

# “Low-regret” adaptation measures in Coastal Engineering – chances in research and development !?

„Low-regret“ Anpassungsmaßnahmen im Küsteningenieurwesen - Chancen für Forschung und Entwicklung!?



*10. FZK Kolloquium  
Feb. 26, 2015 – LUH, Hannover*

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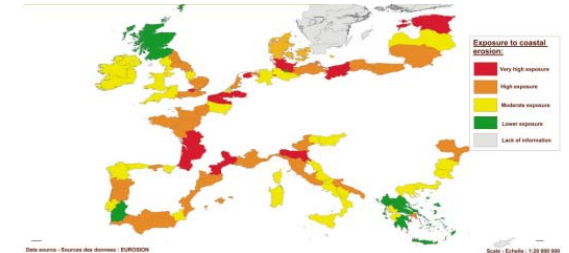
# (1) Background and rationale of “low-regret” adaptation strategies and measures



Island Darß,  
Baltic Sea Coast  
(StäLU, 2009)

## Background and rationale

- >70 % sandy coastlines worldwide in recession (Eurosion, 2004). Climate change aggravates developments (AR5, IPCC, 2014)!
- >20 % European coasts actively retreating. Costs will average to 5,4 bn. €/a to sustain shorelines
- >70 Mio. people with economic asset of  $10^3$  bn. € exposed in 500m buffer zone from coastline
- Coastal ecosystems generate 40% of services of all ecosystems (Costanza et al., 1997)
- But, also in EU-frameworks, i.e. Flood Directive (2007/60/EG), Habitat Directive (92/43/EWG), Marine Strategy Framework Directive (2008/56/EG) and, recently, Maritime Spatial Planning Directive (2014/89/EU)



## Background and rationale

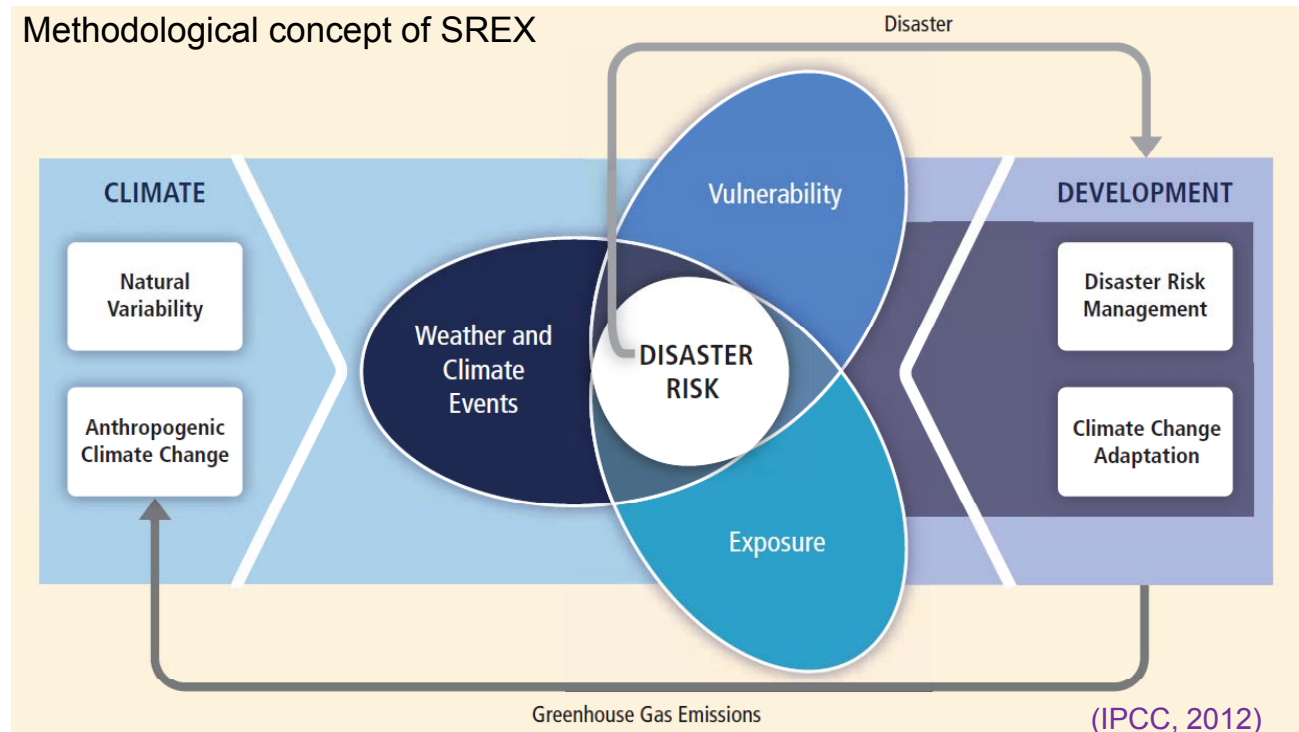
- Methodological concept of **SREX - Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation** (IPCC, 2012)
- SREX promotes to establish diverse portfolio of options, e.g. **“low regrets” adaptation measures** to adverse environmental impacts from future climates, i.e. exposure, resilience, share/transfer risks or awareness, etc.

### Regret:

*“Feeling of sadness or disappointment over an occurrence, measure or something that someone has done or failed to do”*

(Oxford Dict., 2014)

dt.: *“Bedauern”, “Reue”*  
oder *“Kummer”*



## (2) Hard-coastal protection systems – Typical examples and their evaluation

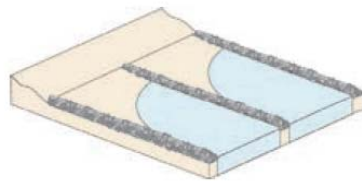


## Hard-coastal protection systems – Typical examples and their evaluation

- Higher **likeliness** and **consensus** of more severe impacts from **gradual processes**, i.e. sea-level rise, coastal erosion, etc., and likewise from **extreme events**, i.e. storms and storm surges are given, esp. near-shore, estuaries
- Engineering-type **hard-coastal protection systems** encompass traditional approaches to protect coastal areas from coastal hazards
- Each measure is **site-specific**, proves **system-relevance** and addresses a certain degree of **implementation necessity**
- **Typical hard-coastal protection systems** can moreover be **described and evaluated** regarding following features or characteristics:
  - **Coastal hazards** addressed (i.e. effectiveness, reliability)?
  - **Life-time, appropriateness** and **durability**?
  - **Financial burdens** in dimensions of construction and maintenance?
  - Assessment of **Ecological side-effects** and (ir)reversible impacts?
  - **Co-benefits** and level of **public acceptance**?
- Well-established **design basis** established with **monitoring and maintenance guidelines** – **Best practices in Coastal Engineering broadly provided!**

## Hard-coastal protection systems – Typical examples and their evaluation

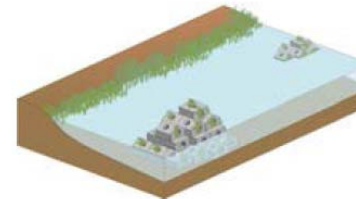
- Traditional engineering-type **hard-coastal protection systems** encompass approaches to protect coastal areas from coastal hazards, e.g.
  - In coastal waters (shallow water environments)



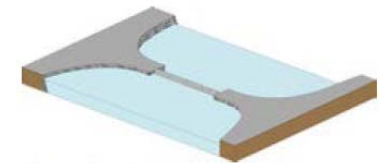
Groins



Breakwaters

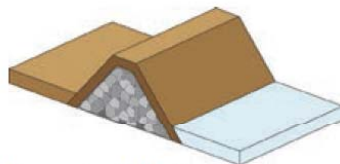


Artificial Reefs

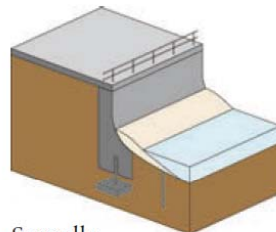


Surge Barriers

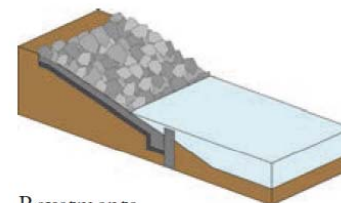
- On the shoreline



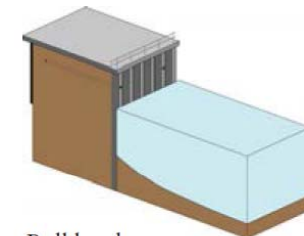
Levees (or Dikes)



Seawalls

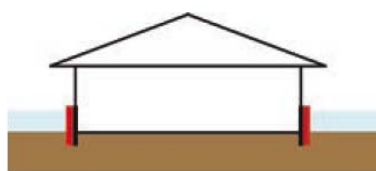


Revetments

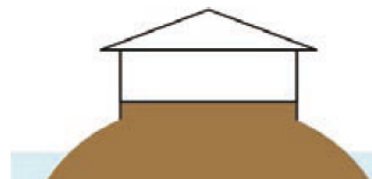


Bulkheads

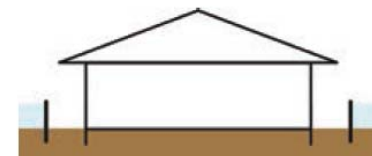
- On Site



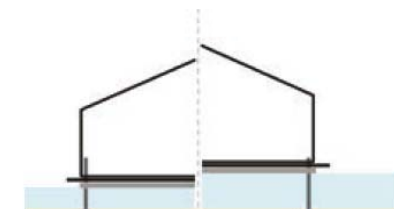
Dry Floodproofing



Elevate on Fill or Mound



Site Protection



Floating Structures

Source: UWAS, 2013



## Hard-coastal protection systems – Typical examples and their evaluation

- (Historically) Coastal adaptation strategies to hazards have been relatively well developed building on the discipline of Coastal Engineering

...but, too often “**high-regrets**” revealed in the mid- or long-term since

**Engineering approaches** are most often in opposition with  
“well-being” of ecosystems and its preservation

as coastal habitats are, i.e. (too) often destroyed, coastal erosion elsewhere aggravated or natural migration of shores prevented

- How are typical “**soft-coastal**” protection systems designed?
- Are these constructional attempts of “**low- or even of no-regret**”, yet?
- And if so, how could these novel measures be designed and **assessed/monitored** in regard of the above listed common queries?

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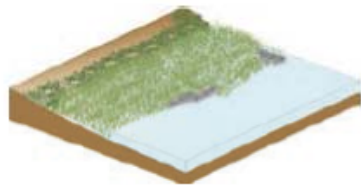
- How are typical “soft-coastal” protection measures evaluated?
- Are these common “low-regret”, yet?
- ...**chances in research and development?**  
... novel measures be designed and  
... assessed/monitored in regard of the above listed common queries?

# Candidates for “low-regret” adaptation strategies and perspectives

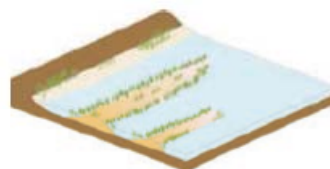


## Candidates for “low-regret” adaptation strategies and perspectives

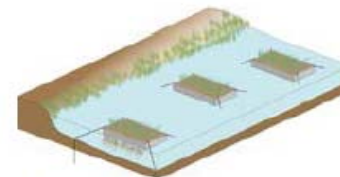
- Novel engineering-type **soft-coastal protection systems** encompass innovative approaches to protect coastal areas from coastal hazards, e.g.
  - In coastal waters (shallow water environments)



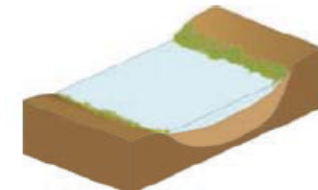
Constructed Wetlands



Constructed Breakwater Islands

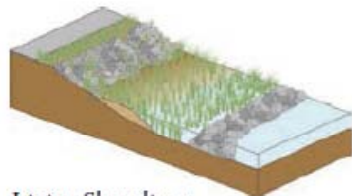


Floating Islands



Coastal Morphology Alteration

- On the shoreline



Living Shorelines



Waterfront Parks



Beaches and Dunes

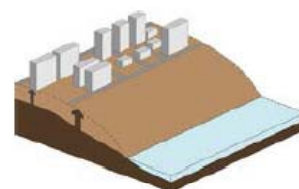


Multi-purpose Levees

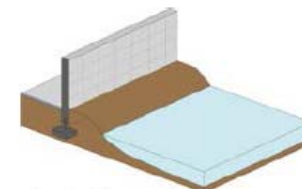
- Upland



Strategic Retreat



Elevation of Land and Streets



Floodwalls

Source: UWAS, 2013

## Candidates for “low-regret” adaptation strategies and perspectives

- „Low-regret“ measures could also follow the [Ecosystem Approach to Management \(EEA, 1999\)](#) approach following a paradigm shift

### “Working with Nature”

covering a [transitional process](#) from building *in* towards building *with* nature



Ecological  
waterfront  
development

Brooklyn Bridge Park, NYC (UWAS, 2013)

■ PIANC, 2011, promotes the co-called [WwN](#) as a [proactive, integrated approach](#) by means of:

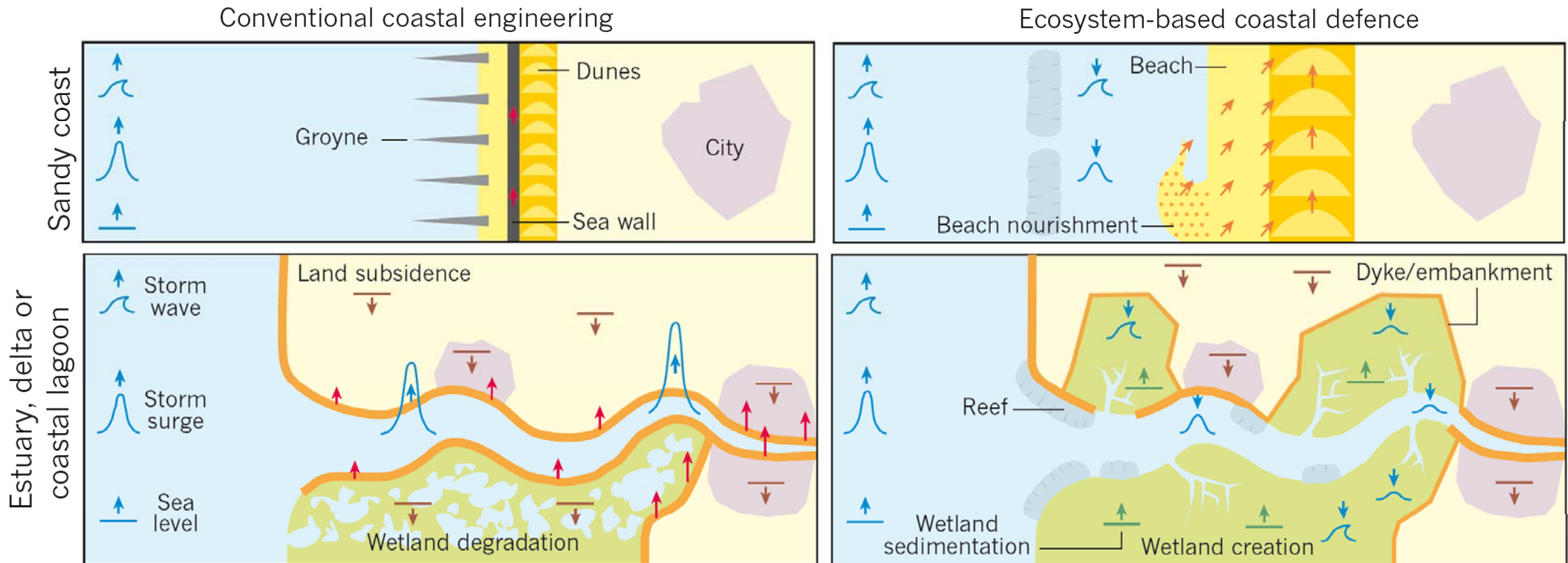
- Achieving project [objectives](#) in an [ecosystem context](#) rather than assessing the [detrimental consequences](#) of a predefined project design
- Identifying [win-win solutions](#) rather than simply [minimizing environmental deteriorations](#) or ecological irreversible damages

## Candidates for “low-regret” adaptation strategies and perspectives

- Conventional Coastal Engineering compared with new **Ecosystem-based defense measures** (Temmerman et al., 2013)



Nature 504, pp 79–83



**Blue arrows:** Increase/decrease in intensity of storm waves, storm surge and sea level, **Red arrows:** Indication of need for maintenance and heightening of dykes, embankments and sea walls with sea-level rise, **Brown arrows:** Land subsidence due to inhibited sediment supply and soil drainage, **Green arrows:** Stimulation of wetland sedimentation/creation with sea-level rise, **Orange arrows:** Stimulation of beaches and dune sedimentation with sea-level rise

## Candidates for “low-regret” adaptation strategies and perspectives

- Ecosystem protection and restoration increasingly recognized as legitimate novel coastal protection systems to provide or even enhance function and structure of ecosystems services
- Engineered hard-protection coastal adaptation strategies **gradually supplemented by soft-protection measures** in coastal zones, e.g. beach or foreshore nourishments, revised land management as well as updated building codes or flood insurance programmes (Cheong, 2011)

### On the other hand side research questions arise:

- Quantification of **uncertainty of applicability of coastal adaptation with “low-regret” elements** in dynamic coastal environments?
- **Robustness, resilience and cost-effectiveness** of “low-regret” adaptation **approaches** to prepare coastal communities and authorities for highly uncertain coastal environment in the future?
- Principles and technical know-how on **“low-regret” measures** exist, but only few have been examined comprehensively. What are their benefits in terms of **efficiency, reliability, durability or (un/wanted) ecological side-effects?**

## Candidates for “low-regret” adaptation strategies and perspectives

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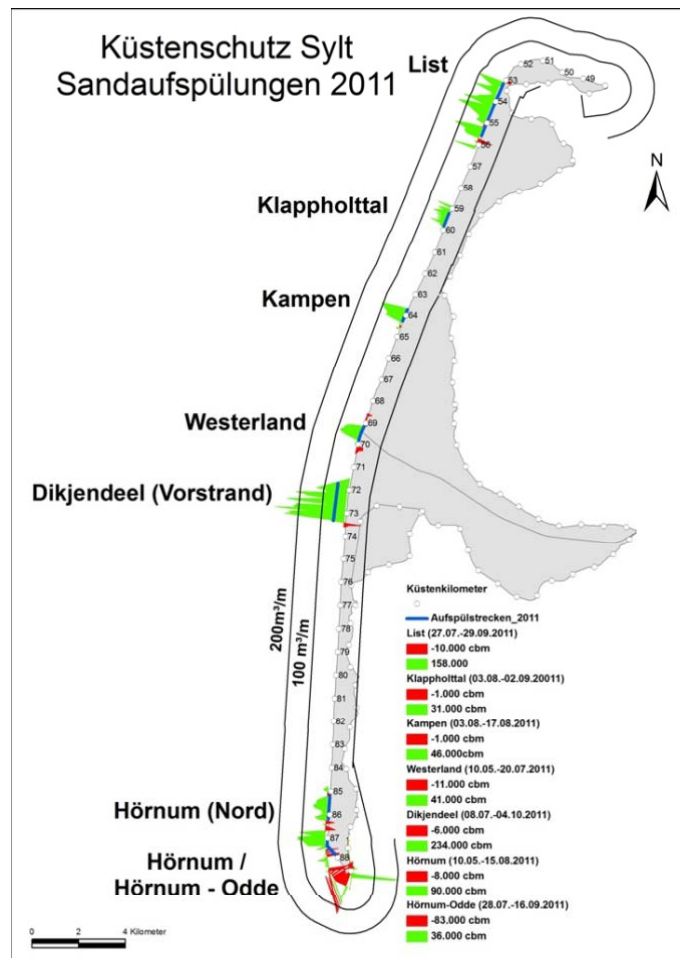
**...indeed, chances in research and development!**

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## Candidates for “low-regret” adaptation strategies and perspectives

- Beach and foreshore nourishments to **artificially sustain coastal environments** and enable soft (i.e. low-regret) measures for coastal protection



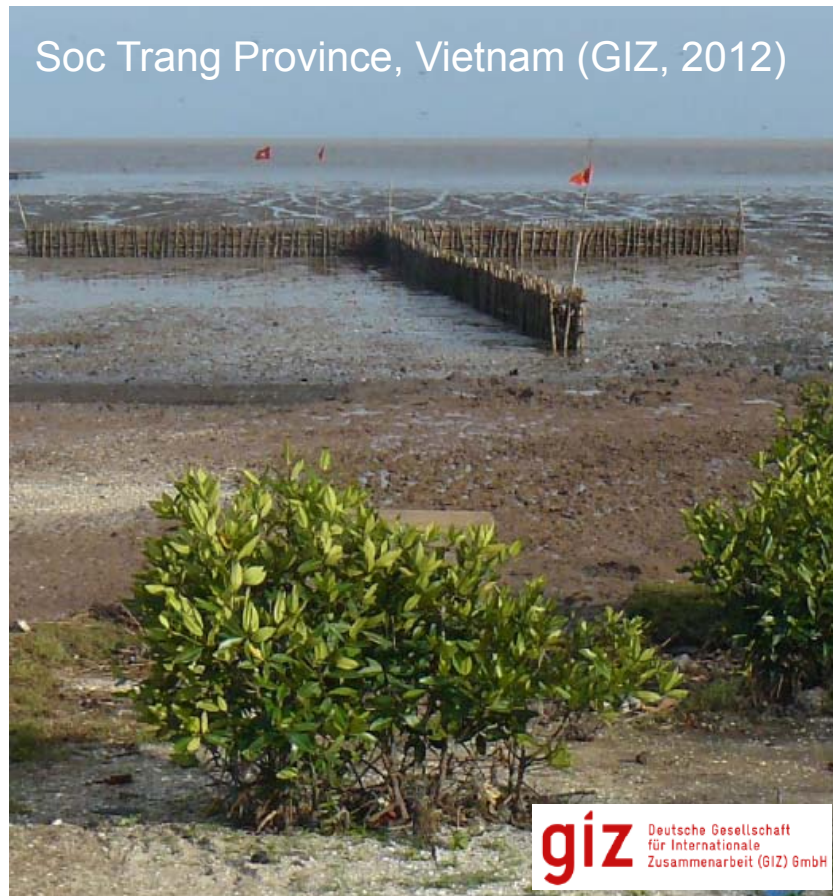
Pilot project to test the efficiency of local mega-nourishments as a counter measure for an anticipated enhanced coastal recession (Stive et al., 2013)



„Sand Engine“ (~21,5 Mio. m<sup>3</sup>)  
in the Netherlands

## Candidates for “low-regret” adaptation strategies and perspectives

- **Bamboo Breakwaters** as coastal stabilization measure (sediment accretion) by means of installation and maintenance of innovative, ecologically-friendly materials (bamboo) with participatory involvement of local communities



## Candidates for “low-regret” adaptation strategies and perspectives

- **Coconut fiber beach revetments** (Coir seed fiber from coconuts). Raw material for products in the domestic usage as i.e. for mats and carpets, automotive industry or for insulating building materials.



## (4) Summary and discussion




## Summary and discussion

- “Low-regret” adaptation measures are needed and feasible in technological and ecological dimensions for long-term efficient coastal protection
- The way forward in Coastal Engineering:  
Clear statement: R&D on sustainable, multi-functional and adaptive coastal protection solutions in environmentally sensitive areas in order to endorse favourable ecological side-effects, especially in regard of enhancing coastal habitats in terms of low-regrets.
- Objectives might be achieved by means of:
  - Transdisciplinary fundamental and applied coastal research
  - Education of students, and, training of operational capacities/authorities
  - Participatory involvement of local communities → ownership, identification
- Overarching principle is to (scientifically) assess complementarities and compatibilities of low regret measures -> **MARE:N Input**
- Need for definition of clear design and evaluation criteria, monitoring and inspection guidelines and share experiences on how “low-regret” measures are effective and by what means demanded key benefits are proved  
-> **MARE:N Input**

# Thanks for your kind attention!

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