Climate sensitivity analysis and adaptation strategies for biodiversity in estuaries: a case study in the Scheldt estuary

Gunther Van Ryckegem, Erika Van den Bergh, Alexander Van Braeckel, Wim Mertens, Joost Vanoverbeke, Frank Van de Meutter & Veerle Campens
Mesohaline
Oligohaline
Freshwater zone (long retention)
Freshwater zone (short retention)

Tidal nature

The Netherlands
Belgium
Antwerp
Ghent

Estuaries – the case Seascheldt

Legende
- Green: Tidal nature
- Orange: Mesohaline
- Red: Oligohaline
- Green: Freshwater zone (long retention)
- Yellow: Freshwater zone (short retention)

Scheldevallei: saliniteit- en OMESzones
SalZone + code OMESzone
Physical drivers

- Sea level rise
- Temperature rise
- Precipitation pattern
- Extreme events

Main effects

- Erosion (increase hydrodynamics)
- Silting up / drawning
- Salinity changes
- Drought
- Nutrients & toxic load increases
- Shifting distribution
- Population fluctuations (locale extinction)

Adaptive strategy
Sensitivity analysis of estuarine ecosystem

1. Landscape integrity = how climate prove are present estuarine habitats
   • Adapting Gillson et al. 2012 (Trends Ecol. Evol. 28:135) methodology
     • Axes of sensitivity
       ▪ Habitat degradation
       ▪ Habitat vulnerability
     • Environmental pressures
Habitat degradation
Estuarine habitat vulnerability

Sensitive

Resistant & adaptive (resilient)

Wide gradients
Gentle slopes
Low watervelocities
Low shipe waves

Small gradients
Steep slopes
High watervelocities
High shipe waves

Small area
Heavily fragmented
Much disturbance/edge effects

Large area
Less fragmented
Less disturbance/edge effects

Shipping lane

Legende
- zones en lijnen Jesweerstata
- Scheldevaart: zalen en OMEzones
- landzone + code OMEzone
- waterweg
- duin en helling stuwpluimpje
- drift boven stuwpluimpje

Flanders
State of the Art
Sensitive

Resistant & adaptive (resilient)

Erosion risk – ER INDEX

Habitat Degradation
- HD INDEX

Small area
Heavily fragmented
More disturbance/edge

Wide gradients
Gentle slopes
Low water velocities
Low shipping waves

Small gradients
Steep slopes
High water velocities
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Erosion risk – ER INDEX

Resistant & adaptive (resilient)
Habitat degradation (HD) index

- Based on:
  - Fragmentation (% lateral sections every 50m with < 5m marsh)
  - %Shape index marsh (~edge effect)
  - Area towards goal (%Distgoal)

- Value categorised between 1 and 10
- Weighted mean 3 indices (1 %Distgoal, 1 edge effects, 0.5 fragmentation) = HD INDEX
Axis Y

- **Fragmentation index**
- **Shape index**
- **Area index**
- **Habitat degradation index**

Legend:
- ecozone
- Mesohalien
- Salinity gradient
- Oligohalien
- Zoet lang
- Zoet kort

Zones
Habitat vulnerability (ER index)

- Habitat width
- Slope
- Water velocities (modelled Flanders Hydraulics Research)
- Waves

Axis X
**Wide gradients**
- Gentle slopes
- Low water velocities
- Low ship waves

**Small gradients**
- Steep slopes
- High water velocities
- High ship waves

**Estuarine habitat vulnerability**
- Sensitive
- Resistant & adaptive (resilient)

**Habitat degradation**
- Small area
  - Heavily fragmented
  - Much disturbance/edge effects
- Large area
  - Less fragmented
  - Less disturbance/edge effects

**Shipping lane**
- Small area
  - Heavily fragmented
  - Much disturbance/edge effects
- Large area
  - Less fragmented
  - Less disturbance/edge effects

**Legends**
- Habitat types
- Shipping lane types
- And other geographical markers
Other environmental pressures

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<th>Other environmental pressures</th>
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Resistant & adaptive (resilient)

Estuarine habitat vulnerability

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Gentle slopes
Low watervelocities
Low ship waves

Small gradients
Steep slopes
High watervelocities
High ship waves

Habitat degradation

Relative position!
Small area
Heavily fragmented
Much disturbance/edge effects

Connect
Enlarge

Large area
Less fragmented
Less disturbance/edge effects

Habitat degradation

Management in function of habitats and species:
- estuarine network
- increases heterogeneity, reduces hydrodynamics
- reduces environmental pressure – improves abiotic conditions, reduces extreme events

Resistant & adaptive (resilient)

Connect
Enlarge

Diversify, gentle gradients, reduce hydrodynamic pressure

Adaptation strategy

- Reduce
- Intensive management
- Sensitive
- Connect
- Enlarge
- Diversify
Adaptation strategies for biodiversity management

1. Intensive management
2. Mesohaline
3. Oligohaline
4. Freshwater zone (long retention)
5. Freshwater zone (short retention)
6. Tidal nature
7. Improve estuarine network
8. Diversify
9. Increase heterogeneity, reduce hydrodynamics
10. Intensive management
11. Diversify
12. Diversify
13. Intensive management

Legend:
- Tidal nature
- Salinity- and OMES zones
- SalZone + code OMESzone
  - Mesohaline
  - Oligohaline
  - Freshwater zone (long retention)
  - Freshwater zone (short retention)
Physical drivers

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Main effects

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- Silting up / drawning
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- Population fluctuations (locale extinction)

Strategy

- Reduce extreme events
- Ensure abiotic conditions
- Reduce environmental impact
- Enlarge ecosystem heterogeneity
- Improve connectivity
- Other measures
Climate adaptive power of planned projects

updated Sigmaplan

Planned 2010-2030
- 989ha Managed Realignments
- 759ha FCA-CRT

989ha Managed Realignments

759ha FCA-CRT

Freshwater zone

Brackish zone

Durme

Rupel

Intensive management

Diversify

Improve estuarine network

Lower & middle

Intensive management

increase heterogeneity, reduce hydrodynamics

Resistant & adaptive (resilient)

Habitat degradation

Estuarine habitat vulnerability

Work in progress
Conclusions

- Methodology gives insight in the spatial diversity for climate sensitivity in an estuary
- Diverse adaptive strategies are needed (combined) to face climate change in one ecosystem
- Ecosystem based strategies at landscape level if possible – effect based strategies to save/protect what is left
Thank you