From developing at the expense of nature to developing with nature: an example of river restoration in the river Schelde

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ECOSYSTEM MANAGEMENT RESEARCH GROUP

- In Flanders many river restoration projects are carried out:
  - State of most rivers was very bad due to
    - Water quality
    - Very severe hydromorphological changes
- Different scales of projects: from very small (m^2 to very large scale)
- In this talk I will focus on a large scale project

WESTERSCHELDE

Vlissingen

THE NETHERLANDS

Antwerpen

BELGIUM

Gent

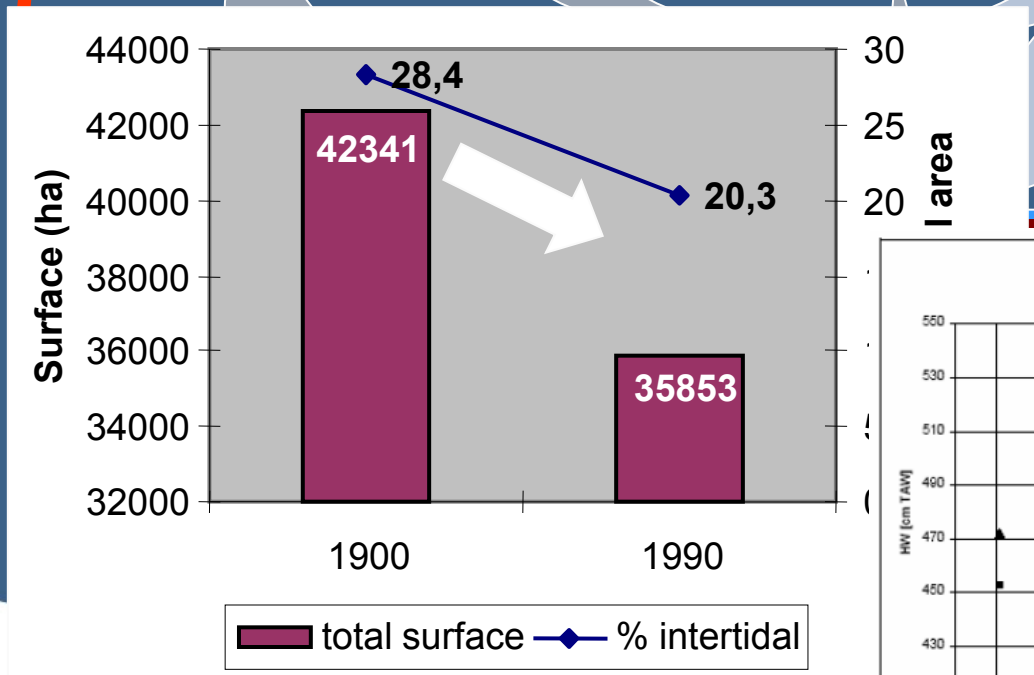
The Schelde estuary:

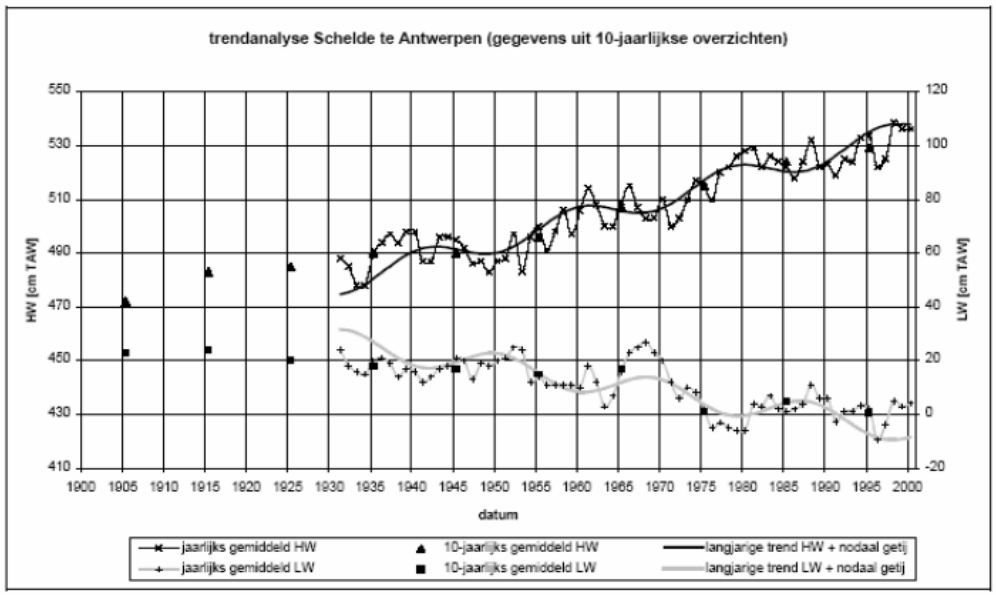
- 160 km long and macro-mesotidal
- Entire salinty gradient from fresh to salt
- 36.000 ha
  - Deep channels
  - Shallow subtidal areas
  - Tidal flats
  - marshes

The System

Dredging/ sand extraction
Embankments
Infrastructure (breakwaters etc.)

Sea level rise
Changes in the catchment





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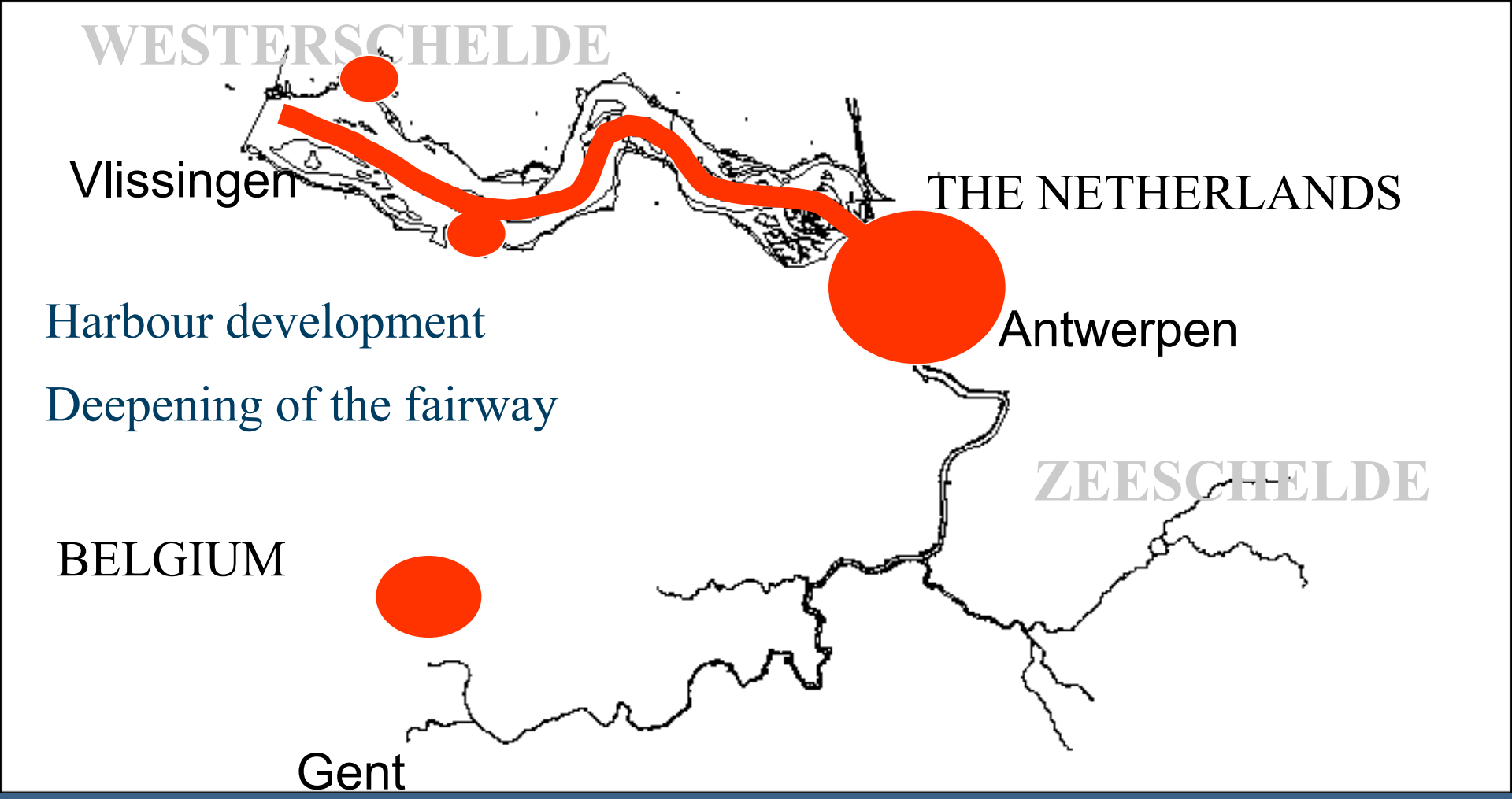

WESTERSCHELDE
Vlissingen
THE NETHERLANDS
Harbour development
Deepening of the fairway
Antwerpen
ZEESCHELDE
BELGIUM
Gent

The nature conservation legislation

➔ designation of sites
➔ management

RAMSAR convention

EU Bird directive

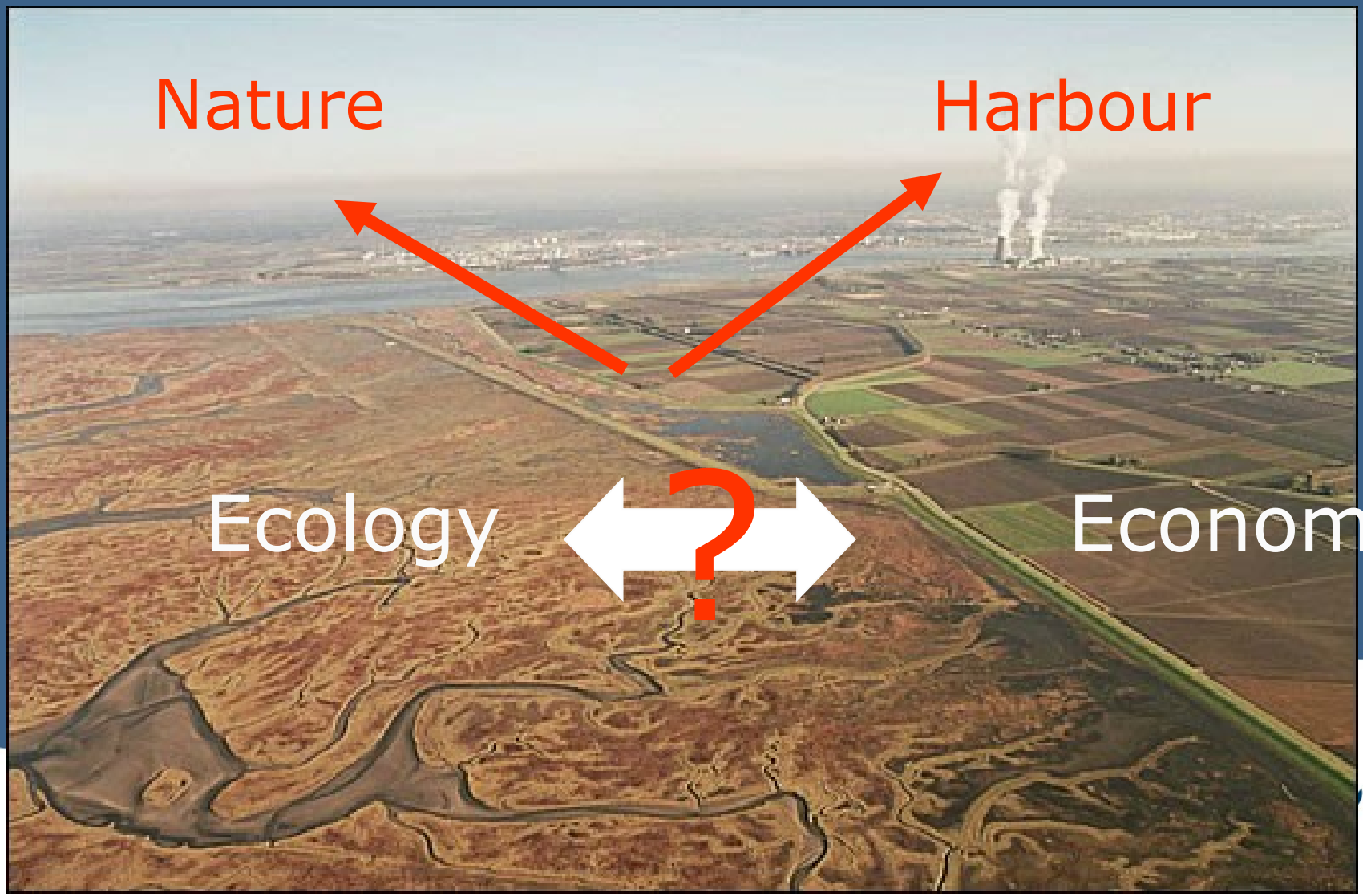
EU Habitat directive

…
National regulations

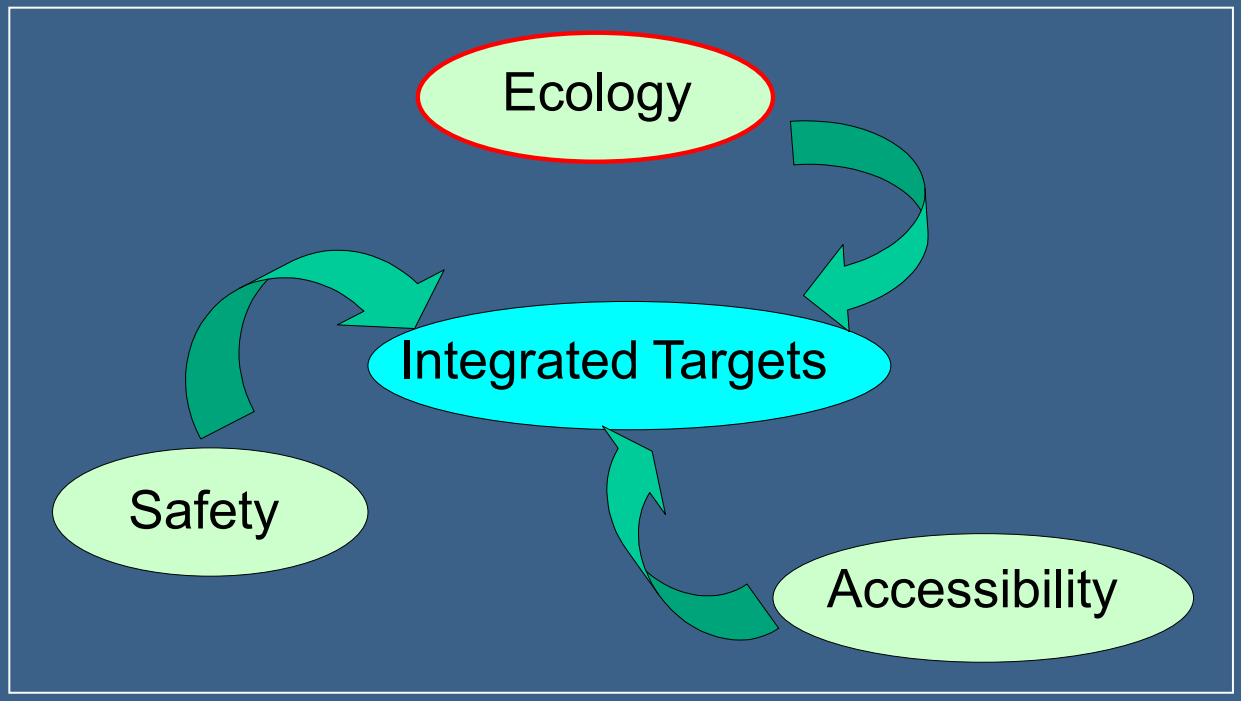
Legenda

- Ramsar gebieden
- Vogelrichtlijngebieden
- Habitat richtlijngebieden

Intro



Long Term Vision for the Schelde estuary



Towards a restoration plan

- To develop the vision we did not use historical nor geografical references but we tried to derive a picture based on the results of basic ecological and scientific theories and models.
- A central element was the optimzation of the ecosystem services of the estuary.
- This also allows the intergation of functions (safety and habitat, ….)

Methodology

- For the estuary, a detailed analysis was made of the different goods & services
  - Which one are relevant
  - What is the present state
- Analysis of trends indicated major problems with:
  - Tidal charateristics
  - Water quality
  - Habitats and species
- ➔ MAJOR LOSS OF GOODS & SERVICES

An integrated strategy

- Requires:
  - Understanding of ecosystem services
  - Quantification of ES

An integrated strategy

- Requires:
  - Understanding of ecosystem services
  - Quantification of ES

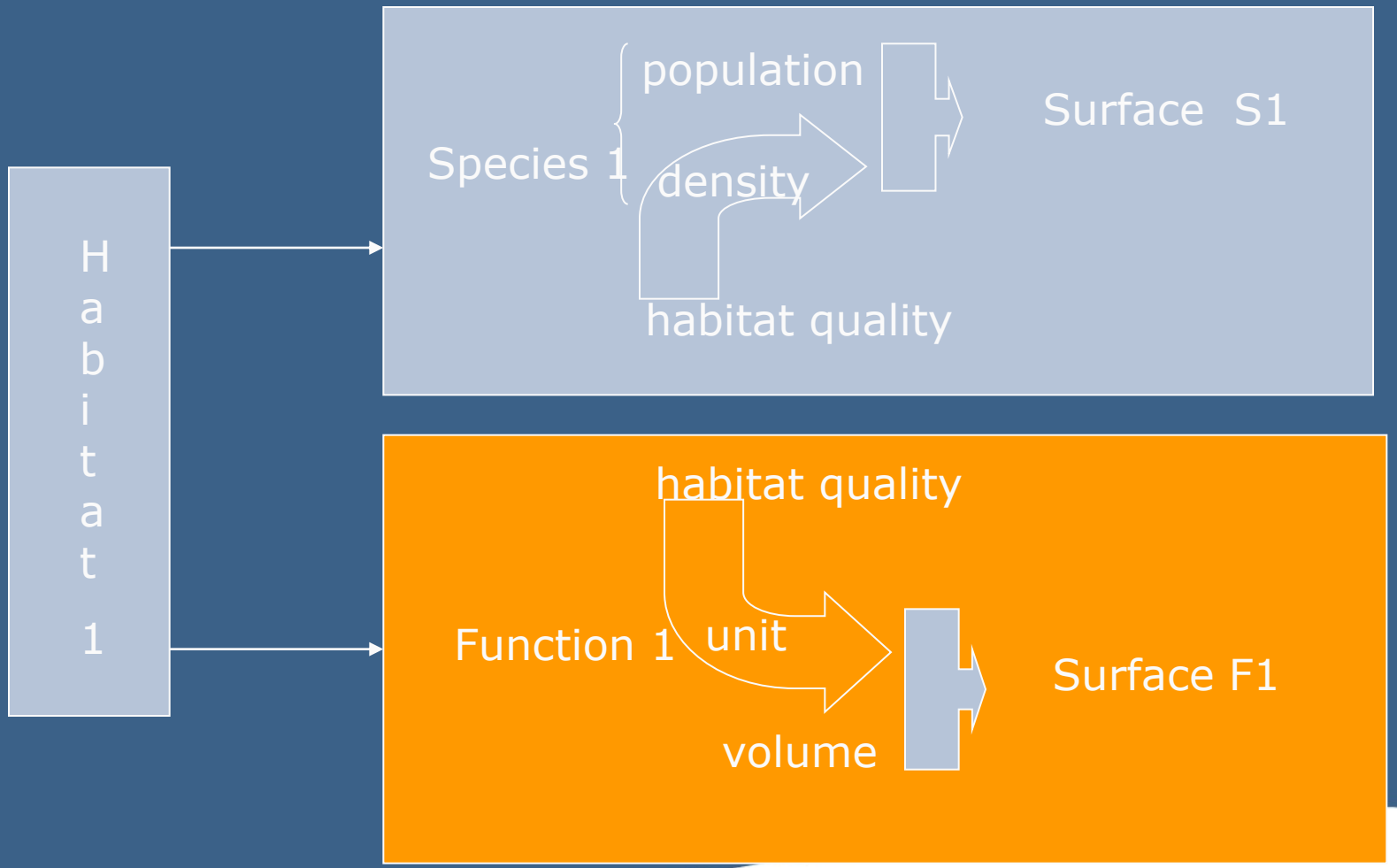
➔ determine conservation objectives!

- What biodiversity we need to have (structural approach)?
- Which and how much services the ecosystem must deliver (functional approach)?

An integrated strategy

- Ecosystem services can be:
  - A volume of water that can be stored on marshes (➔ safety)
  - Amount of primary production needed to sustain the nursery function
  - Retention of nutrients
  - Buffering tidal energy
  - recreation
  - =➔ This are different ways to express a carrying capacity of the system

Conservation Objectives (CO)

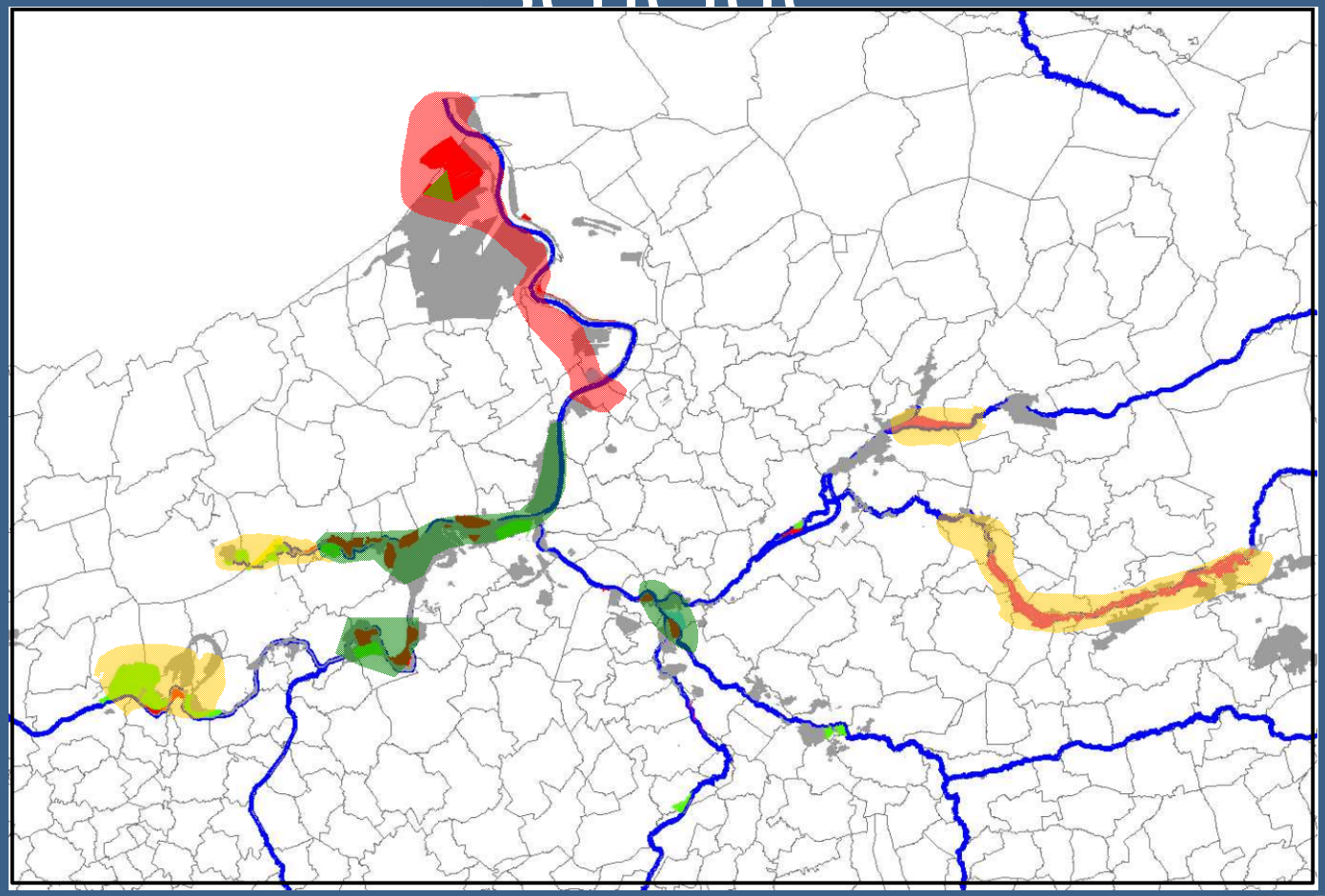


Final CO: ➔ Max (surface S1,..Sn; F1,…,Fm)

Required surface of different habitats

Habitattype	opp (ha)
Buitendijks brak	740
Buitendijks zoet	1040
Binnendijks bos alluviaal	570
Binnendijks anderen	370
Binnendijks grasland dotter (RBB)	840
Binnendijks grasland anderen	910
Binnendijks riet/ruigte	560
Binnendijks plas/oever	240

Spatial distribution of CO-Schelde:



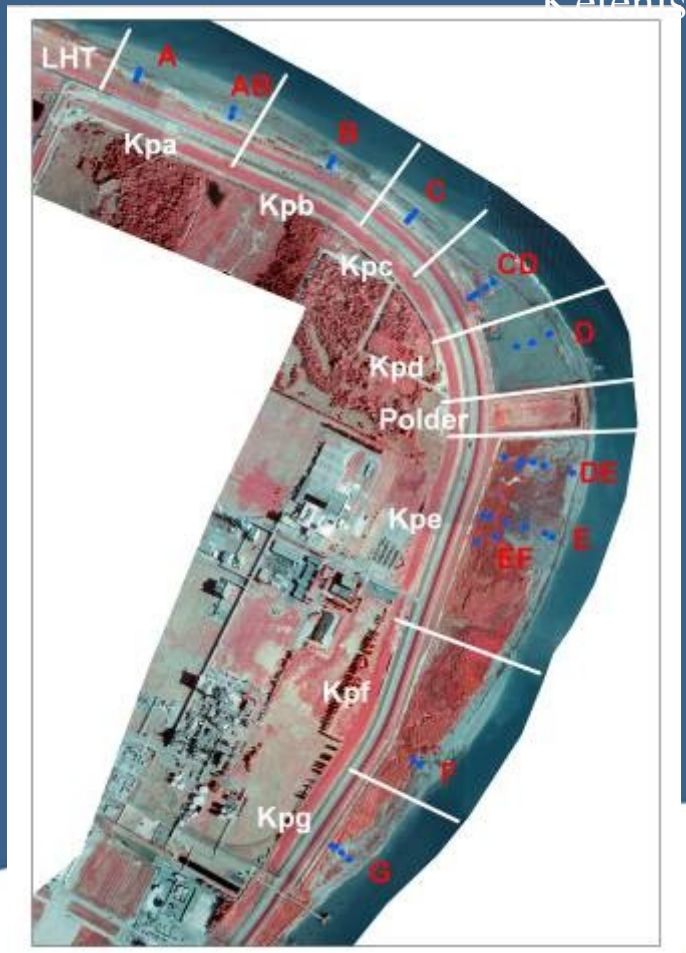
An integrated strategy

- Understanding and quantification of ES
- Formulation of objectives
- The calculation of habitats surface needed
- Measures to maintain or restore habitats

Maintenance

Use « soft » measures instead of « hard engineering »

Habitat restoration



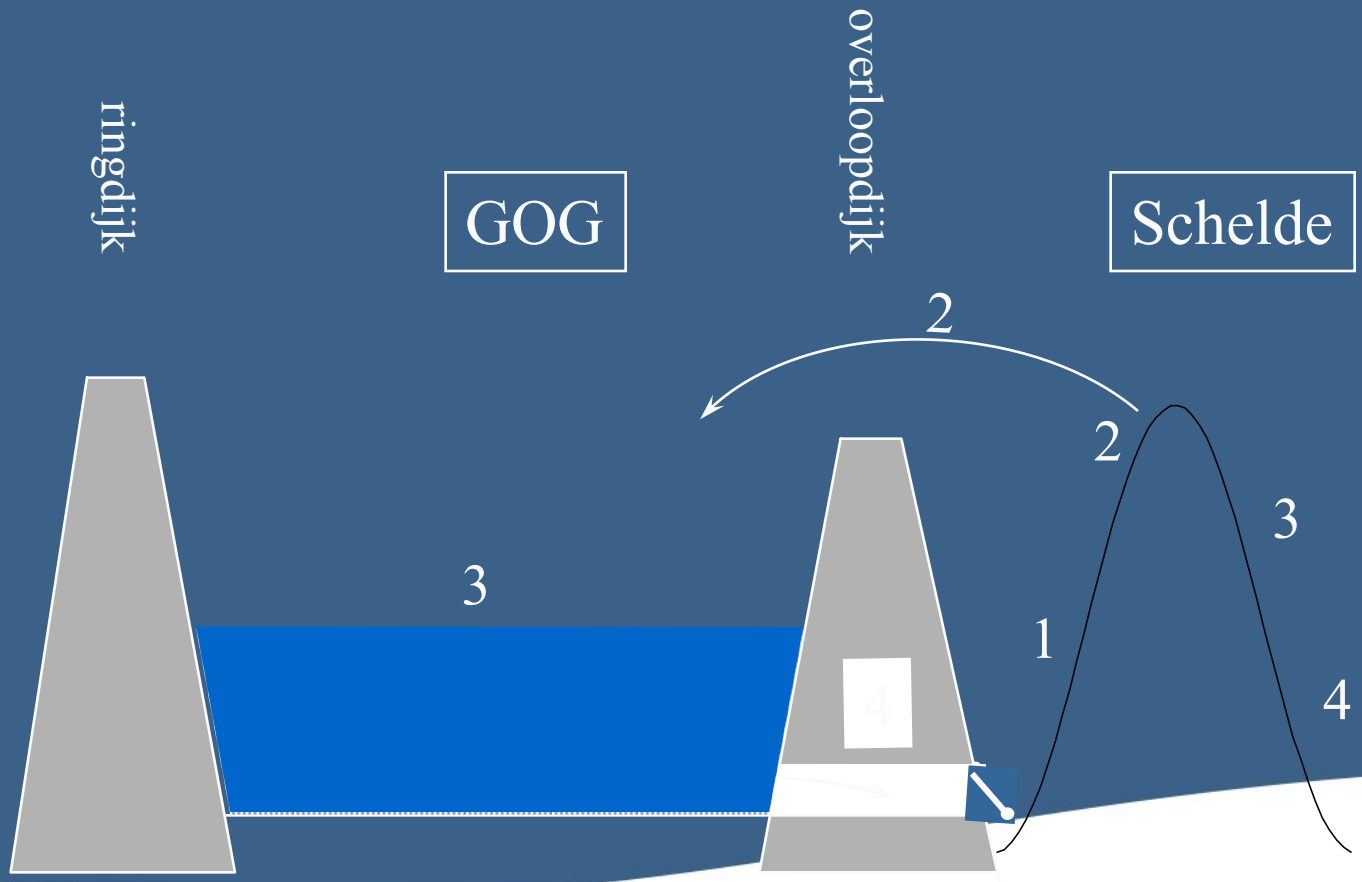
Managed retreat

1990

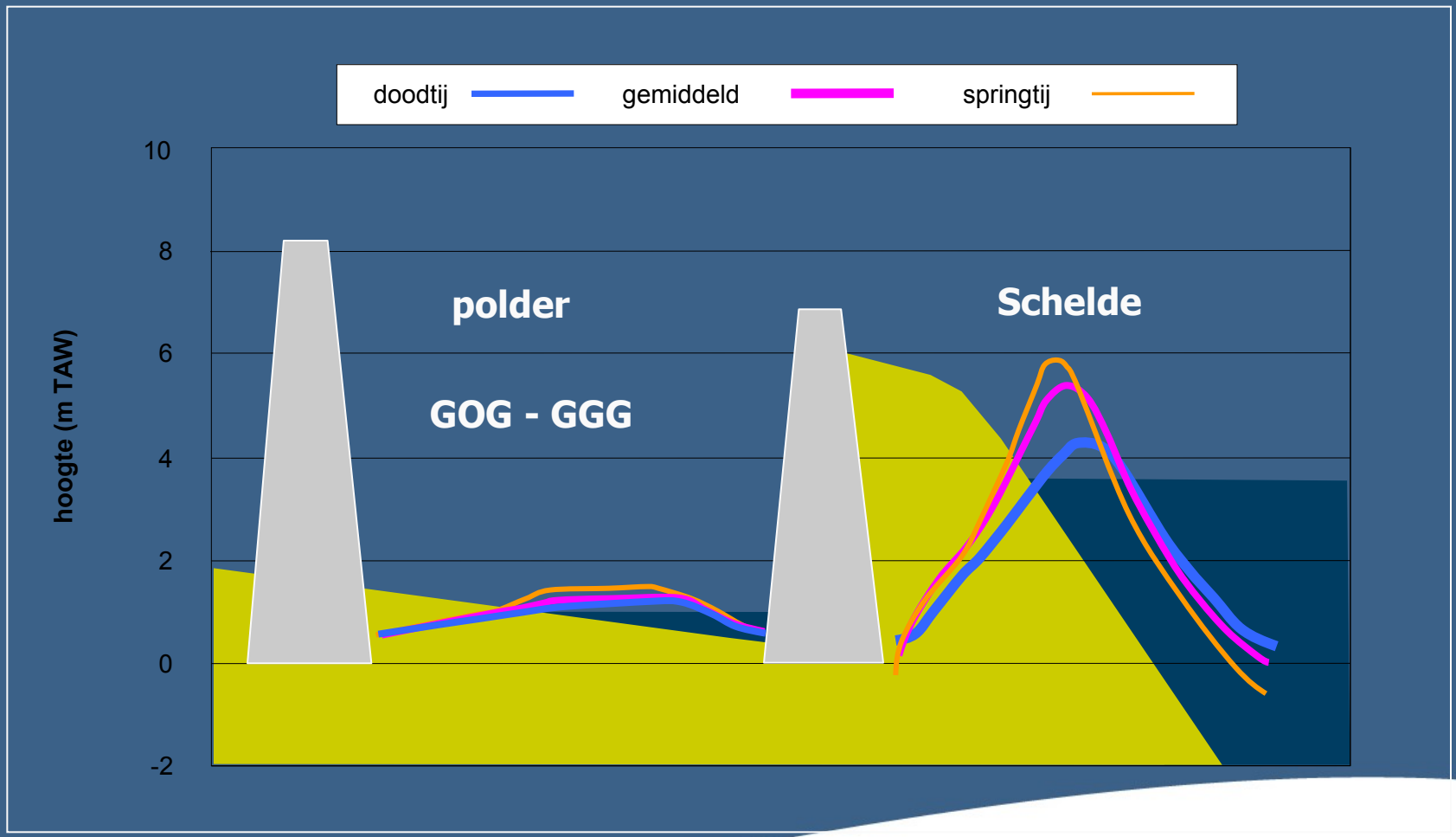
1998

Managed retreat: bv Sieperdaschor

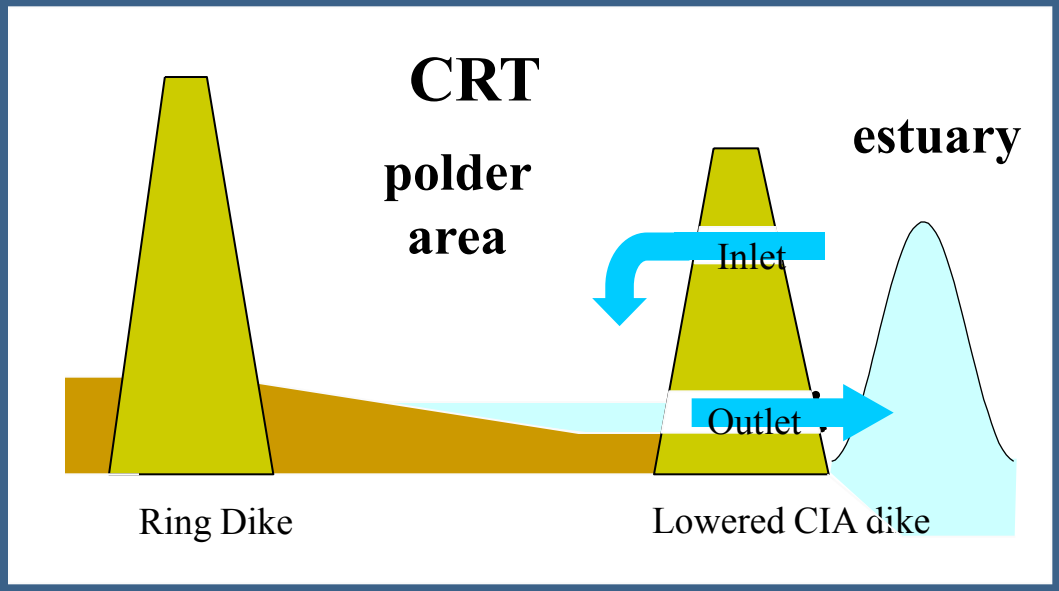
Controled inudation area



- Increase exchange between pelagic and marsh to:
- Enhance biogeochemical functioning
- ➔ how to do?


doodtij
gemiddeld
springtij
hoogte (m TAW)
10
8
6
4
2
0
-2
polder
GOG - GGG
Schelde

Controlled inundation area with reduced tides



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Pilot project Lippenbroek

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Water quality: Silica

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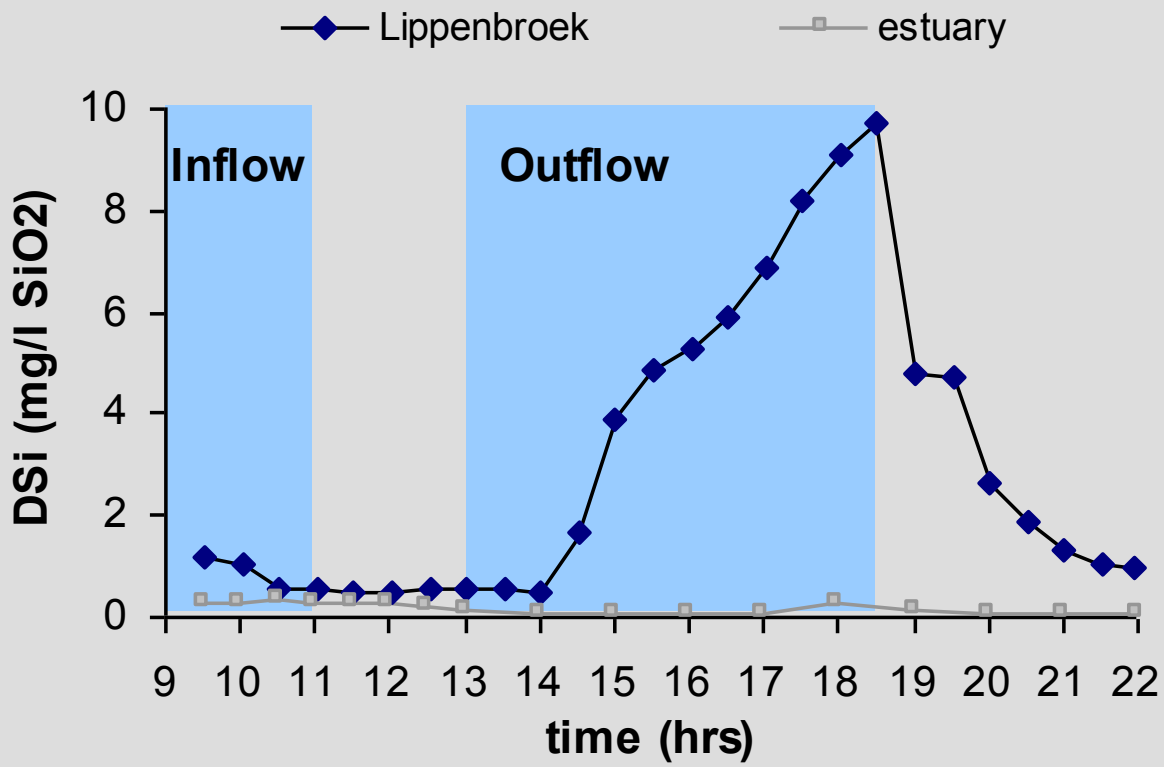
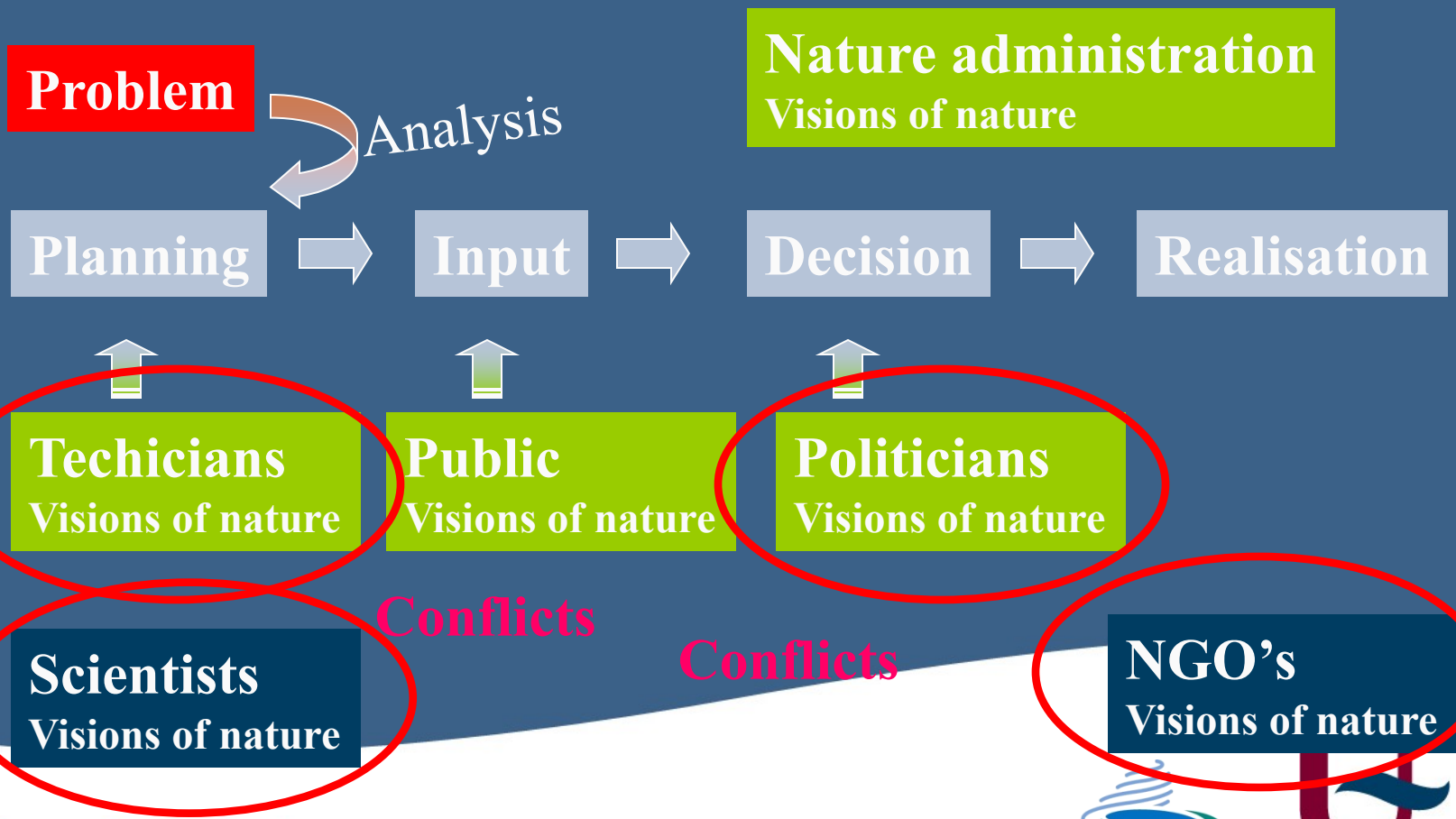
DSi delivery on 3/7/2006



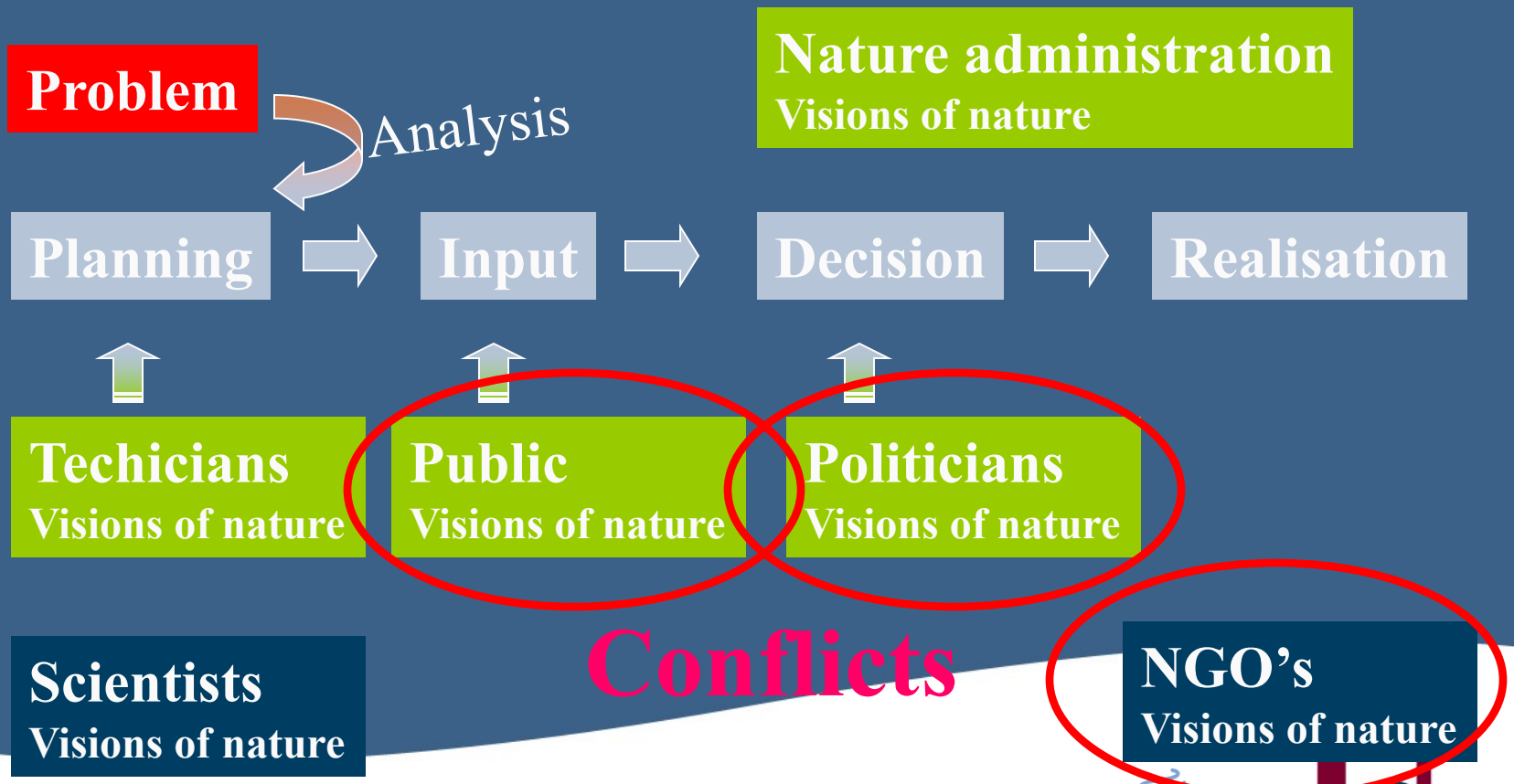
Controled inundation area of Kruibeke Bazel Rupelmonde

History of nature management

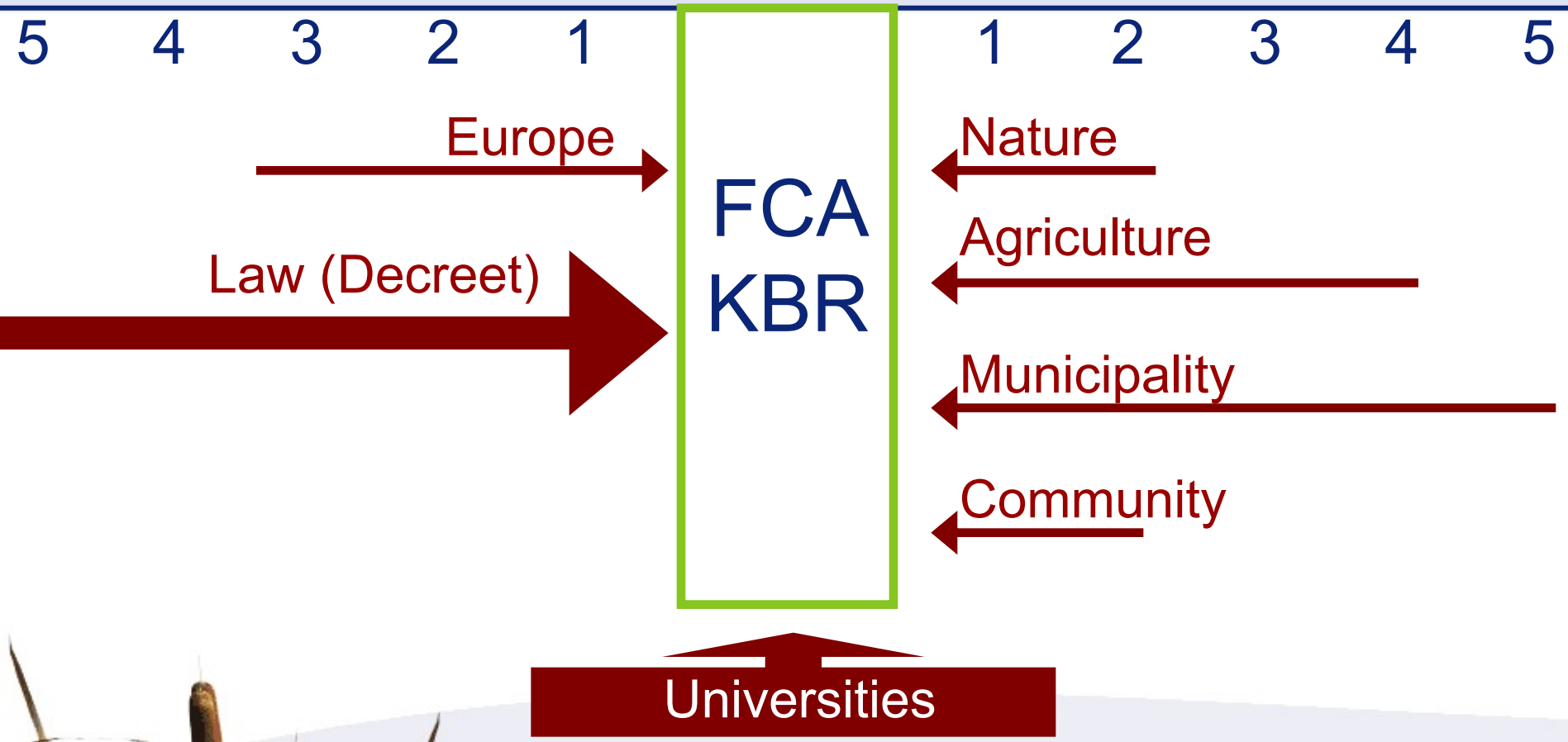


History of nature management

After adoptation of ES concept and restoration plan



Forcefield analysis



Isolate opponents

gecontroleerd overstromingsgebied
Kruibeke - Bazel - Rupelmonde

5 4 3 2 1 1 2 3 4 5

Europe

Law (Decreet)

Nature

FCA
KBR

Municipality

Universities

Agriculture

Waterwegen en Zeekanaal NV

Stay alert

gecontroleerd overstromingsgebied
Kruibeke - Bazel - Rupelmonde

5 4 3 2 1 1 2 3 4 5

Europe

Law (Decreet)

Nature

FCA
KBR

Neighbours

Municipality

Universities

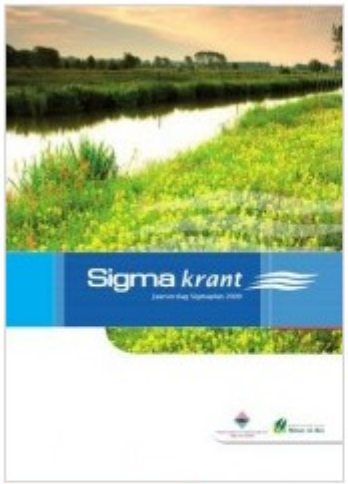
Agriculture

Community

Waterwegen en Zeekanaal NV

- communication

SIGMAgazine



Jaarverslag

SIGMAgazine

Terug naar het overzicht

- To deal with the diversity of visions:
- Common language between the different groups: Ecosystem services is a good candidate

Techicians
Visions of nature

Public
Visions of nature

Politicians
Visions of nature

Scientists
Visions of nature

NGO's
Visions of nature

Klaar voor het grote werk !?

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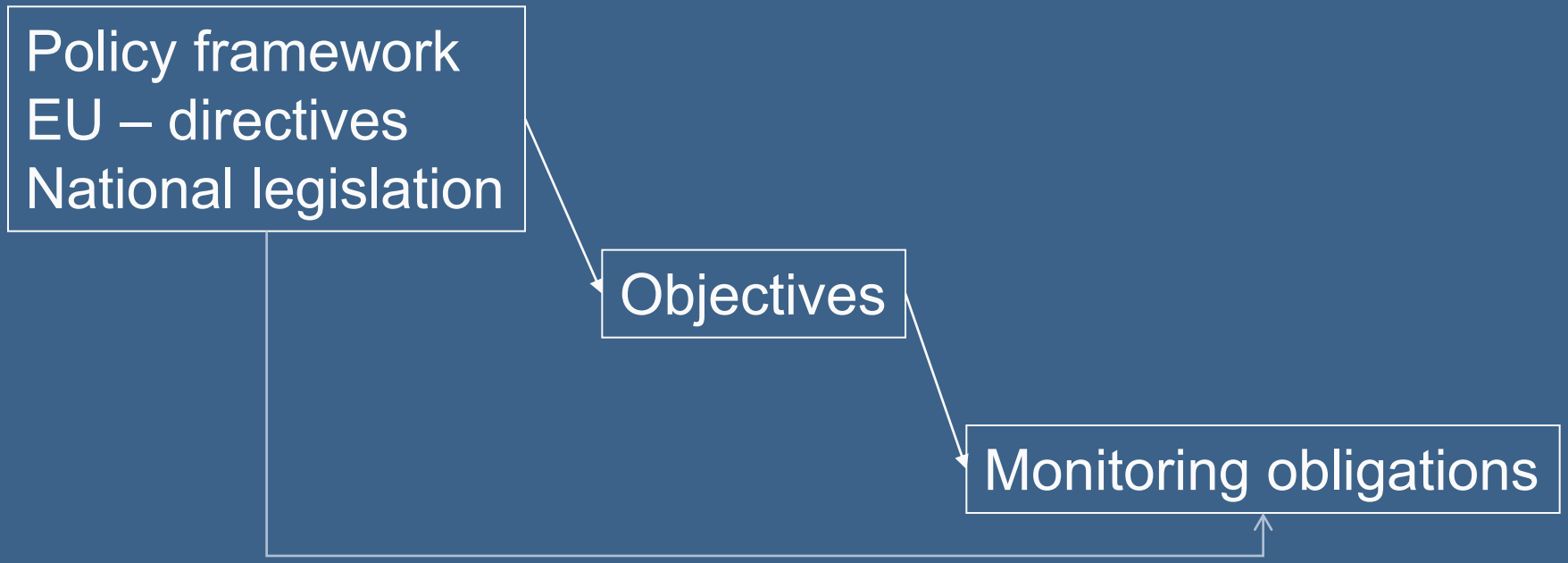
Conclusion

- Using the ES concept, allowed to:
  - Improve the communication between different managers
  - Work out integrated solutions
  - Formulate conservation objectives for different ES
  - Translate these CO into a surface of habitat necessary
  - Make a cost benefit analysis
  - Significantly change the approach
- Restoration is the most profitable scenario!!
- BUT INTEGRATED MANAGEMENT REQUIRES NEW APPROACHES!

What to measure?



- Many parameters were monitored without any legal obligation nor framework
  - Estuary wide bathymetry
  - Discharge and sediment transport
  - Detailed water levels
  - Part of OMES campaigns
  - ……
  - ➔ however, it is obvious that these parameters are essential for managing the estuary

- What if questions?
  - Number of Oystercatchers declines with 25%
    - External factors: compare with counts in other areas
    - Internal factors:
      - Habitat surface
      - Habitat quality:
        - » Height of tidal flats, granulometry
        - » Food
        - » disturbance ********
      - Competition between species

- If food, eg. Cockle population declines:
  - Interaction with other sectors: fisheries
  - Less food available:
    - Link with phytoplankton/benthic primary production
      - If less phytoplankton: more zooplankton ➔ fish?
  - Changes in food supply:
    - Changing composition of phytopalnkton
      - possible Si limitation
    - Changing ratio's of phytoplankton/detritus
    - changes in SPM concentrations

- What if herring population declines with 25%?
  - External factors in the North Sea
  - Internal factors:
    - Hydrodynamics ➔ current velocity/ salinity gradient
    - SPM, turbidity of the water
    - food
      - zooplankton

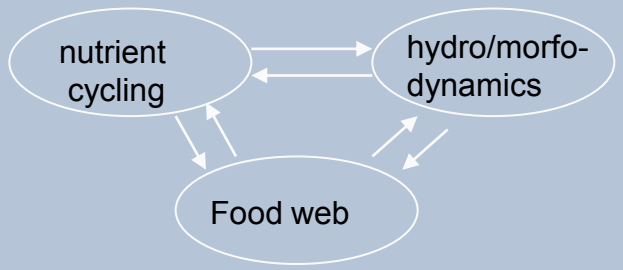
- But we must also understand how the system evolves as we may expect quite a number of unexpected developments which will require a flexible and adaptive mangement
- ➔ This requires knowledge of the functioning of the system

Philosophy of the monitoring plan

Ecosystem Goals
-accessability
-safety
-ecology

RESEARCH MONITORING
Knowlegde gaps

SYSTEM MONITORING
general knowlegde



Specific targets

Current situation

Projected measures
-accessability
-safety
-ecology

PROJECT MONITORING
Causal relations

Legislation
EU HD, BR, WFD
National

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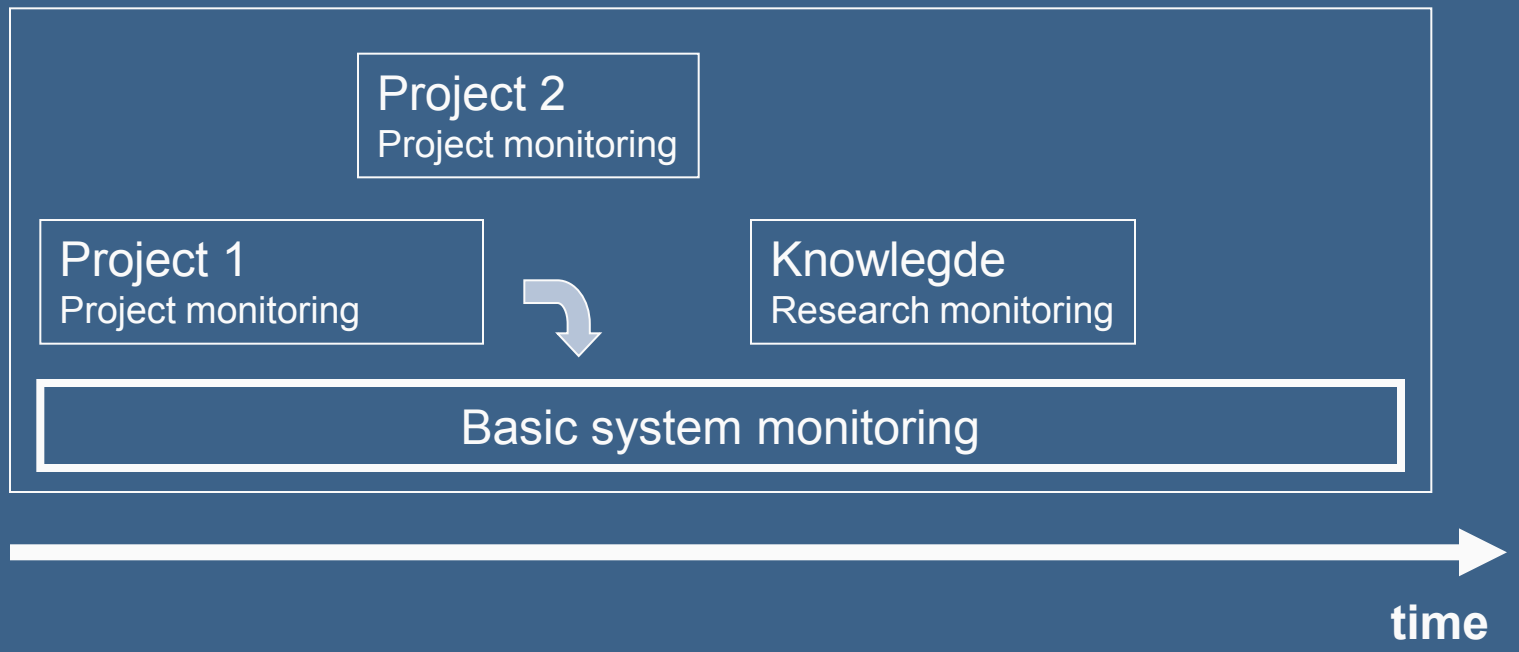
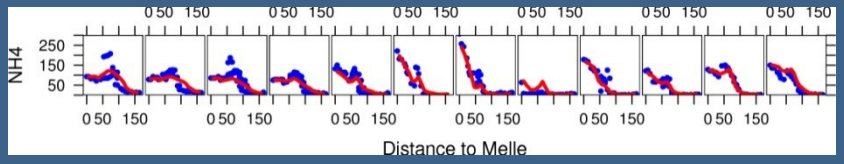
Integreated system monitoring



Upscaling in time

- large variability

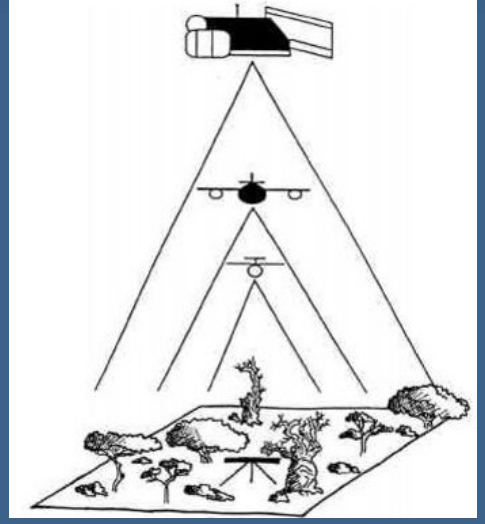
Point measurements
spatial spreading



Continuous measurements
Temporal spreading

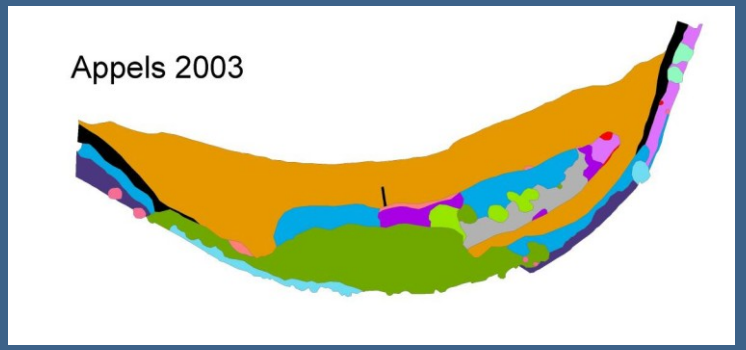
Models

upscaling in space



Remote sensing

area covering spatial info



Point and transect measurements

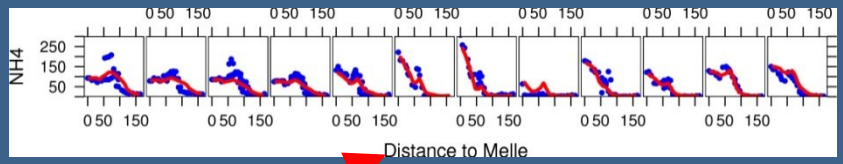
Models

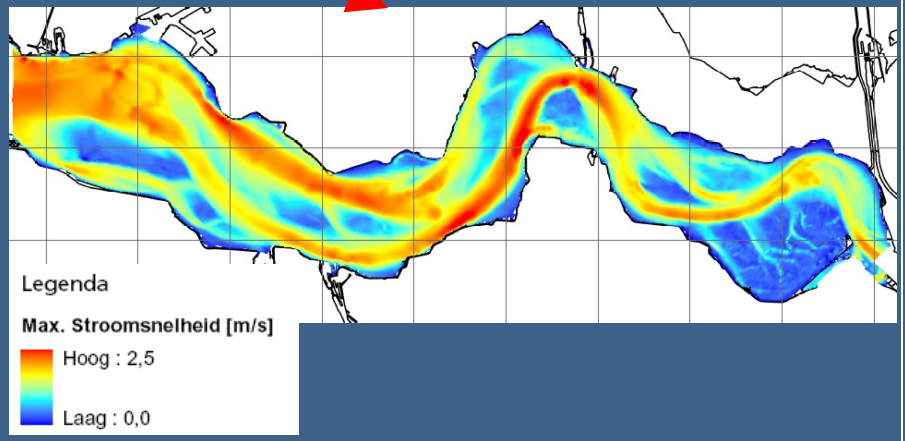
Point measurements
Spatial distribution

Continuous measurements
Temporal distribution

Transect measurements
Spatoial/temporal
distribution

Models

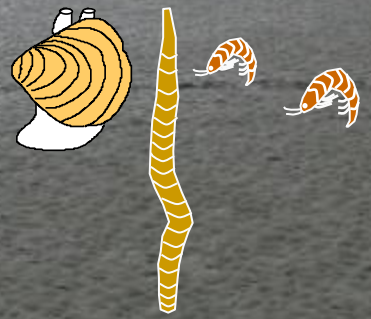




Chlorofyl

microphytobenthos

Macrozoobenthos

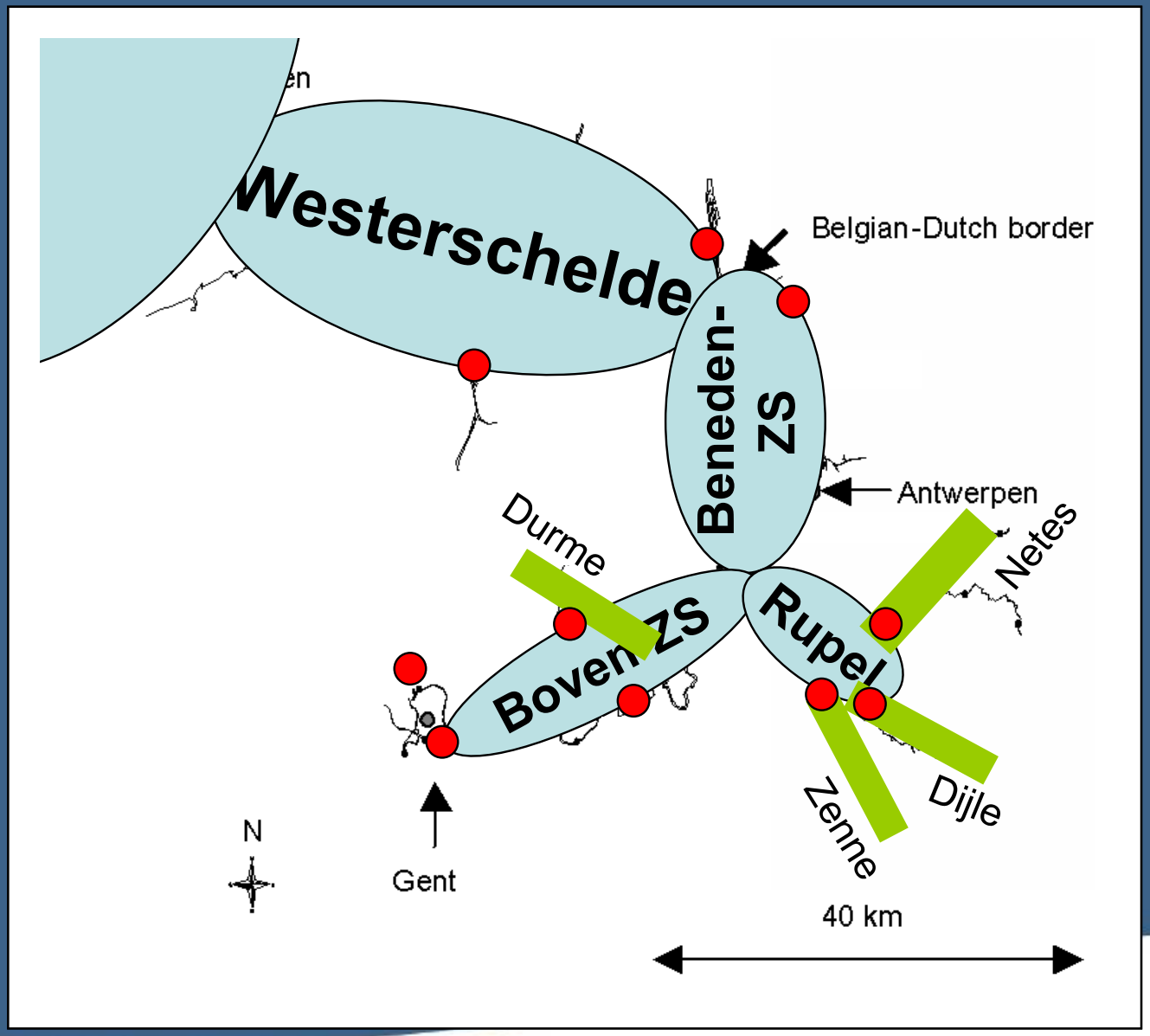


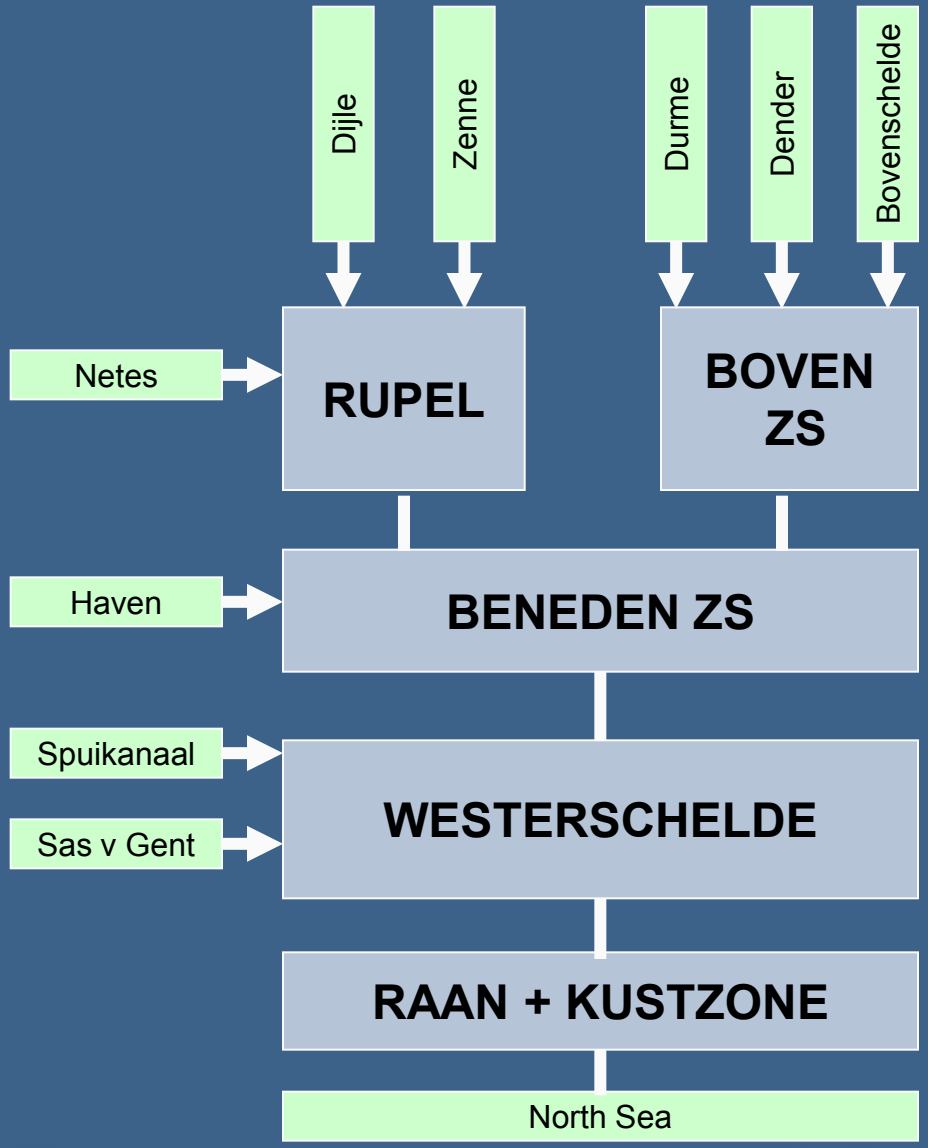
Granulometry

Bathymetry

sedi/ero

Microtopography


Westerschelde
Belgian-Dutch border
Beneden-ZS
Antwerpen
Durme
Netes
Boven ZS
Rupel
Zenne
Dijle
N
Gent
40 km



Permanent stations
+
sampling 1 – 2/month

BOUNDARIES
system boundary
(input models)

1 permanent station
sampling 1-2/month

2 permanent stations
Sampling 1-2/month

2 permanent stations
Sampling 1-2/month

2 permanent stations
Sampling 1-2/month

SYSTEEM

System monitoring

describing

processes

Validation/callibration
of models

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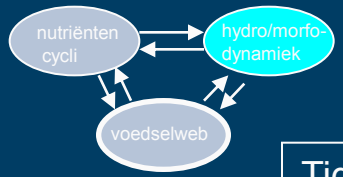
- Based on:
  - Requirements of legislation
  - Knowledge of the system
  - theoretical background
  - Expected questions to be answered
  - Goals of the different projects
  - A SYSTEMS APPROACH
- ➔ a list of parameters to be measured was constructed

Program

- Headlines of the program
  - Hydrodynamics
  - Morphodynamics
  - Diversity of habitats
  - physico chemistry of water and soil
  - Ecological functioning
  - Diversity of species
  - safety



HYDRO DYNAMICS

Tide gauge | Tidal campaigns | Permanent sections | point measurements | point Measurements (flats)

Water levels → Vertical tide

velocities discharges → horizontal tide

velocities discharges → spacial variation

velocities → velocities → temporal variation

stations → discharge → discharge catchment

stations → Wave height → waves

stations → Ground water levels → Grond water

Hydro-dynamics

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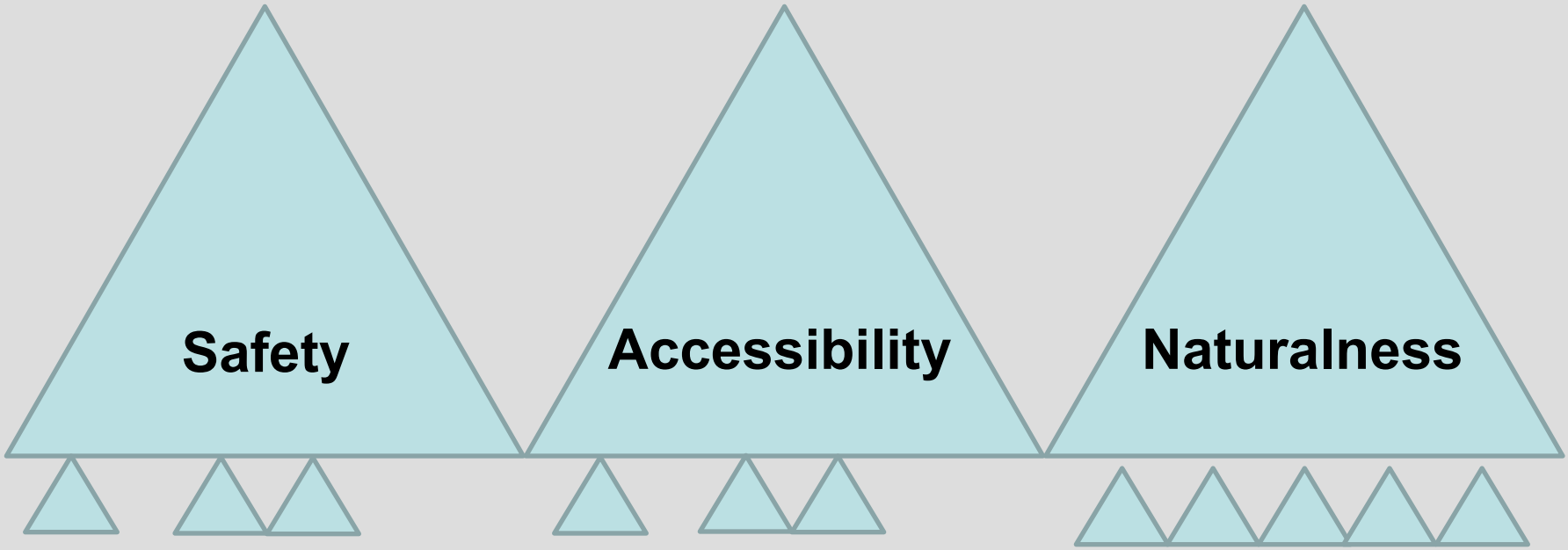
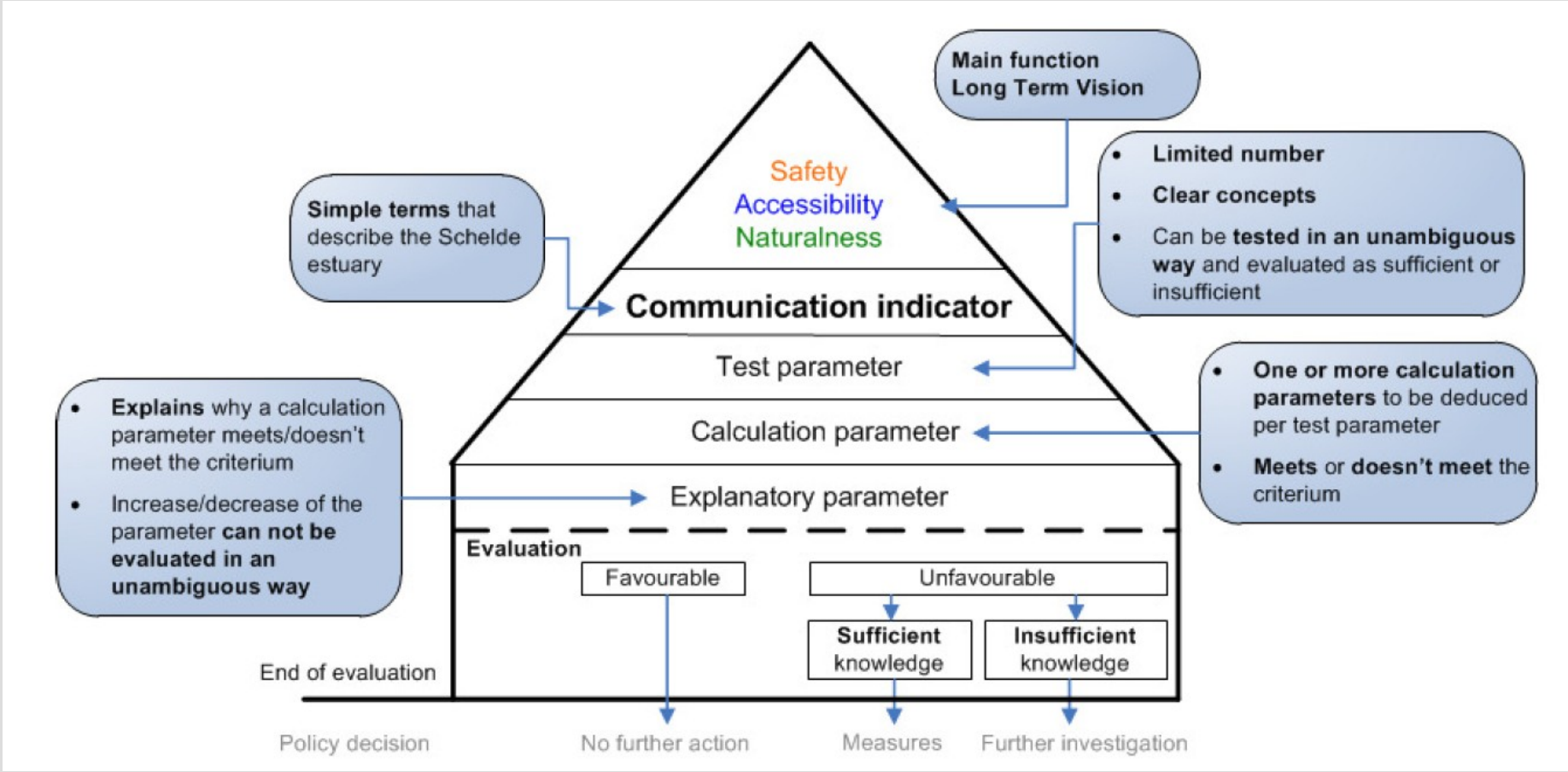
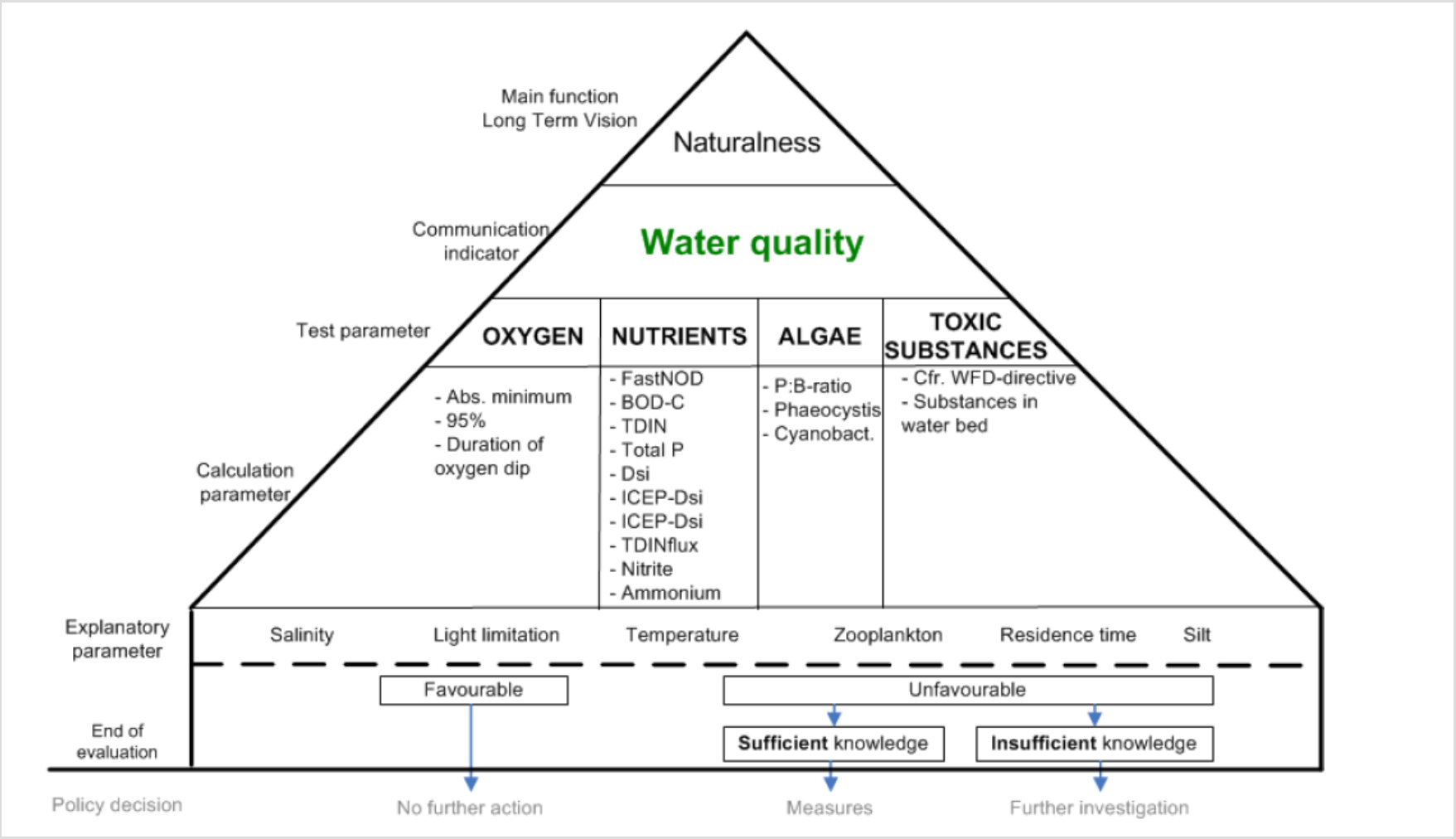

Safety
Accessibility
Naturalness

Pyramid approach



- Every communication indicator is evaluated based on **test parameters**:
  - Limited in number
  - Consist of one or more **calculation parameters**
  - Clear concepts
  - Unambiguously to quantify and to evaluate
  - Trends in these test parameters will be explained by **explanatory parameters**

Example: water quality



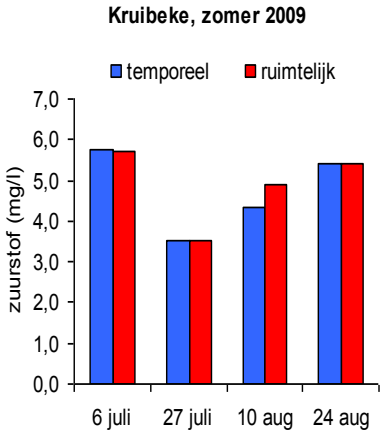
Zuurstof T2009

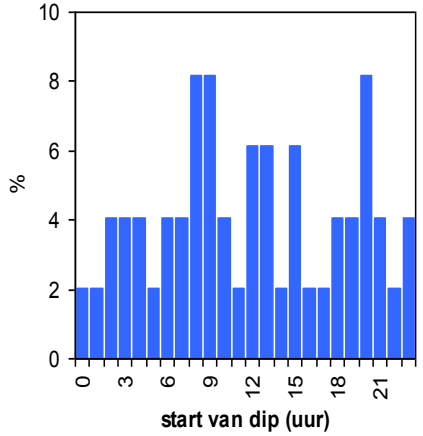
Ruimtelijk

Zone	absoluut minimum	95% winter* (6 mg/l)	95% zomer* (5 mg/l)
monding	7,1	100%	100%
poly	7,3	100%	100%
meso	7,3	100%	100%
9 (gradient)	4,7	100%	97%
10 (gradient)	5,0	100%	95%
11 (gradient)	4,0	100%	91%
12 (gradient)	4,1	71%	79%
13 (oligo)	3,5	76%	73%
14 (oligo)	3,1	85%	68%
15 (zoet lang)	4,2	100%	77%
16 (zoet lang)	4,6	96%	98%
17 (zoet kort)	3,9	100%	91%
18 (zoet kort)	4,7	94%	91%
19 (zoet kort)	3,2	100%	86%
Rupel	3,3	85%	73%
Durme	4,8	100%	91%

Temporeel (Kruibeke): zomer

- Absoluut minimum: 49 tekorten in 2009
- 56% van de meetwaarden boven 5 mg/l
- Zuurstofdip tot meerdere dagen





Conclusions

- Economic development was the driver behind river restoration
- An integrated approach based on the ecosystem services that should be delivered by the system is essential and should be a combination of different methods, from classicial engineering to complete nature restoration.
- Communication with locals is crucial, with the power of legislation behind you

Where will we restore the river here?

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