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ECONOMIC AND ENVIRONMENTAL FORESIGHT AS A TOOL FOR INTEGRATED COASTAL ZONE MANAGEMENT

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OBJECTIVES

OBJECTIVES

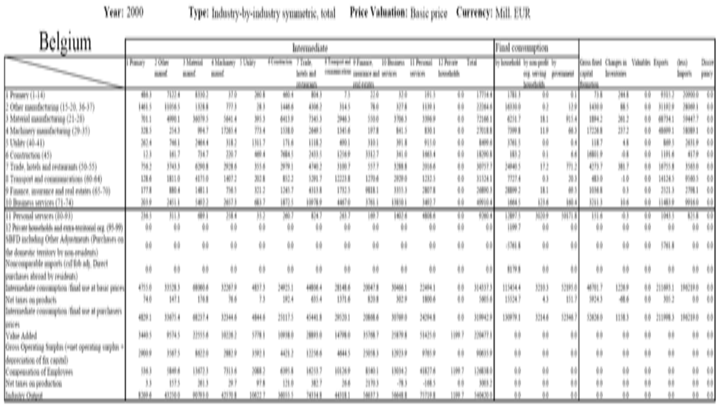
- **Global objective :** Developing a methodology for a quantitative economic analysis of relationships between economy ↔ environment …

… and demonstrate the potential of this methodology for Integrated Coastal Zone Management processes (ICZM)

OBJECTIVES

- **Specific objective :** build a generic methodology enabling transfers to other study sites, based on green I-O analysis and NAMEA approaches

  ("green Input-Output" and "National Accounting Methodology integrating Environmental Assets")



ACCOUNT (classification)	Goods and services (product-groups)	Consumption of households (purposes)	Production (industry)	Generation of of income (value added categories)	Distribution of income and consumption (sectors)	Capital	Taxes (types)	Rest of the world, current	Rest of the world, capital	Substances	Environmental themes	TOTAL
Goods and services (product groups)		Consumption of households	Intermediate consumption		Consumption of government	Gross capital formation		Exports (fob)				Use at purchasers' prices
Consumption of households					Consumption of households					Emission of pollutants by consumers		Consump-tion of households
Production	Output at basic prices									Emission of pollutants by producers		Output at basic prices
Generation of income (value added categories)			Net value added				VAT not handed over to the government	Compensation of employees from r.o.w.				Origin of generated income
Distribution of income and consumption				Net national generated income	Property income and current transfers		Taxes less subsidies	Property income and current transfers from r.o.w.				Current receipts
Capital			Consumption of fixed capital		Net national savings				Capital transfers from r.o.w.	Other domestic emission of pollutants and changes in natural resources		Capital receipts
Financial balance						National net lending (+) or net borrowing (-)			Net lending from the rest of the world			
Taxes (types)	Taxes less subsidies on products		Other taxes less subsidies on production		Current taxes on income and wealth			Current taxes on income and wealth from r.o.w.				Tax payments (less subsidies)
Rest of the world, current	Imports (cif)			Compen-sation of employees to r.o.w.	Property income and current transfers to r.o.w		Current taxes on income and wealth to r.o.w.		Surplus of the nation on current transactions	Cross border pollution from r.o.w.		Current payments to the rest of the world
Rest of the world, capital						Capital transfers to r.o.w.						Capital payments to the rest of the world
Substances			Absorption by producers					Cross border pollution to r.o.w.			Contribution to environmental themes	Destination Of substances
Environmental themes						Environmental indicators						Theme-equivalents
TOTAL	Supply at purchasers' prices	Consumption of households	Input at basic prices	Destination of generated income	Current expenditures	Capital expenditures	Tax receipts (less subsidies)	Current receipts from the rest of the world	Capital receipts from the rest of the world	Origin of substances	Theme-equivalents	

OBJECTIVES

- **This methodology** will consist in structuring, integrating and presenting existing knowledge into a useful format in order to make it accessible for decision processes in the framework of ICZM

OBJECTIVES

- **Integrated Coastal Zone Management (ICZM) :**

Cyclic process of data collecting → planification → decision making → and finally implementation of measures for sustainable management of coastal zones

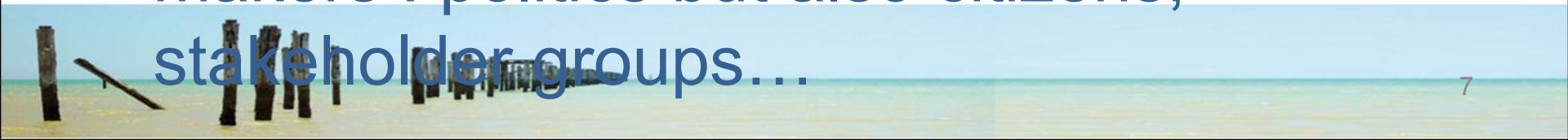
ICZM is based on the **informed** participation of all group of interests (stakeholders)

Integration of knowledge, stakeholders, multi-level of public authorities

OBJECTIVES

- All this will be carried out in a foresight perspective based on scenario modeling simulating the behaviour of the "*anthropo-ecosystem*" in the Seine estuary

- Our model will be a support tool for **deliberation** addressed to decision makers : politics but also citizens, stakeholder groups…



OBJECTIVES

Main questions to be answered

How economic analysis might bring support to governance processes in coastal zones?

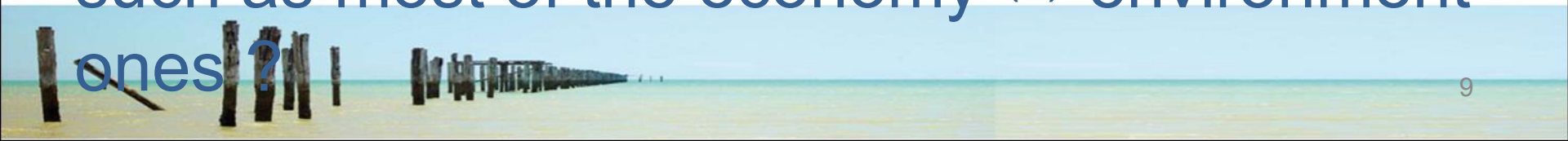
How to adapt I-O and NAMEA methods, usually used at national levels, to smaller scales best suited for ICZM

OBJECTIVES

Main questions to be answered (continued)

How carrying out a DPSIR systemic quantification of relationships economy ↔ environment while several DPSIR interfaces flows are too complex to be quantified ?

How to deal with non deterministic relationships such as most of the economy ↔ environment ones ?



OBJECTIVES

Work structured in 3 pillars

1. **Characterization of the study zone in economic and environmental terms** :

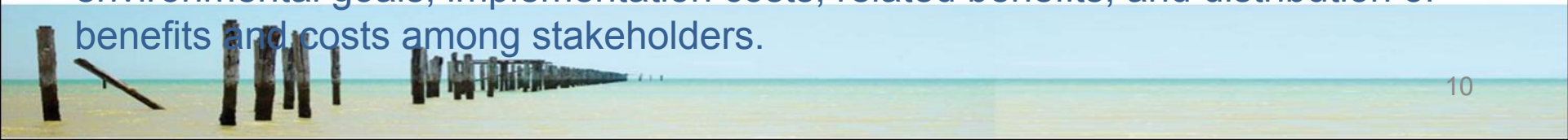
   Methodologies : NAMEA, green input-output matrix, construction of sustainable development indicators

2. **Modeling**:

   Parametrising as fine as possible relationships between economic components of the system and their impacts on the environment (with feedback of the environment on economy).

3. **Foresight** strictly speaking:

   Simulating management scenarios. Each scenario will be assessed in terms of environmental goals, implementation costs, related benefits, and distribution of benefits and costs among stakeholders.



STUDY CASE

STUDY CASE

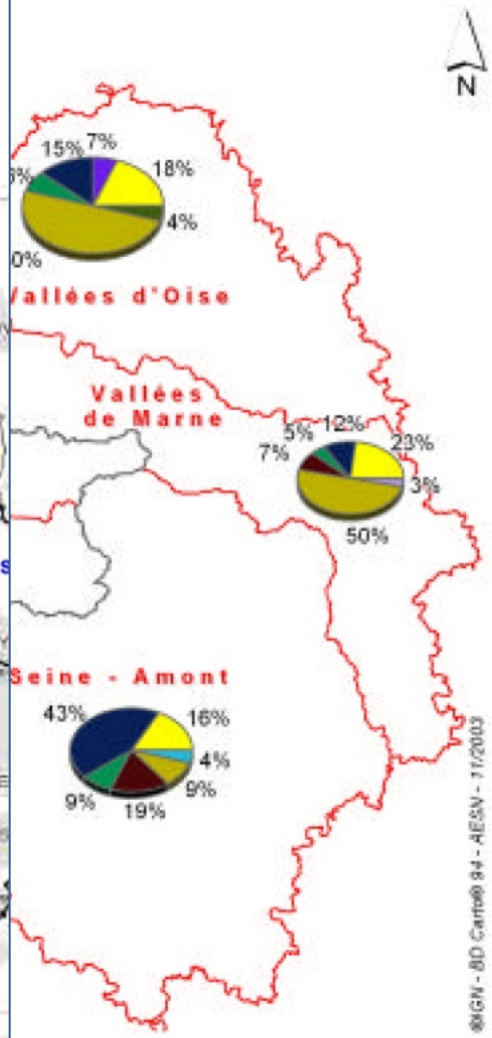
- **Main environmental issue :** heavy metals
- **Complementary issue :** eutrophication
- **Constraint to take into account :** climate changes

sses d'eaux de surface
phique Seine-Aval

groupement d'intérêt public Seine-Aval

Somme
DIEPPE
Seine-Maritime
LE HAVRE
ROUEN
Calvados
Eure
EVREUX
Val-D'ois
Yvelines
Orne
DREUX
Eure-et-Loir
CHARTRES
Sous-bassin Seine aval

raccordées



METHODOLOGY

METHODOLOGY

Impact of environment on economy

Conventionl GDP calculation (non adjusted) for an hypothetical environmentaly adjusted economy (i.e. scenario simulations).

+

Impact of economy on environment

Indicators in physical units
- Green I-O
- NAMEA
- Ecological footprint
- Ecological Ref.

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***EXTEND* Modeling Building Block**

METHODOLOGY

Green I – O matrix

1. BASIC PRINCIPLE

An Input-output matrix (I-O) is a representation of national or regional economic accounting that records the way industries both trade with one another and produce for consumption and investments.

	Agriculture	Industry	Households consumption	Total output
Agriculture	Tomatoes (30 €)	Tomatoes (50 €)	Tomatoes (100 €)	Tomatoes (180 €)
Industry	Chemical fertilizers (20 €)			
Work (Added value)	50 man/month (130 €)			
Total input	180 €			

Output

Output

Output

0,1 € of input from industry is needed to produce 1 € of agricultural output

	Agriculture	Industry	Households consumption	Total output
Agricul-ture	0,2	0,6	Household Consumption Agric	Xagric
Indus-try	0,1	0,1	Household Consumption ind	Xind
Work (Added value)	0,7	0,3		
Total input	1	1		

	Agriculture	Industry	Pollutant abatment activities	Households consumption	Total output
Agriculture	0,2	0,6	**Production of goods and services** resulting from the implementation of the **environmental measures** for pollutant elimination	Household Consumption Agric	X agric
Industry	0,1	0,1		Household Consumption ind	X ind
Pollutant emissions	40 tonnes of nitrates	150 tonnes of nitrates		80 tonnes of nitrate (residual pollution tolerated)	110 tonnes of nitrates eliminated
Work (Added value)	0,7	0,3			
Total input	1	1			

Household Consumption Agric = X agric * (1 – 0,2) – Xind * 0,6 – 0 – a_{ij}*Xdépol.

Household Consumption Ind = –X agric * 0,1 + Xind*(1–0,1) – 0 – a_{ij}*Xdépol.

Work (€ converted in jobs number) = 0,7 * X agric + 0,3 * Xind – 0 + a_{ij}*Xdépol.

Residual Tolerated pollutants = X agric * 0,2 + 1,9 * Xind – X pol. Elim. + 0

Input-output Matrix :

$$\begin{pmatrix} (1-0,2) & -0,6 & 0 & -a_{ij} \\ -0,1 & (1-0,1) & 0 & -a_{ij} \\ 0,7 & 0,3 & 0 & -a_{ij} \\ 0,2 & 1,9 & -1 & 0 \end{pmatrix}$$

Matrix inversion

Production according to final consumption (given exogenously)

X agric = Hous.Cons.agric * (A_{11}) + Hous.Cons.Ind. * (A_{12}) – 0 – Tolerated Poll. * (A_{13})

X Ind = Hous.Cons.agric * (A_{21}) + Hous.Cons.Ind. * (A_{22}) – 0 – Tolerated Pol. * (A_{23})

Work(€ or #jobs)=Hous.Cons.agric*(A_{31})+ Hous.Cons.Ind.*(A_{32}) –0–Tolerated Pol.*(A_{33})

X pol. Elim. = Hous.Cons.agric * (A_{41}) + Hous.Cons.Ind. * (A_{42}) – Tolerated Pol * (A_{43})

These 2 equations show that :

<u>if</u> the residual **Tolerated pollution** is reduced (i.e. if we increase the measures of pollution reduction),

<u>Then</u> the agricultural production ***X agric*** will increase

<u>The reason is that</u> agricultural products are required for pollution reduction activities.

<u>And</u> Employment (**Work**) will also increase since employees are needed to carry out pollution abatement activities.

2. Production according to final consumption (given exogenously)

$$X\ agric = Hous.Cons.agric * (A_{11}) + Hous.Cons.Ind. * (A_{12}) - 0 - Tolerated\ Pol. * (A_{13})$$

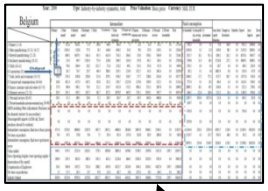
$$Work(€\ or\ \#jobs) = Hous.Cons.agric * (A_{31}) + Hous.Cons.Ind. * (A_{32}) - 0 - Tolerated\ Pol. * (A_{33})$$

METHODOLOGY

Where the Green I – O matrix is included in the DPSIR systemic approach ?

DRIVING FORCES
Good & services production (€)

Matrice I-O



RESPONSE
Quotas (prices, quantitity)
Taxes (%)
Budgets allocated
Subsidies

Scenarios

- Modif. technical coeff.
- Modif. final consumption
- Modif. pollutant rejections
- Modif. Intermediate inputs value (enter costs of env. mesures)

Pollutants rejections data

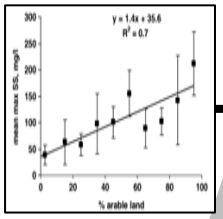
Technical Coefficients

$$\frac{\text{Rejet polluant}}{\text{Output total}}$$

(Tonnes / €)

PRESSURES
Total amount of rejected pollutants in each of our scenarios (tones/yr)

Equations (Scientific literature)



Verification of the sustainability of the economy

Indicators in physical units : *[Pollutant] METOX, ERI Ecol. Foot. Etc.*

↔

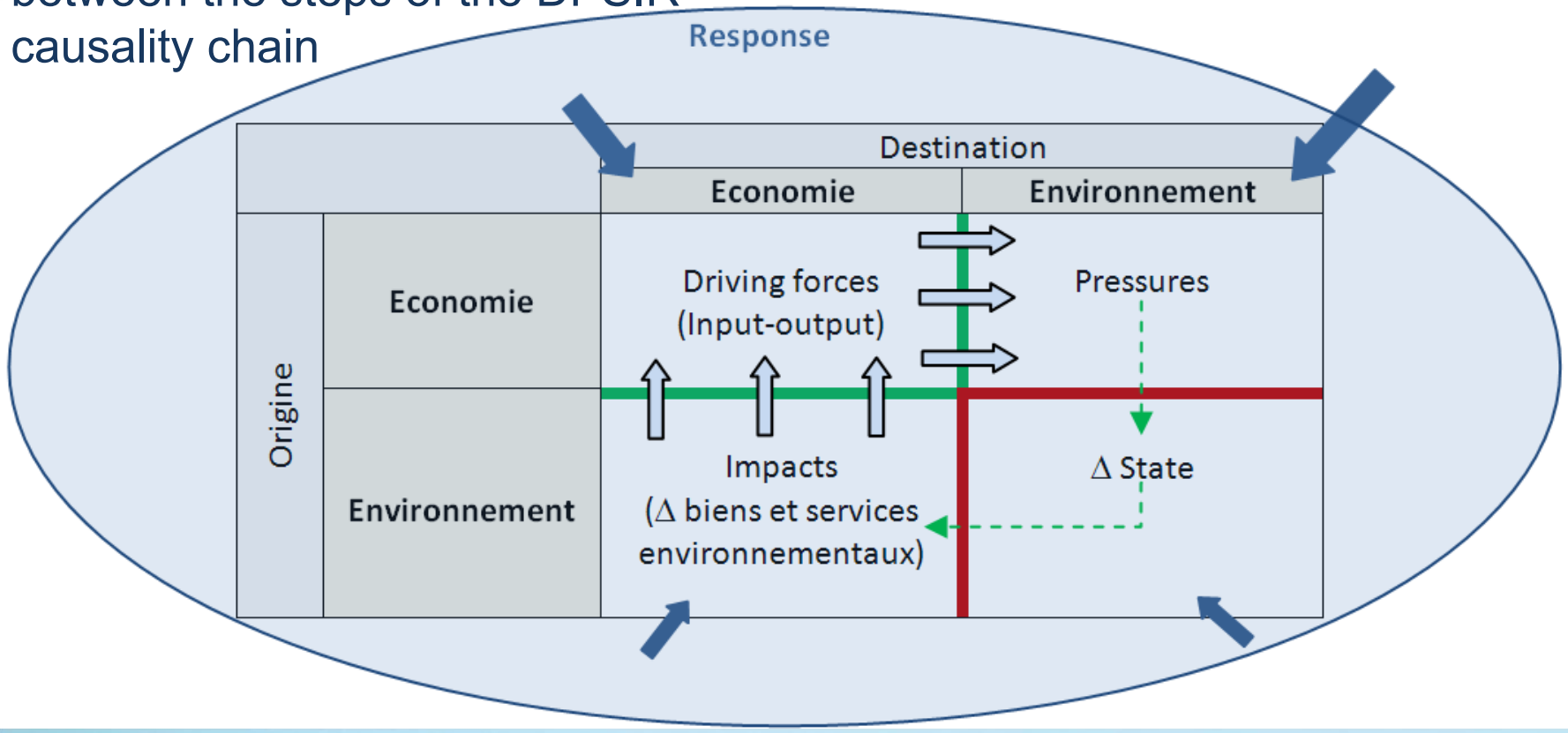
Sustainability norms : *WFD ERI<1 Biocapacity Etc.*

STATE
Pollutants concentrations in natural environmentl (State indicators : mg/l, kg pollutant/kg sediment,…)

IMPACT (ECONOMIC)
GDP_{BAU} – $geGDP_{green\ scenarios}$
(Calculated by I-O)

METHODOLOGY

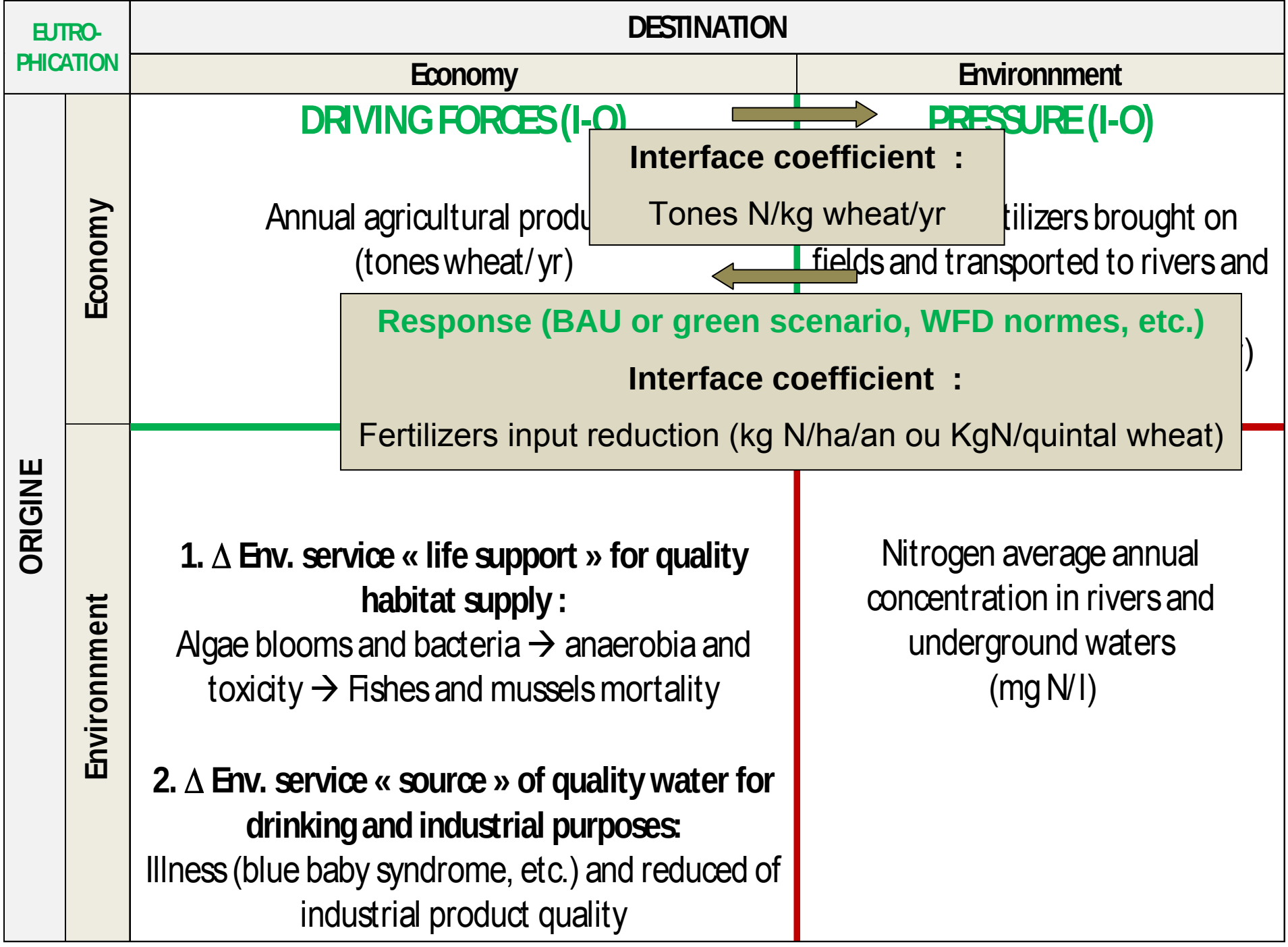
We will work on interfaces flows between the steps of the DPSIR causality chain



METHODOLOGY

Eutrophication example :

EUTRO-PHICATION		DESTINATION	
		Economy	Environnment
ORIGINE	Economy		
	Environnment		


EUTRO-PHICATION
DESTINATION
Economy
Environnment
ORIGINE
Economy
Environnment
DRIVING FORCES (I-O)
PRESSURE (I-O)
Interface coefficient :
Tones N/kg wheat/yr
Annual agricultural produ
(tones wheat/yr)
tilizers brought on
fields and transported to rivers and
Response (BAU or green scenario, WFD normes, etc.)
Interface coefficient :
Fertilizers input reduction (kg N/ha/an ou KgN/quintal wheat)
1. Δ Env. service « life support » for quality habitat supply :
Algae blooms and bacteria → anaerobia and toxicity → Fishes and mussels mortality
2. Δ Env. service « source » of quality water for drinking and industrial purposes:
Illness (blue baby syndrome, etc.) and reduced of industrial product quality
Nitrogen average annual concentration in rivers and underground waters (mg N/l)

EUTRO-PHICATION		DESTINATION	
		Economy	Environnment
ORIGINE	Economy	**DRIVING FORCES (I-O)** Annual agricultural production (tones wheat/yr)	**PRESSURE (I-O)** Nitrogen fertilizers brought on fields and transported to rivers and underground water (tones N/ha/yr and Kg N/km^2/yr) **Interface Coefficient :** Deterministic equations (Scientific literature)
	Environnment	**IMPACT** **1. Δ Env. service « life support » for quality habitat supply :** Algae blooms and bacteria → anaerobia and toxicity → Fishes and mussels mortality **2. Δ Env. service « source » of quality water for drinking and industrial purposes:** Illness (blue baby syndrome, etc.) and reduced of industrial product quality	Nitrogen average annual concentration in rivers and underground waters (mg N/l)

EUTRO-PHICATION		DESTINATION	
		Economy	Environnment
ORIGINE	Economy	**DRIVING FORCES (I-O)** Annual agricultural production (tones wheat/yr)	**PRESSURE (I-O)** Nitrogen fertilizers brought on fields and transported to rivers and underground water (tones N/ha/yr and Kg N/km^2/yr)
	Environnment	**IMPACT** ← **STATE**	

Interface Coefficient :

1. Δ

Alg
t

2. Δ E

Illness

- Potential risk of toxic bloom if Redfield ratio between N, P and Si < x : (Billen et al., 2007)
- Fish and mussel mortality (# dead/mg N/l) : /
- Human illness (# of patients affected /mg N/l) : /
- Reduced quality of industrial products (% of unsold production /mg N)
- Research of other site for water extraction (m^3 water pumped outside the study zone/mg N/l) or intensification of water treatments before use (m^3 treated water/mg N/l : /

EUTRO-PHICATION		DESTINATION	
		Economy	Environnment
ORIGINE	Economy	**DRIVING FORCES (I-O)** **Interface coefficient :** **a. DPSIR links easily quantified (flows of env. services) :** - Total annual amount of catched fish and harvested mussels (t/yr et €/yr) - Volume of quality water extracted for industrial and drinking purposes (m^3/yr) and price (€/m^3)	**PRESSURE (I-O)** Nitrogen fertilizers brought on fields and transported to rivers and underground water (tones N/ha/yr and Kg N/km^2/yr)
	Environnment	Algae blooms and bacteria → anaerobia and toxicity → Fishes and mussels mortality **2. Δ Env. service « source » of quality water for drinking and industrial purposes:** Illness (blue baby syndrome, etc.) and research by industries of cleaner water in other sites	**STATE** Nitrogen average annual concentration in rivers and underground waters (mg N/l)

EUTRO-PHICATION

DESTINATION

Economy

Environnment

ORIGINE

Interface Coefficient :

Monetisation when PSI flows cannot be quantified:

- Total number of additional waste water treatment plant to be constructed or upgraded and cost (treatment capacity in EH and €) for WFD respect
- Investments in water treatment technologies before industrial use and increase of operating and maintenance costs for treatment (m^3 of treated water, tones polluants, €)
- Number of cured patients/yr and hospitalisation cost (# and €)
- Value of the unsold industrial production or of the losses du to lower quality (% and €)

2. Δ Env. service « source » of quality water for drinking and industrial purposes:

Illness (blue baby syndrome, etc.) and research by industries of cleaner water in other sites

PRESSURE (I-O)

Nitrogen fertilizers brought on fields and transported to rivers and underground water (tones N/ha/yr and Kg N/km^2/yr)

STATE

Nitrogen average annual concentration in rivers and underground waters (mg N/l)