project. This could will be performed through a large number of virtual and, when possible, face-to-face workshops and meetings.

4 - THE ROADMAP FOR SUCCESSFUL IMPLEMENTATION

4.1 - Feasibility Study

A comprehensive feasibility study shall be the first step of the project implementation and shall be led through a collaborative approach with all potential stakeholders.

4.1.1 - Objectives

The feasibility study will focus on the setting-up of Trans-Sand principles on a pilot project (with minimum to 2-3 ports in 2 countries) within the West African region, while ensuring the applied principles are then upscalable to a full Trans-Sand scheme involving several countries and ports. However, as detailed below, if more ports and countries are identified as front-runners, a larger pilot project could be implemented.

As such, the feasibility study aims to address the following topics:

1. Identify front-runners for case studies:

- a. Identify countries and ports who are open towards the idea of reusing up-drift and/or port-dredged sediments to combat down-drift coastal erosion. It is likely that this initiative will be most successful in countries that are presently expressing the ambition of developing plans for integrated coastal zone management (countries to be identified with the help of the WB) or which may be exposed to significant port developments in coming years. Local authorities may then organize the involvement of the ports. For this we envisage:
 - i. Technical Workshops with existing partners of WACA and any other parties identified in the Road Map. This could be extended in the course of this first step.
 - ii. Assessing their needs and motivations but also the added value of the Trans-Sand principles for all potential front-runners.
- b. Select at least 2 case studies (from front-runners) in 2 different WACA countries to form a pilot project and obtain insights into:
 - i. present governance structures
 - ii. present roles & responsibilities
 - iii. present magnitudes of sedimentation/erosion and dredged quantities
 - iv. present dredging scheme: equipment, methodology, contracting
 - v. present cost

2. For each case study:

- a. Identify which parties/stakeholders are responsible for:
 - i. Coastal (erosion) management
 - ii. Permitting of dredging/nourishing works/environmental impact management
 - iii. Maintaining the navigable depth in the port(s) and access channels.
- b. Interview those stakeholders:
 - i. What is current practice?
 - ii. What are the strong and weak points in the current practice (according to the stakeholders)?
 - iii. What do they think of bypassing/reusing dredged sediments (the Trans-Sand idea)?
 - iv. Under what conditions are they willing to do a pilot with bypassing/reusing dredged sediments?
 - v. To what extent are they willing to cooperate on a national and transnational level?
- c. Perform the required feasibility studies for the pilot – in line with needs/conditions identified under step 2b.

3. Overall feasibility study closing:

- a. Assess the compatibility of the adopted governance with a future up-scalable Trans-Sand scheme
- b. Go/no-go investment decision from partners and WB to do a pilot

At this stage the main expected benefit is that port and coast-related dredging are combined.

4.1.2 - Step 1 – Pre-feasibility study / Identify front-runners for case studies

4.1.2.1 - Step 1.1 – Awareness and capacity building

The objective of this task is

1. **To introduce the principles of the innovation, thanks to the prepared Roadmap, to potential targets (ports, ministries, institutional leaders, funding agencies).** In that perspective, together with the WACA support, the *Team* will plan and execute a high-level webinar designed to reach and inform the potential market.
2. In the continuity of the high-level webinar or any contact made by the WACA representatives or the *Team*, **to lead a program of technical workshops with potential front-runners**, with the aim to engage with specific stakeholders that are showing an interest to learn more about the proposed dredging fund and by-passing scheme.
3. **To lead technical workshops with third parties which may provide insight into and information for the feasibility study.** The workshops are to be run as small symposia and involve researchers with extensive local knowledge, with the aim to inform stakeholders on knowledge gaps, in relation to transnational processes, institutional gaps, and financial gaps.

4.1.2.2 - Step 1.2 – Quick scan - Screening of potential case studies and involved parties

Thanks to all information collected during the awareness and capacity building step, a second step will consist of a **quick scan**. The **quick scan** of all potential front-runners will be carried out based on a high-level assessment of all required parameters, in order to be in the position together with the WACA support to select among the front-runners, and to select the case studies:

1. Technical assessment:

- Estimate the sediment bypass requirements based on available data, for all areas of interest. The main objective of this step is to verify that the local conditions for the selected cases are suitable for the Trans-Sand concept from a technical point of view. At this stage, complementarity of the requirements in order to form a suitable case study technically speaking will be of paramount importance. Based on previous studies and literature the *Team* has insights into the sediment transports in the region, which will be used to make a first indicative estimate of the total required sand bypass capacity. Particular care will be given to the sensitivity, and the needs and impacts at the down-drift side will be critically looked at.
- Evaluate possibilities for the creation of sediment trapping capacity up-drift of ports and sand buffers down-drift, including with the use of Nature-based Solutions and integration of green and grey measures, with the objective to enlarge the recurrence interval for dredging. For the ports in the WACA countries opportunities, the creation of up-drift buffer space for sand accumulation and space for sand buffers at the down-drift side will be evaluated. This is an important aspect for the optimization of the bypass operations and innovative aspects are expected to be found here.
- Assess the type of dredging methods suitable and ideally fit for purpose for all case studies.
- Assess environmental and socioeconomic benefits of proposed solutions.
- Based on the above outcomes, define a draft bypassing scheme for each potential case study.

2. Governance assessment:

- Identify which stakeholders are responsible for:
 - Coastal (erosion) management
 - Permitting of dredging/nourishing works/environmental impact management
 - Maintaining the navigable depth in the port(s) and access channels
 - Monitoring socioeconomic and environmental performance.

- Assess the existing governance schemes and/or collaborations and/or relationships which may already exist at the level of a case study between the potential stakeholders, as well as between case studies.
- Assess the potential barriers in terms of governance, for each case study, as well as between case studies.
- Identify their current involvement in WACA.
- Assess the needs and benefits for each potential stakeholder, as well as the complementarity of mutual needs and benefits. Through this assessment, the perimeter of a case study identified through the technical assessment could be adjusted accordingly.
- Identify the stakeholder representation to be involved in the dredging consortium, for each case study and in case of a combination of case studies.

3. Financial assessment:

- Assess the existing costs for maintenance of the nautical accesses of the ports potentially involved. This will aim at compiling and assessing figures provided by the stakeholders on the past cost of the maintenance dredging to ensure appropriate levels of operations, whether this has been performed through direct maintenance dredging or indirectly by increase of the capacity of the sediment trapping buffer.
- Assess the existing costs associated to the down-drift erosion (direct and indirect cost), all based on existing studies and figures collected during the awareness and capacity building.
- Assess the existing costs associated with socioeconomic and environmental issues, all based on existing studies and figures collected during the awareness and capacity building.
- From the above cost gathering, assess the global cost/saving and benefits of the draft bypassing scheme for each potential case study, as developed in the technical assessment. This will take in due consideration the potential procurement scheme (dredger purchase or dredging works contracting), as well as identified dredging methods. Cost of the governance will not be considered at this stage, as its impact will remain limited compared to the other costs, and is expected to remain within the same order of magnitude for each case study.

During the **quick scan**, additional meetings may be organised with the various stakeholders in order to fill gaps in the assessment.

In order to support the decision, together with WACA support, the *Team* will perform a SWOT analysis through a joint workshop.

4.1.2.3 - Step 1.3 - Select case studies to form the pilot project

From the screening above and jointly with the WACA team, workshops will be organised in order to select for the pilot project, the most adequate case studies. At least 2 case studies shall be selected to get a valid pilot project, however this could be extended to a larger amount of case studies in case many of them are identified to be valid and merged in a complementary way.

Once the selection process is agreed between interested stakeholders and the WACA team, it is of paramount importance to get an official commitment from front-runners to move ahead if the feasibility study is conclusive (conditionality to be clarified by partners).

4.1.3 - Step 2 – Feasibility study

Once the pilot project has been defined and agreed, a **feasibility study** could be carried out **in an integrated manner at the level of the pilot project**, which would include the following steps:

4.1.3.1 - Step 2.1 - Technical feasibility

- Improve the estimate of sediment volumes, evaluate optimizations and fine-tune the costs/benefit analysis based on:
 - A detailed analysis of satellite images and hydro-sedimentary conditions. Based on recently developed satellite image analysis techniques the insight into the sediment balance will be extended for relevant areas for which detailed analyses are not yet available.
 - Numerical modelling studies of sediment transport for the entire WACA region, resulting in a detailed estimate of the required sand bypass capacity. For a considerable part of the area wave and sediment transport models are already available ([2]). Numerical modelling of waves and longshore sediment transport will be carried out for areas for which such studies are not available yet. Computations will be verified on the basis of the observed sediment balance (analysis of satellite imagery) and calibrated if relevant. Based on the results the required bypass capacity for each port will be assessed, as well as the total bypass capacity for the WACA area.
 - Investigate in more detail the use of sand traps and buffers and integration of green and grey measures. As discussed above, the use of sand traps and buffers around the ports, possibly in combination with nature-based interventions, is considered to be a critical aspect for the optimization of the bypass arrangement. Particularly for the case of large-scale buffers ("sand motors"), opportunities may be created to apply green measures for slowing down redistribution of sand (for example the use of vegetation) and to create new ecological value (for example via the creation of lagoons). Significant attention will be given to this aspect, based on expert judgment, possibly supported by detailed numerical modelling.
 - Look into effective nourishment strategies at the down-drift side. The placement of the sand down-drift of the port should be considered in detail, since it may largely affect the effectiveness of the nourishment for mitigation of the erosion, as well as the costs. This is therefore also a basis for optimization of the scheme. The following aspects are relevant:
 - ▶ Location of the sand placement in the cross-shore profile: on the foreshore versus on the beach. Placement of sand on the beach (in other words, high in the coastal profile) is generally more effective in terms of restoration of the sediment balance. However, it is often also more expensive than placement on the foreshore (lower in the coastal profile, as for example for a submerged bar). This implies that some optimization may be achieved here.
 - ▶ Size of the nourishments: many small nourishments versus a few big "sand motors" or hybrid schemes (bypass of sand combined with structures). The nourishment volumes per operation will be considered as an optimization parameter. Large bulges of sand may be considered which should feed the down-drift coast for a long period of time ("sand motors"), but also smaller and more uniformly spread nourishments will be considered. In some cases, it may be beneficial to combine the nourishment with grey structures (for example groins) and green solutions (for example artificial reefs, mangroves, dunes, coastal wetlands) to slow down the redistribution of the nourished sand along the coast. The Consortium has already developed this type of solution for the Saly project in Senegal, where coastline restoration works included sand nourishments coupled with groins. Nourishment frequency: costs and benefits of low-frequency versus high-frequency dredging. Apart from technical considerations on the size and frequency of nourishment, this also affects the costs and environmental impacts of the dredging operations (mobilization and demobilization, optimization of use of dredging equipment). Based on all above insights, conclusions will be drawn on the effect of the nourishment frequency on the effectiveness of the bypassing scheme in the WACA region.
 - Fine-tune costs and benefits on the basis of local figures. The cost benefit analysis will be fine-tuned on the basis of the above-described considerations and on local figures of costs and benefits (more detailed than the figures used in the quick scan phase).
- Assess the expected social and environmental impacts (such as CO₂ emissions and ecological impacts, as well as jobs creation and capacity building) of alternative bypassing schemes (qualitatively). For that

purpose, a scoping study will be performed in close consultation with all potential third parties and stakeholders, through a collaborative approach. This will aim at defining:

- The preliminary assessment of the benefits and positive impacts of such a bypass system compared to existing practice.
- The preliminary assessment of impacts of such works, including potential mitigation measures
- The required scope for the SEIA study to be performed at the implementation stage.
- Look into potential tipping points in relation to climate change. The plans should be evaluated against possible tipping points in climate change, which could result in relatively fast changes of local conditions (waves, water levels, sediment transports, erosion rates, subsidence). The concept of sediment bypassing - due to its flexibility - is potentially suitable to deal with considerable changes in environmental conditions, but the consequences of such changes on the feasibility should be considered in advance.
- Look into other potential tipping points in relation to further dam developments.
- Organize a final technical workshop with relevant stakeholders to identify the technical feasibility and local acceptance of the proposed plans (in combination with workshops on requirements for viable and sustainable economic arrangement and governance).
- Define the scope for the required implementation technical studies to be performed.

4.1.3.2 - Step 2.2 - Governance feasibility

The set-up of a regional dredging Consortium and a dedicated pooled Fund requires the wilful consent and proactive contribution from a diversity of stakeholders and this will be achieved through both central leadership and a strong coordination of the participating countries' Governments. In order to carry out this process, the following aspects should be carefully addressed through the governance feasibility study, taking input from the financial feasibility which will provide detailed evidence as regards the source of the main financial gains at stake:

- Designate the central body to be tasked with overseeing the process of gathering all parties around the table (e.g., World Bank Group, PMAWCA, African Union, etc..); this needs to be a leading and widely recognized Authority, able to voice its sponsorship and to facilitate the emergence of views on the most appropriate governance.
- Process mapping: Prior to any recommendations on the governance structure, an initial step will consist in identifying all the existing processes that fall within the overall ambitions of the Trans-Sand project and in detailing how these processes are being conducted under existing frameworks (input / output / timescale). This will include, not only Port Management issues e.g., the budgetary process for maintenance costs or the decision process for port expansion investments, but also, issues relating to coastal management (e.g., sand procurement), community livelihood (e.g., social impact evaluation), environmental aspects, and the funding of coastal rehabilitation costs.
- Stakeholder mapping: This step will consist in making a preliminary mapping of the parties / formal bodies, that have either direct responsibility, or exert influence over the decisions relating to the above processes (e.g., Private Port Operators, Ministries, heads of local authorities, environmental agencies, Chambers of commerce, local community groups, etc.). The purpose is to evaluate the interdependence and the balance of powers between parties to design the optimal governance structure
- Propose the stakeholder representation to be designated in the dredging consortium (port authorities, port operators, govt. representatives, dredging companies, etc.). Define their respective roles & responsibilities (e.g., decision power, funding body, technical operator, etc.)
- Propose the operational contribution from each member of the Consortium and the pooled Fund, based on the new requirements and on the role & responsibilities of each stakeholder before the solution is implemented (functions at the Port Authorities are expected to remain broadly identical at least initially to facilitate the integration)
- Define the governing principles of the dredging consortium, in view of the current stakeholders' roles & obligations, put in their respective national legal context.
- Propose specific requirements for operating and maintaining the fund, including:

- Governance arrangements, e.g., Executive Committee, Technical Committee, and central function to administer the fund, deal with the planning and logistical issues, document and receive requests, ensure contract management, overall coordination and monitoring.
- Define and justify Member Contributions to the Fund
- Design and agree a Process for making funding requests (eligibility, scheduling, use of funds, reporting)
- Define an external peer reviewer to oversee processes and ensure unbiased approaches.
- Organize a final governance and financial workshop with relevant stakeholders to identify the related feasibility and local acceptance of the proposed plans (in combination with workshops on requirements for technical feasibility)

4.1.3.3 - Step 2.3 - Financial feasibility

- Define the conceptual bypassing scheme and financial model, including business case.
- Justify, compute and plan the types, amounts and budgetary processes for the financial contributions from each stakeholder to the pooled Fund and compare them with the present costs for dredging and coastal erosion (i.e., the benchmark).
- Identify potential financing parties and partners, based on a set of eligibility criteria to be agreed with the Project sponsors
- Design the Fund and propose the pro-rated mechanism for cost allocations between ports and countries as per the outputs of the optimization model:
 - Step 1: Under confidentiality agreements, the first step will be to gather financial cost data from Pilot Group members as previously detailed (including the maintenance of the port access, down-drift erosion) and to compile this data to assess cost savings expected to result from the bypassing scheme.
 - Step 2: Data collection will be expanded to include any other source of identified cost savings (e.g., the new procurement scheme), with the view to determine the magnitude of the overall savings to result from the Trans-Sand technical proposition.
 - Step 3: Data gathering will be further opened to include the entire scope of impacts (e.g. indirect costs resulting from coastal erosion and weighing on the local communities) and which currently require funding for mitigating / correcting actions. This will form a new holistic cost avoidance picture to be achieved by WACA Pilot group members, as a result of setting up Trans-Sand.

This impact measurement exercise will be conducted based on a recognized methodology to monetize impacts, establishing *Causality* by applying scenario techniques such as *Deadweight* i.e., outcome that would have happened even if the project had not taken place, *Displacement* i.e., what are the possible unintentional outcomes, and *Attribution* i.e., how much the outcome is caused by other projects.

4.1.3.4 - Step 2.4 - Upscaling feasibility

In view of the pilot project feasibility study, the *Team* will perform a thorough compatibility assessment of the adopted governance with a future upscalable Trans-Sand scheme, in order to ensure that any decision taken at this stage does not impede future upscaling of the governance and scheme to other countries and ports.

4.1.4 - Step 3 – Overall feasibility study closing

4.1.4.1 - Go/no-go investment decision from partners and WB to do a pilot

Through a final workshop with the WACA team and all front-runners, the Go/No-Go decision will be sought, with potential amendments to the proposed overall scheme to fit the front-runners becoming now partners, as long as the initial philosophy of Trans-Sand remains, including but not limited to the up-scalable potential.

4.2 - Implementation of the pilot project

4.2.1 - Set-up of the governance and funding

During a series of dedicated working sessions, the final governance and funding agreement will be established, including but not limited to the following tasks:

■ On the Governance side, the work shall include the following:

1/ Process Mapping

- Confirm from the feasibility study, all the existing processes that fall within the overall ambitions of the Trans-Sand project and in detailing how these processes are being conducted under existing frameworks (input / output / timescale).
- The exercise should confirm all relevant parties involved in Trans-Sand as per below.

2/ Stakeholder Mapping

- This step will consist in making a detailed mapping of the parties / formal bodies that have either direct responsibility, or exert influence over the decisions relating to the above processes (e.g., Private Port Operators, Ministries, heads of local authorities, dam operators, tourism sector, environmental agencies, Chambers of commerce, local community groups, etc.). The purpose is to evaluate the interdependence and the balance of powers between parties to design the optimal governance structure, and propose voting rights & responsibilities suitable for participants within each body.
- Specific focus will be placed on two aspects of this stakeholder mapping:
 - (i) drawing up a picture of the organization - and the ultimate responsible party - for each stakeholder; and identifying potentially 'common' parties with ultimate authority over several entities, or several topics within the scope of Trans-Sand ;
 - (ii) investigate to what extent there are existing cross-border discussions between WACA member countries, including with potentially joiners of Trans-Sand (e.g., on economic cooperation, joint procurement agreements, non-competition logistics agreements, etc.) which could influence the governance structure in any way.

3/ Roles & Responsibilities Mapping

- Based on the above work, this step will consist in confirming the conditions under which some of the current responsibilities and mandates of the Port Authorities / other Govt. bodies can be delegated and/or transferred, by the current stakeholders to the new governance (e.g., dredging contract reviews, budgetary commitments, joint procurement terms, performance monitoring and evaluation, etc.). This step will also aim to define an operational plan to achieve such reorganization.
- Beyond organizational impacts, this task will consist in assessing the regulatory / legal dependencies of the new governance. Legal advice will be sought to identify any blocking points or regulatory restrictions which may affect members' capacity to join in. This would be a separate exercise from the legal review which will take place when members consider joining the new set up.

4/ Governance Structure Recommendations

- The above steps will result in the formulation of one (or most likely several) governance structure(s), with details on their respective remit / mandate, proposed membership rules, and individual participants' commitments and process maps.
- Successful execution of the project will depend on whether the right people are assigned to the right spot. Roles & responsibilities will be defined and positioned within their respective chains of command to minimize confusion and troubleshooting when the model is deployed. Project sponsors will play a critical role to support interactions with potential participants to explain the benefits of the new governance model and to engage them to champion the project.

- On the Compensation/funding mechanism side, the work shall include the following tasks:

1/ Data Collection and Impact Assessment: already performed during the feasibility study, but could be completed in light of any new data made available by the partners.

2/ Fund Set up

- A formal process will be set up to document how scenarios are formalized and computed, based on hard evidence and softer assumptions, as gathered in 1/ above; this may include fully documented analysis of port access requirements, dredging capacity options, but also of coastal erosion management & funding plans, socio-economic priorities, as well as financial/timing constraints.
- Scenarios represent the basis of the Fund's net payment contributions requested of / or made to individual Members. The evaluation methodology used to formulate such scenarios is therefore critical, particularly in relation to 'softer items, requiring data integrity and robust justification for the underlying assumptions.
- A scheme is to be created to generate scenarios at different levels, for each Member individually, for the Consortium as a whole, or potentially for sub-groups (e.g., for pairs of countries), with the goal to model and define optimal scenarios.
- The Fund's legal structure will be recommended based on a legal/financial assessment to be made together with the initial Pilot group, with the idea to create an entity perceived as independent (for ex. not overtly associated with one potential Member country)

3/ Funds Flow / Compensation Mechanism setup

- A pooled fund mechanism is to be set up to include notably (i) a definition of each money inflow and outflow purpose and (ii) a description of the funds flow triggering factors and authorized parties.
- Detailed Processes will be defined to outline funds flow modus operandi
- A compensation mechanism will be designed and co-created with the appointed Members to agree the process under which such mechanism will apply and can be activated.

From a methodological viewpoint, it is intended that the governance pilot project implementation work will include:

- On site data collection, data mining with governments & local authorities
- Interviews with key stakeholders,
- Workshops to raise and discuss options as well as co-create and validate operational processes.

4.2.2 - Detailed technical studies

The scope of the detailed technical studies will be refined through the feasibility study, but this could include:

- Look into the required (optimized) number of dredging vessels and optimized sailing routes across the WACA countries (accounting for maintenance needs, costs, environmental impacts, and CO2 emissions). Based on the required bypass capacity and recurrence intervals for bypass operations the number of dredging vessels can be assessed and recommendations on their operations will be made. This will also take into account whether dredging equipment will be purchased internally or whether use will be made of contracts with commercial dredging firms.
- Perform the detailed Social Environmental Impact Assessment., including modelling required to assess the various dredging techniques (sediment plume modelling,...)

- Define in detail the bypassing scheme. The bypassing scheme will consist of recommendations for dredging and placing of sand in terms of volumes, locations (alongshore and cross-shore in the coastal profile) and estimated recurrence intervals of bypass operations, based on a sound technical study. It will include the number of dredging vessels and recommendations on their sailing routes. The plan will take into consideration the costs and benefits, as well as environmental and social impacts.
- Make a monitoring and future optimization plan. Monitoring of the performance of the bypass operations is considered to be essential to optimize the scheme in the course of time, based on the actual performance of the scheme. Differences between observed and predicted behaviour of the scheme should be understood and based on this understanding the sand bypassing scheme should be fine-tuned.
- Provide general guidelines for new (greenfield) port developments (mainly related to site selection and port layout), taking into consideration ecological impacts of ports (which also include coastal impacts).

4.2.3 - Implementation

The implementation will consist in:

- Signing all required agreements to launch the pilot project
- Mobilizing the set-up governance
- Initiating the by-pass system: subject to the decision taken on dredging equipment purchase or dredging works contracting, tenders shall be prepared for either equipment purchase or works performance.

4.2.4 - Monitoring and evaluation of the pilot project

It is of paramount importance that a proper monitoring is put in place of the pilot project and that the results are carefully evaluated, in order to demonstrate the benefits of the Trans-Sand scheme but also convince others to adhere. This will aim to respond to following queries:

- a. How successful was the pilot in terms of reducing maintenance dredging (ports) and coastal erosion (government)?
- b. What are the financial consequences for the stakeholders. Was the business case positive? If not, what is needed to make it positive? Or how can it be made even more positive?
- c. Are there differences between case studies in different countries? If so, what can we learn from these differences?
- d. Is there willingness to cooperate between countries involved in the pilot? If not, why not and how can cooperation be made more attractive?
- e. Are the results sufficiently promising to involve more countries? Which additional cost-reductions and benefits may potentially be achieved if more countries are involved? Is it possible to make a draft business case for multiple countries?
- f. In the case it would be concluded that the pilot was not successful: do we have a clear insight into why it was not successful, and can modifications be made to change this.

4.3 - Upscaling

On basis of monitoring and the outcomes evaluation, subject to positive results, the upscaling process could then be initiated. The upscaling process will be founded on the same collaborative and integrated approach than for any previous steps. The sub-tasks which may be required should be the following:

- Awareness build-up around the results of the pilot project to any former potential front runners as well as any new comers resulting from the extension of the WACA program.
- Once, candidates have been selected, their incorporation to the Trans-Sand initiative will require implementation studies to be performed with a scope similar to the ones described above. The exact

content will remain however to fine-tune to the candidates, with due incorporation of the findings of the pilot project.

4.4 - Required level of support

The Trans-Sand *Team* offers the advantages to cover most of the required technical, governance and financial capacities, as well as an in-depth knowledge of the involved themes, thanks to its past and current experience in West Africa either within WACA program or with DFIs, public port authorities and private port operators.

However, the Trans-Sand team will need support from:

- All programmatic partners from the WACA program in terms of data collection, e.g., the GIE Dragage in France through the programmatic partner "Ministère de la transition écologique".
- Internally to World Bank or any existing DFI partner of the WACA program, from their PPP specialist (transaction structuring on infrastructure and large projects) / Legal & Compliance / Sovereign & Government sector specialists, and environmental and socioeconomic specialists.
- From same experts from the private sector investment bank community or from Ecowas, specifically on transaction structuring on infrastructure and large projects, in light of their significant experience with intergovernmental infrastructure projects.

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