

# COMMENT PENSER LA RESTAURATION DES ESTUAIRES DANS LE CONTEXTE DES CHANGEMENTS GLOBAUX ?

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*Comment risque d'évoluer la résilience des  
systèmes ?*



## Protection et valorisation des estuaires : une synthèse des connaissances

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*15.5x24 cm · Broché ·*

*Quadrichromie*

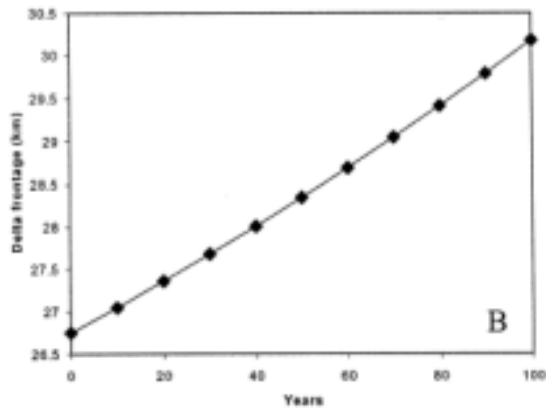
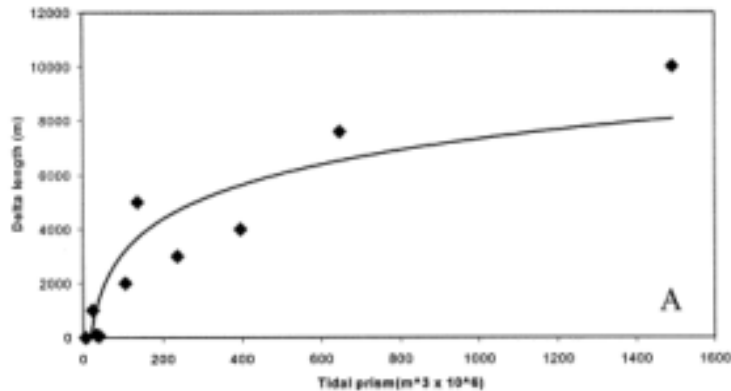
**<https://www.lavoisier.fr/>**

# 1. IMPORTANCE DU CADRE PHYSIQUE



A: positive relationship between the volume of sediment and length of 9 british estuaries

B: Growth of deltas through time



## Tidal deltas

- ✿ Tidal deltas are **ideally suited to protect the estuary**: self-maintained form of defense against floods (Pethick 2008)
- ✿ There is a **whole range of systems** phasing with the new regional oceanographic data (Prandel & Lane 2015)
- ✿ **Temporality** ranges from a decade for the shortest and shallow estuaries to the millennium for deeper estuaries but with low tidal range (Pethick 2013)



## 2. COMPRENDRE LES EFFETS BIOLOGIQUES DU CC



### Sea level

Waves / rugosity / currents

Salinity / deepening

Turbidity maximum / sedimentology

Erosion / mud flats, salt marshes migration

Future of wetland

### Precipitations River flow

Salinity / anoxia

T maximum

Respiration / heart bit

Energy intake

Food webs

### Temperature

Phenology  
Biogeography

Metabolism intensity

Pathology

Acclimation / adaptation

Shifts in distribution

### Radiations

Fecondity, growth and development

Survival / Lethal effects

Mobility

Phototactic responses

Species extinction / opportunists

### CO<sub>2</sub> Increase

Animal hypercapnia

Acidification

Photosynthesis

Primary production

Osmotic pressure in phanerogam plants

New ecosystems

**Expected effects of climate change on temperate estuaries**



## Restoration of the **quantity** (area) of **estuarine habitats**

- **Fight the loss** of intertidal habitats in different areas of the estuary
- **Manage the salinity intrusion** without exacerbating it in the estuary and deal with a possible increase in turbidity

👉 **Promote "soft" amenities**



## Sea level

Waves / rugosity /  
currents

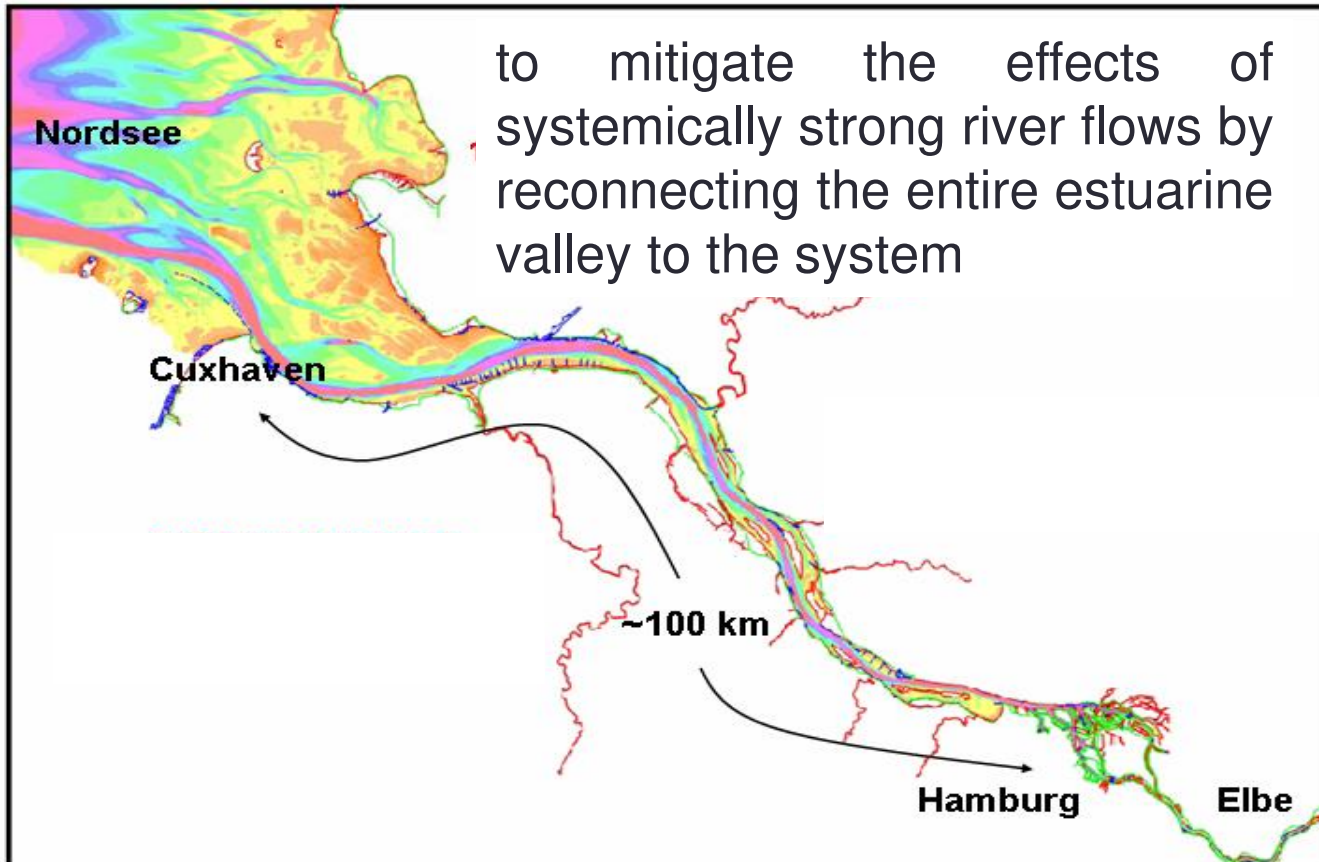
Salinity / deepening

Turbidity maximum /  
sedimentology

Erosion / mud flats, salt  
marshes migration

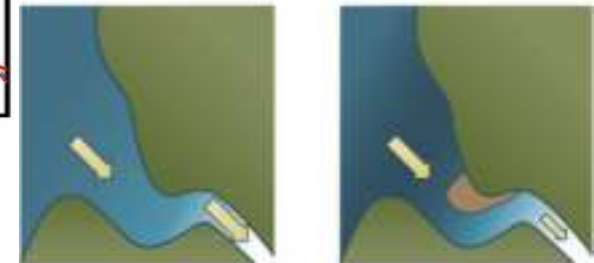
## Future of wetland

# River engineering measures as milestones for a future action plan for the Tidal Elbe River



to mitigate the effects of systemically strong river flows by reconnecting the entire estuarine valley to the system

*to relocate fresh, noncontaminated sediments in areas where there is less possibility for them to return to the place where they were dredged.*



## *Sediment management concept*



Understand and interpret the changes observed in **the watershed**

- on the **river flow**
- on the evolution of **morphology in the upstream zone** of the estuary, such as channelization

Take into account the important role of the upstream part of the estuary in the **functioning** of the ecosystem

- Better document **the ecology** of this area

👉 **To control the dynamics of nutrients**  
(eg. nitrates, silica)

**Precipitations**  
**River flow**

Salinity / anoxia

Turbidity  
maximum

Respiration /  
heart bit

Energy intake

**Food webs**



## Breakdown in geographical barriers Establishment of "**emerging**" **ecosystems**

- Unknown functional characteristics
- Impossible to freeze or return backward

## To **master invasion**

## To consider **changes in species'** **ranges**

☞ **To model climate in relation to species  
potential distribution**

☞ **To better understand shifts in  
ecological niches**



## Temperature

Phenology  
Biogeography

Metabolism intensity

Pathology

Acclimatation /  
adaptation

Shifts in  
distribution

# Himasthla {genus} - Platyhelminthes; Trematoda; Echinostomida; Echinostomatidae;

Pathology

**BOLD**SYSTEMS



- ❖ IP1: Hydrobia ulvae (gasteropod)
- ❖ IP2: Cockle
- ❖ DH: a sea bird (gull or European Oystercatcher)



“favourisation”  
mechanism

Caudron & Ducrotoy  
1983 - Combes, 1995 –  
Ducrotoy 2013



**ARK**ive



## Projet de dépoldérisation - Baie de Somme

- Beware of excellent but local environmental conditions
- Need for **holistic view**

☞ **Installation of CFA controlled flood areas** (notably throughout the upstream zone)

☞ **Provide a network of ecological hot-spots**

☞ **Promote the migration of organisms and their propagules**



**CO<sub>2</sub> Increase**

Animal hypercapnia

Acidification

Photosynthesis

Primary production

Osmotic pressure  
in phanerogam  
plants

**New  
ecosystems**

- Limitation of primary production by residence time or other
- Importance of tripton and microphytobenthos
- To understand invasion mechanisms

☞ **Lateral water supply (karstic or not) to be considered**

☞ **Protect and develop mudflats**

☞ **Create lentic environments**

**CFAs** controlled flooding areas with

**CRTs** controlled reduced tides

## Radiations

Fecondity, growth  
and development

Survival / Lethal  
effects

Phototactic  
responses

Species  
extinction /  
opportunists



# Patrimonial view of ecosystems

Ecosystems are  
**dynamical**

- Restoration to focus on habitats not species
- Need to allow species to adapt to **new biophysical conditions**

European and national legislation aim at protecting habitats are **species based**

- Risk of protected habitats to become "**fossilised**"

**Need to restore appropriate habitats in "new" locations**

# 3. APPROCHE FONCTIONNELLE



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Comprendre  
les  
SYNERGIES



# Complexité / Hétérogénéité

## ✿ Hétérogénéité

- arrangement spatial d'éléments de natures différentes
- valeur analytique ↔ multiplicité et variabilité des facteurs qui la produisent

## ✿ Complexité

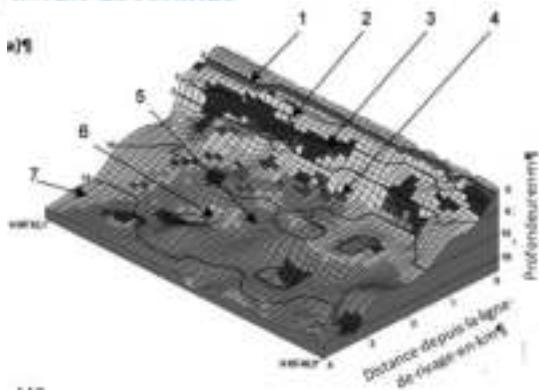
- révèle l'intensité des relations entre espèces
- à la base des communautés



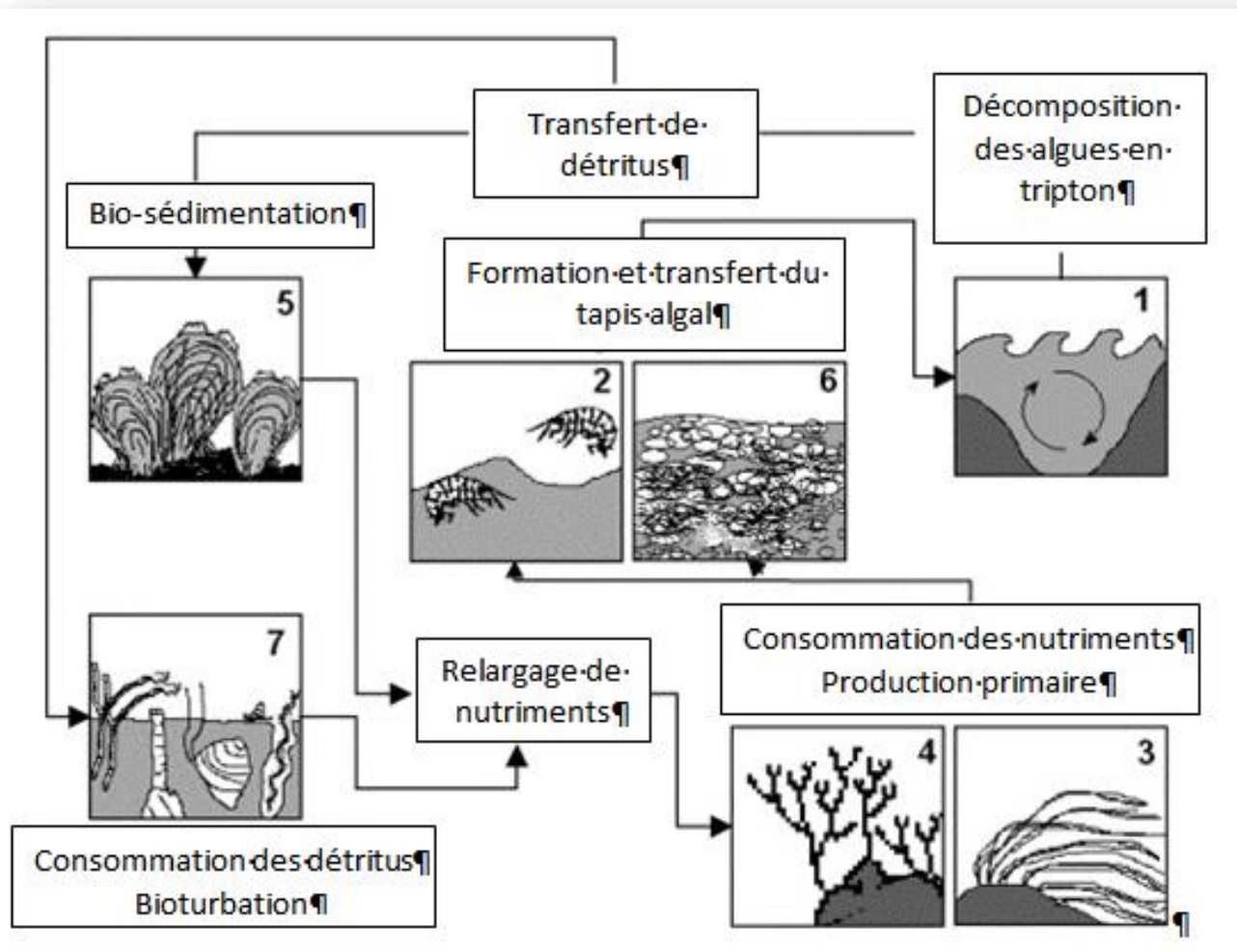
**Ce qui importe  
c'est le  
fonctionnement  
de l'écosystème**



# Le concept de « BIOTOPE » exemple de la Baltique



- 1) dépressions peu profondes entre le rivage et le premier banc de sable avec des tapis d'algues en décomposition en été
- 2) sable mobile dans la partie supérieure de la pente avec des amphipodes et des mysidés
- 3) rochers dans la zone de swash avec des algues vertes
- 4) fonds rocheux avec des algues rouges *Furcellaria lumbricalis*
- 5) récifs rocheux avec des colonies denses de moules bleues
- 6) fonds de gravier et de cailloux avec une macrofaune rare et sans macroalgues
- 7) fonds sablonneux avec le bivalve *Macoma balthica* et le polychète *Pygospio elegans*



# 4. COMPLÉMENTARITÉ AVEC LA SOCIOLOGIE

ECO  
ANTHROPOLOGIE



# ENTRE INTEGRITE ECOLOGIQUE ET BIEN-ETRE HUMAIN

## • INTEGRITE de l'ECOSYSTEME

### – Authenticité

- naturalité écologique

### – Services

### environnementaux

- fonctionnalités intégrales

## • QUALITE DE LA VIE

### – Biens et services attendus

- services sélectionnés

### – Biens et services sociaux et économiques

- exploitation durable

- "bien-être" = BENEFICES

Shared  
responsibility

CONCLUSION  
Towards  
ecosystem  
based  
management

Sustainable development

Holistic approach

Ecosystemic approach

Multiscale

GIZC -  
multipartners

Ecosystem  
Based  
Management

Planification

Prospection

Social  
contract

Ecosystem  
functioning

Ecosystems  
response

Goods and  
services

Adaptive  
management



## Coasts and Estuaries

The Future

### Temperate estuaries: their ecology under future environmental changes

Ducrotoy J.-P., Elliott M., Cutts N.D., Franco A., Little S., Mazik K., Wilkinson M.

Elsevier

Wolanski E (Ed.)

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