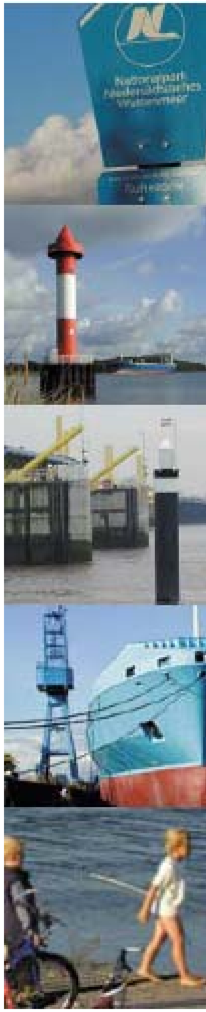
Supporting Integrated Coastal Zone Management (ICZM) by Systems Anaylsis

Summerschool on Limnoecology at Lake Baikal

A joint activity of Irkutsk University and Kiel University at the Biological Station Bolshy Kotie



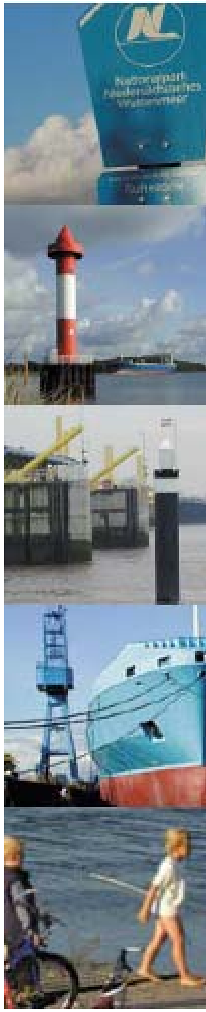
What is ICZM aimed at?
ICZM is aimed at making a contribution to the development and preservation of coastal zones as an ecologically intact and economically prospering habitat for humankind.

What is ICZM not intended to be?
ICZM is not an independent formal planning and decision-making tool and not an instrument for pushing through specialized and individual interests.

What is ICZM?

ICZM is an informal approach to supporting sustainable development of coastal zones through good integration, coordination, communication and participation.

On the one hand, ICZM is a process that should permeate all planning and decision-planning levels as a guiding principle and, on the other hand, is a tool applied for the purpose of integrated identification of potential development and conflict as well as for resolving conflicts in an unbureaucratic manner.



The ICZM strategy is based on the following basic principles*:

- ICZM shall promote **sustainable development** of coastal zones with their specific ecological, economic and social features and support the sustainability strategy of the federal German government.

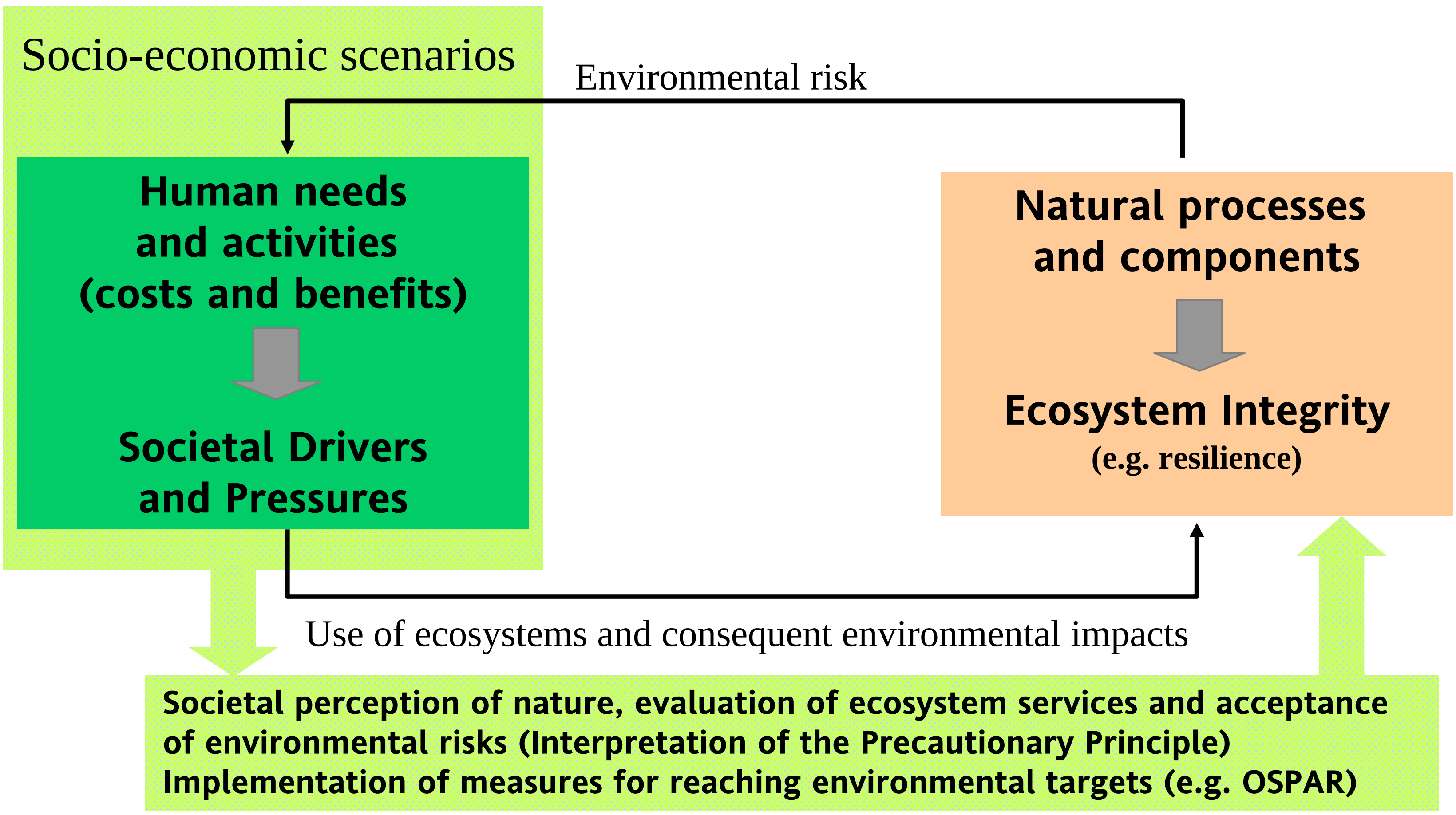
- ICZM represents a guiding principle for political and social action at all levels in coastal zones and is aimed at coordinating the development of coastal zones through a comprehensive approach and **integration** of all concerns.

- ICZM incorporates all relevant policy areas, economic and scientific actors, social groups and levels of administration into the process (**participation**) in order to identify development potential at an early stage, find solutions for which there is a consensus and improve conflict management.

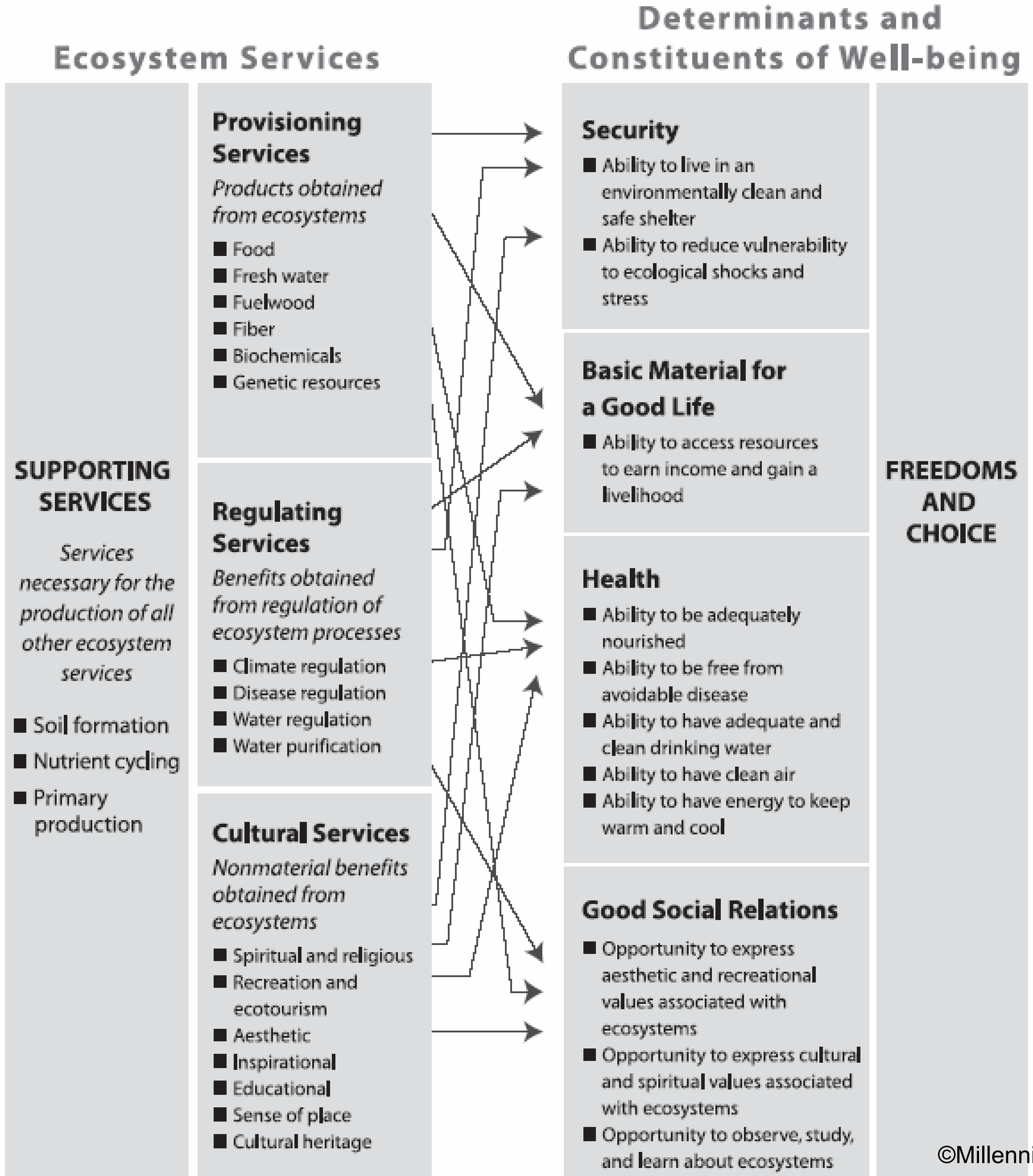
- ICZM is viewed as a continuous process that combines the phases of planning, implementation and evaluation of changes in coastal zones so as to make the best possible use of experience for the future (**experience transfer**).

*ICZM principles based on the EU recommendation 2002/413/EC

Use of ecosystem services and environmental impacts



Modified after Colijn et al. 2002


Ecosystem Services
Determinants and Constituents of Well-being
SUPPORTING SERVICES
Services necessary for the production of all other ecosystem services
■ Soil formation
■ Nutrient cycling
■ Primary production
Provisioning Services
Products obtained from ecosystems
■ Food
■ Fresh water
■ Fuelwood
■ Fiber
■ Biochemicals
■ Genetic resources
Regulating Services
Benefits obtained from regulation of ecosystem processes
■ Climate regulation
■ Disease regulation
■ Water regulation
■ Water purification
Cultural Services
Nonmaterial benefits obtained from ecosystems
■ Spiritual and religious
■ Recreation and ecotourism
■ Aesthetic
■ Inspirational
■ Educational
■ Sense of place
■ Cultural heritage
Security
■ Ability to live in an environmentally clean and safe shelter
■ Ability to reduce vulnerability to ecological shocks and stress
Basic Material for a Good Life
■ Ability to access resources to earn income and gain a livelihood
Health
■ Ability to be adequately nourished
■ Ability to be free from avoidable disease
■ Ability to have adequate and clean drinking water
■ Ability to have clean air
■ Ability to have energy to keep warm and cool
Good Social Relations
■ Opportunity to express aesthetic and recreational values associated with ecosystems
■ Opportunity to express cultural and spiritual values associated with ecosystems
■ Opportunity to observe, study, and learn about ecosystems
FREEDOMS AND CHOICE

What are the current conditions and trends of ecosystems and their associated human well-being?

What ecosystems make what contributions to human well-being?

How have ecosystems changed in the past and how has this increased or
reduced their capacity to contribute to human well-being?

What thresholds, regime shifts, or irreversible changes have been observed?

What were the most critical factors affecting the observed changes?

What are the costs, benefits, and risks of the observed changes in ecosystems, and how have these affected different sectors of society and
different regions?

What are the plausible future changes in ecosystems and in the supply of and demand for ecosystem services and the consequent changes in health,
livelihood, security, and other constituents of well-being?

Under what circumstances are thresholds encountered or are regime shifts
or irreversible changes likely to occur?

What are the most critical drivers and factors affecting future changes?

What are the costs, benefits, and risks of plausible future human-induced
changes in ecosystems, and how will these affect different sectors of society and different regions?

What can we do to enhance well-being and conserve ecosystems?

What are the strengths and weaknesses of response options, actions, and processes that can be considered to realize or avoid specific futures?

What are the trade-off implications of the response options?

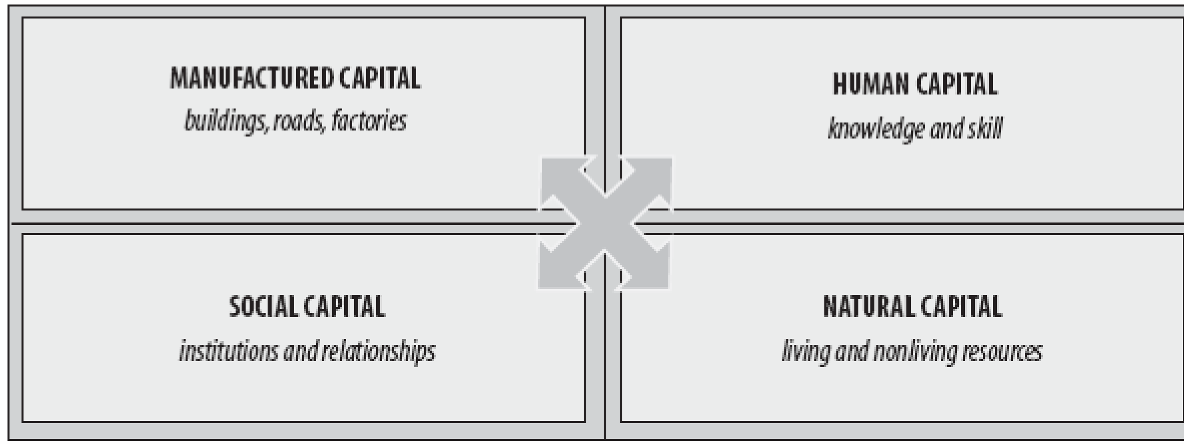
How does inertia in the social and natural systems affect management decisions?

Northern Cod Off Newfoundland, Canada *(NAFO area 2J3KL)*

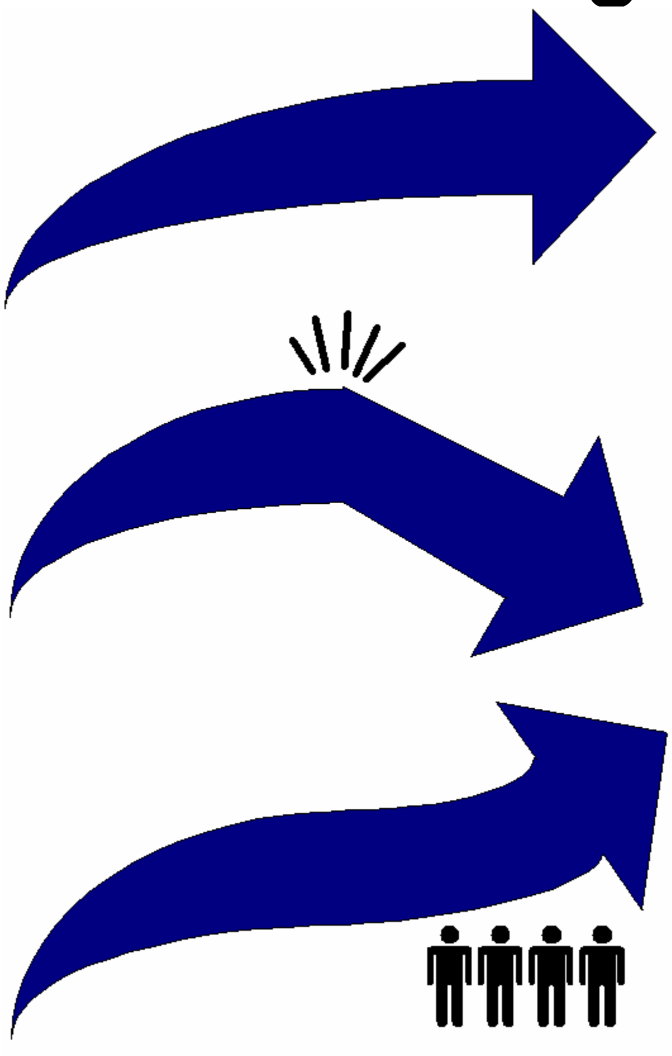
Source: Myers et al. 1995.

Therefore, a full assessment of ecosystems and their services must consider:

- information on the cost of a substitute,
- the opportunity cost of maintaining the service,
- cross-service costs and impacts, and
- the distributional impacts of any substitution.



Sources of Uncertainty when thinking about the Future



Ignorance

Understanding is limited

Surprise

The unexpected and the novel can alter directions

Volition

Human choice matters

Source: P. Raskin

A Definition of Scenarios

Scenarios =

Plausible alternative futures, each an example of what might happen under particular assumptions, told as stories and backed up by quantification and modeling.

Different from

Forecast

is the best estimate from a particular method, model, or individual**.**

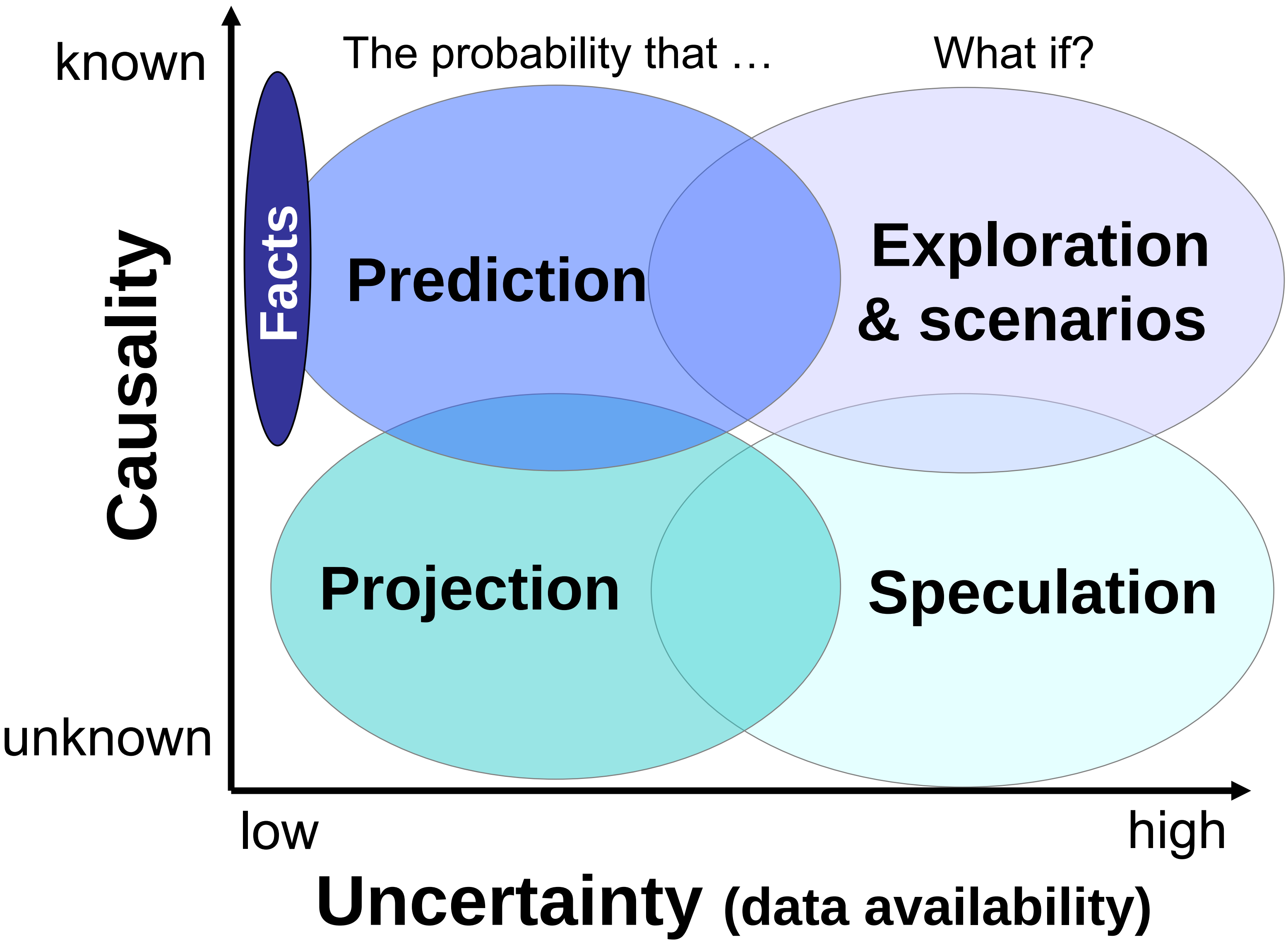
Projections

are heavily dependent on assumptions about drivers and boundary conditions. Projections lead to "if this, then that" statements.

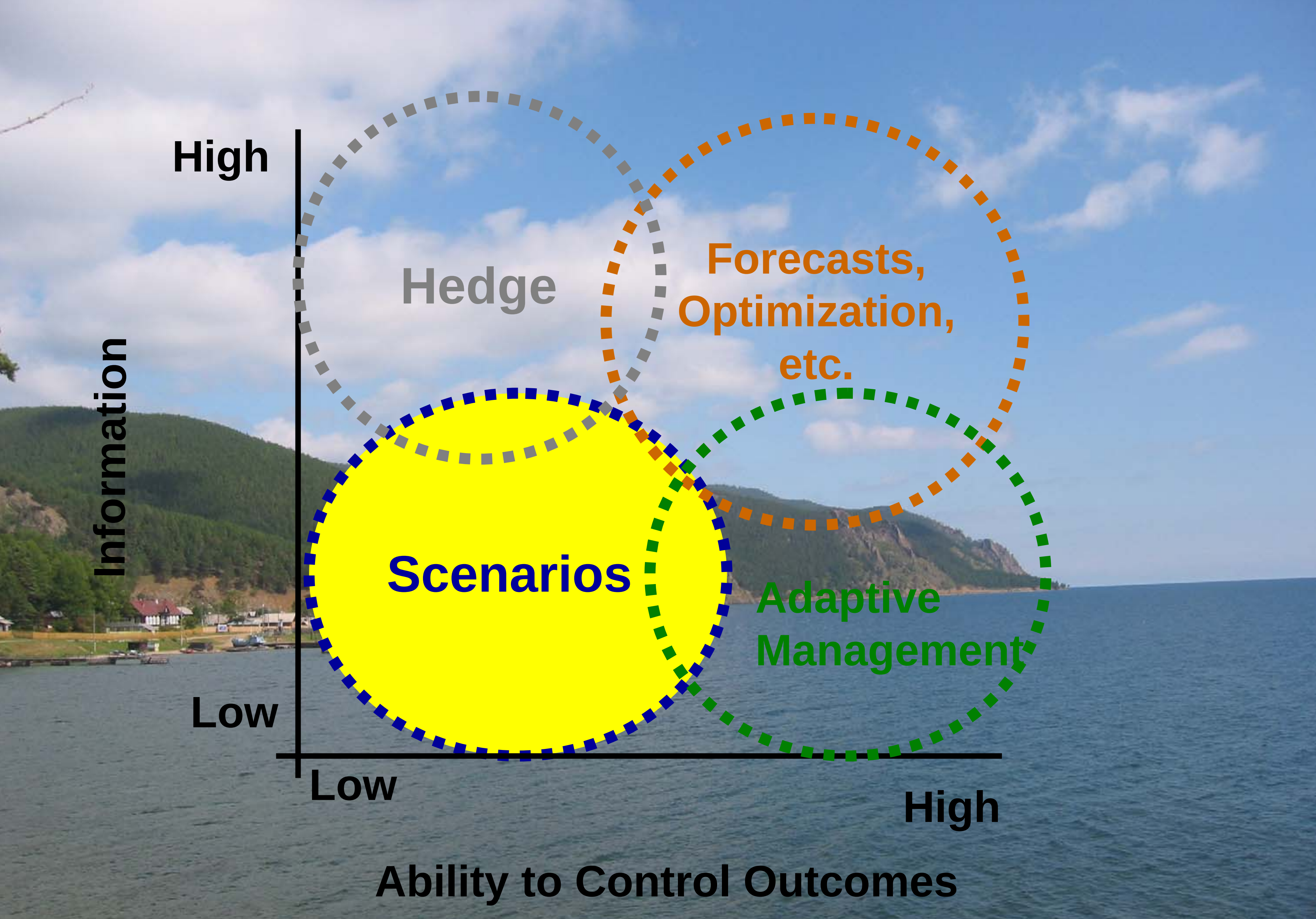
Predictions

are seen by the public and decision makers as things that will happen no matter what they do.

Scenarios, predictions & projections?



Source: R. Leemans 2003

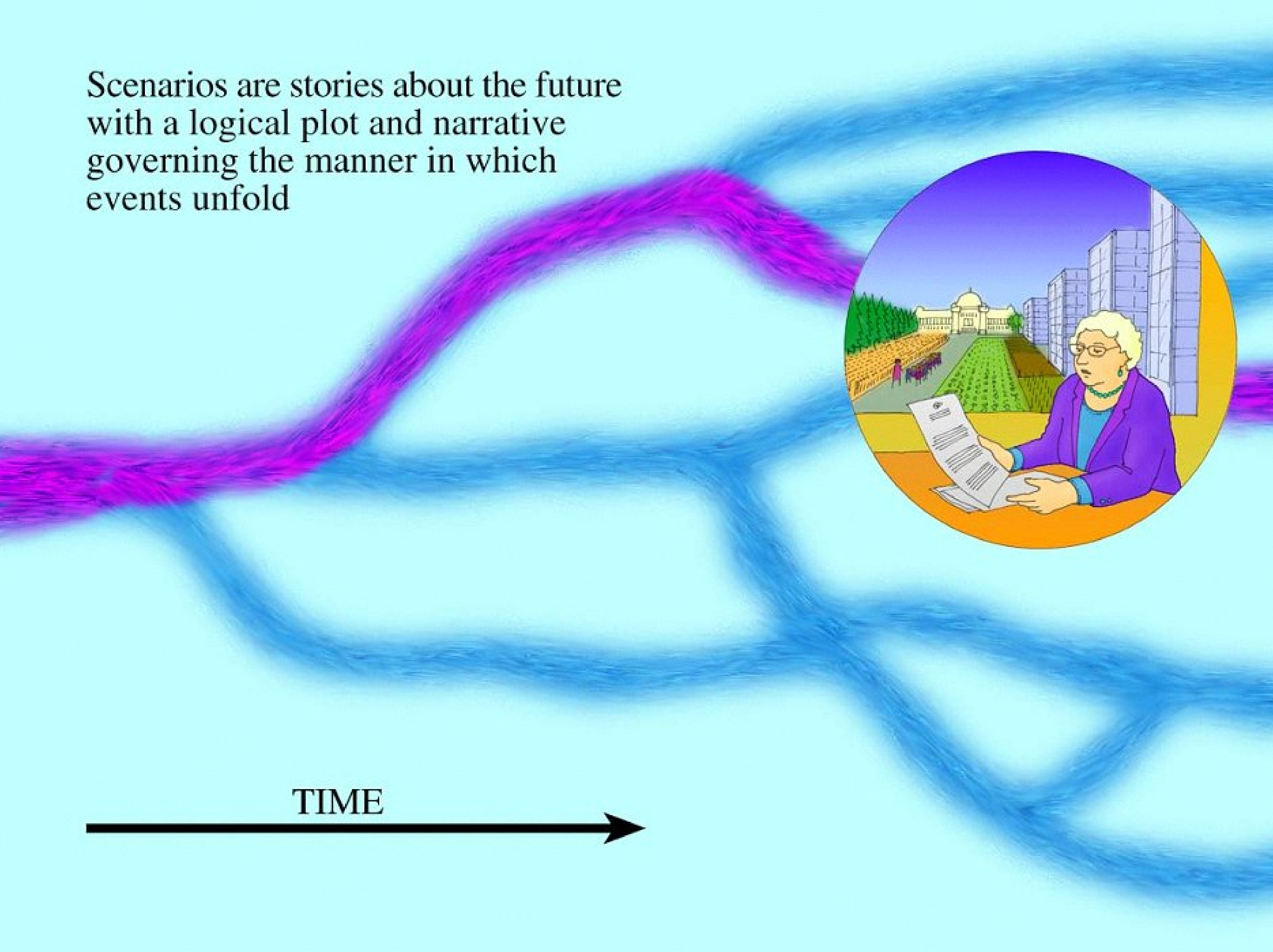


Source: Peterson, Cumming & Carpenter, *Conservation Biology*: in press.

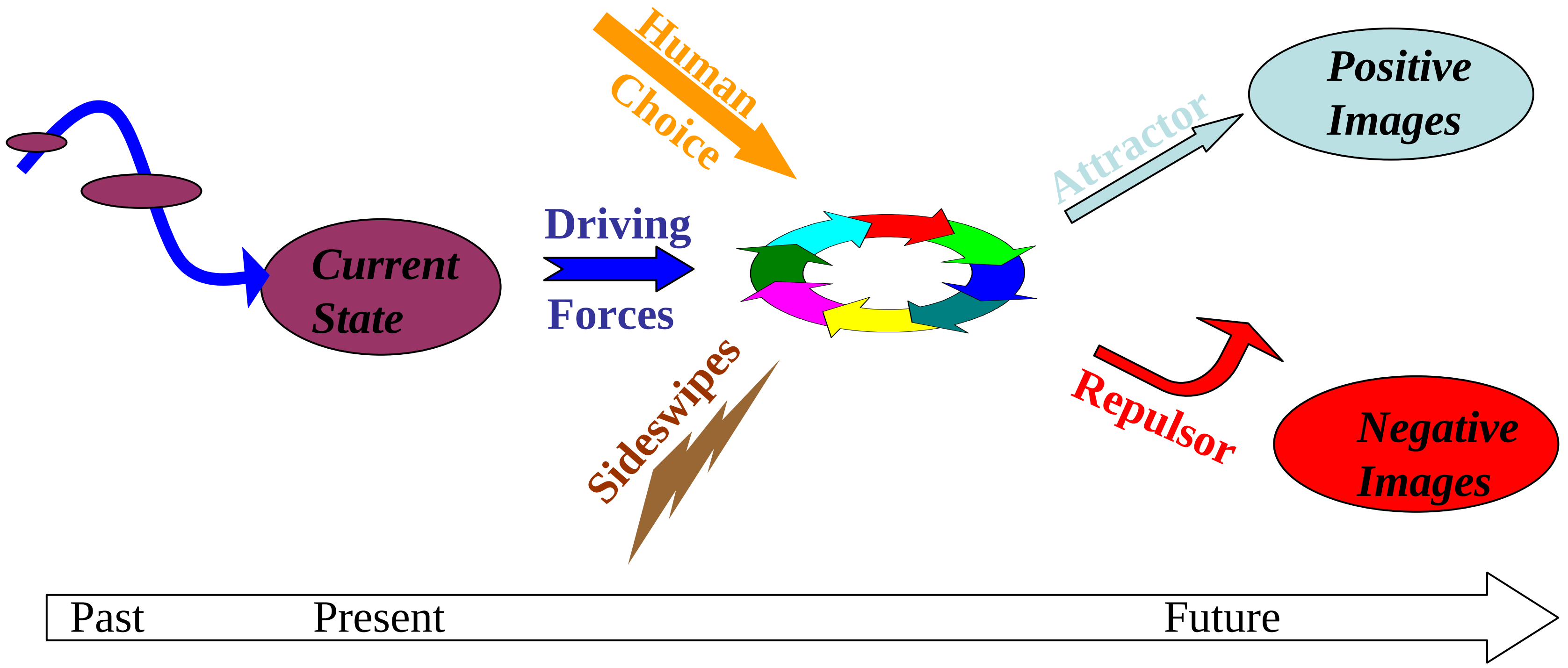
What are scenarios and why use them?

- Purpose of scenarios:
  - Information dissemination
  - Scientific exploration
  - Decision-making tool

  ⇨ Different process of stakeholder involvement in scenario development

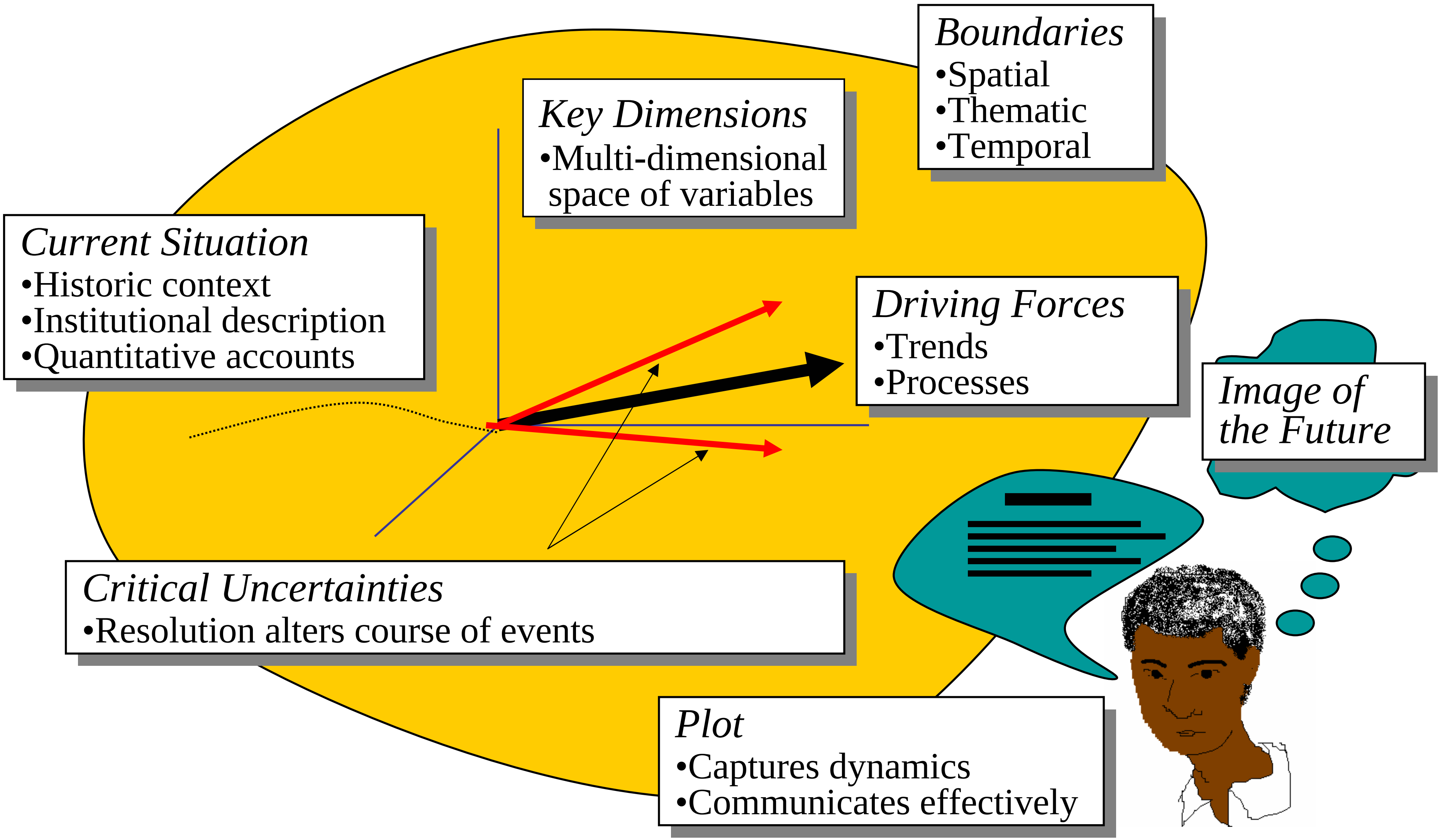

Scenarios are stories about the future with a logical plot and narrative governing the manner in which events unfold
TIME

SCENARIO DYNAMICS



Source: P. Raskin 2002

Anatomy of Scenarios



Source: P. Raskin 2002

The MA approach to scenarios

- Structured accounts of **possible futures**.
- Describe futures that **could** be, rather than futures that will be.
- Alternative, dynamic **stories** that capture key ingredients of our **uncertainty** about the future of our study system.
- Constructed to provide insight into **drivers** of change, reveal the **implications** of current trajectories, and illuminate **options** for action.
- Encompass quantitative models and realistic projections, but much of their value lies in incorporating both **qualitative and quantitative understandings of the system** and in forcing people to evaluate and reassess their beliefs and **assumptions** about the system.

Global Orchestration

Successes of policy and markets of the last century lead to optimism about improving functioning of socio-economic systems and the hope that this will lead to improvements in provision of ecosystem services.

Global “one size fits all” style management and focus on market-based solutions.

Ecological feedbacks are generally dealt with by improved technological capabilities and responsive policies. But later one more surprise arising from simplified ecosystems.

Potential Benefits	**Potential Risks**
• Decreasing economic inequality (Kuznets’ greening) • Economic Prosperity (b/c growing other economies means that there are people to buy rich world products)	• Reactive mgmt proves to be more costly • Ecological crises accelerate inequality (b/c it disproportionately affects the poor • Loss of economic growth due to fragmentation • Inability to benefit from trade

TechnoGarden

Ecosystem services and learning are very important (but protected ecosystems not the best way to provide services).

Technological successes lead to increased substituting technology for regulatory services to improve the supply of ES to people.

General focus on global "one size fits all" style management.

Potential Benefits	Potential Risks
• Highly effective utilization of ecosystem services • Enhancing ecosystem services	• Technological failures have far-reaching effects with big impacts • Wilderness eliminated as "gardening" of nature increases • The gap between people and nature increases • Less economic growth than the max possible because of diversion of resources to management

Order from strength

Security is very important. Control of socio-ecological linkages is strongly in the hands of the rich and powerful nations and powerful individuals in poor nations.

Ecological problems can and should be handled by increasing benefits locally, even if it means exporting some problems to other, less powerful areas.

Trade should flow openly and without barriers except those put in place by elites.

Potential Benefits	**Potential Risks**
• Increased security • Less expansion of invasive species • Islands of quality ecosystems	• High inequality/social tension • Risk of security breaches • Global environmental degradation • Lower economic growth • Malnutrition

Adapting Mosaic

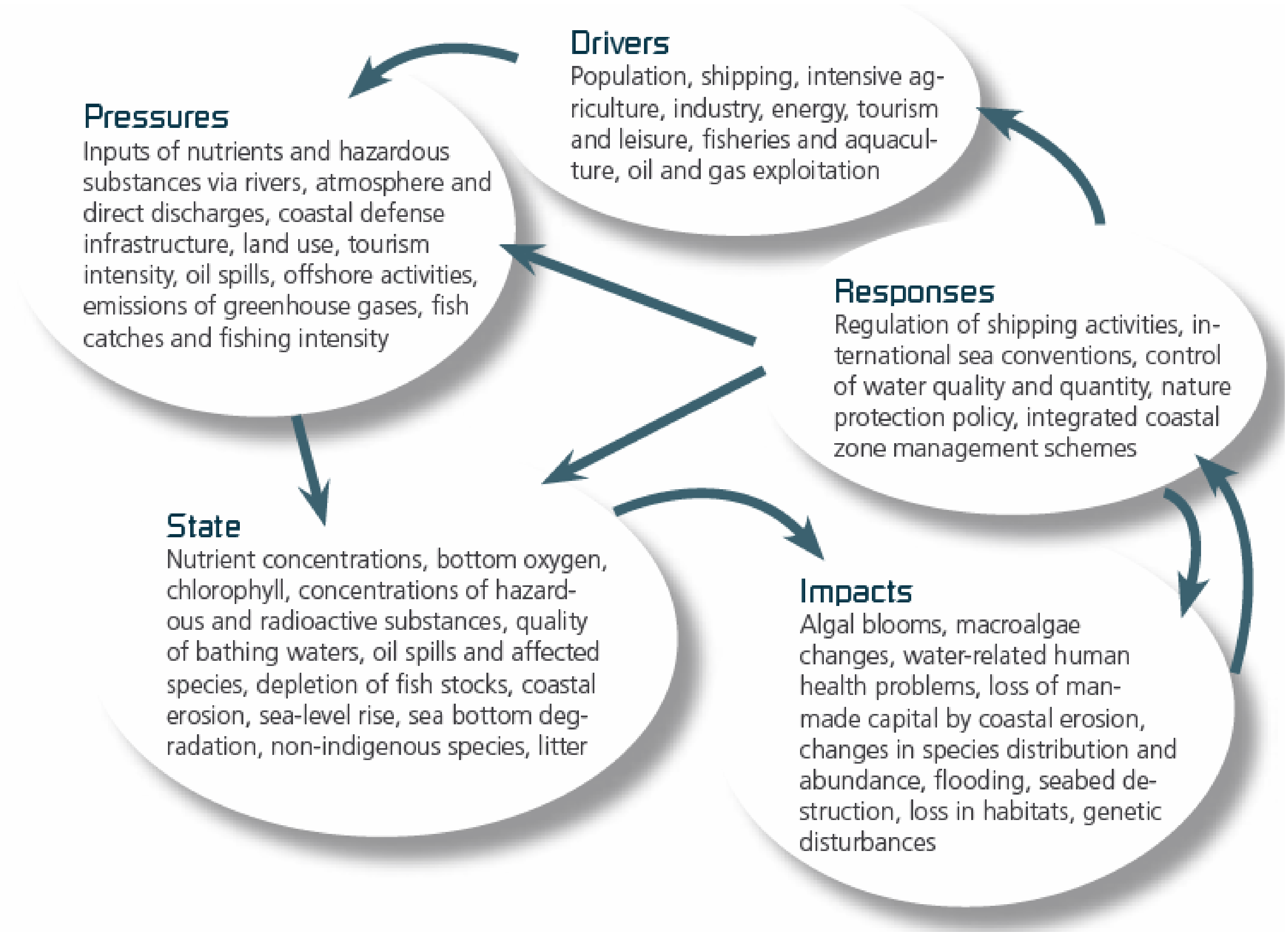
Ecosystem services are important and functioning ecosystems are an important part of providing ecosystem services.

Focus on natural capital is enough to maintain adequate provision of ecosystem services. This changes later in the scenario and there is increased focus on human and social capital.

A mix of management successes and failures has led people to be optimistic about learning, but humble about preparing for surprises and understanding all there is to know about how ecosystems work.

Potential Benefits	**Potential Risks**
• High coping capacity with local changes (proactive) • Win-win management of ecosystem services	• Neglect of global commons • Inattention to inequality • Less economic growth than the max possible b/c diversion of resources to management and b/c less trading

The DPSIR framework applied to the marine environment (EEA, 2000)



General aspects on the development of indicators

Definitions:

Indicators are alternative measures to gain an understanding of a complex system [...] so that effective management decisions can be taken that lead towards initial objectives

Mitchell et al. 1995

Generally spoken, an indicator describes the state of a system

Walz ez al. 1997

Indicators are general Parameters (e.g. physical quantities,..) describing the state of a bigger and often complexer system in a representative way.

ICLEI 1998

„Therefore Indicators generally should be defined as parameters describing distinct, not directly measurable, often complex facts.

Sandhövel 1999

But why do we need indicators?

Wouldn´t it be better to take the full information of the real world than to work with a reduced set of information?

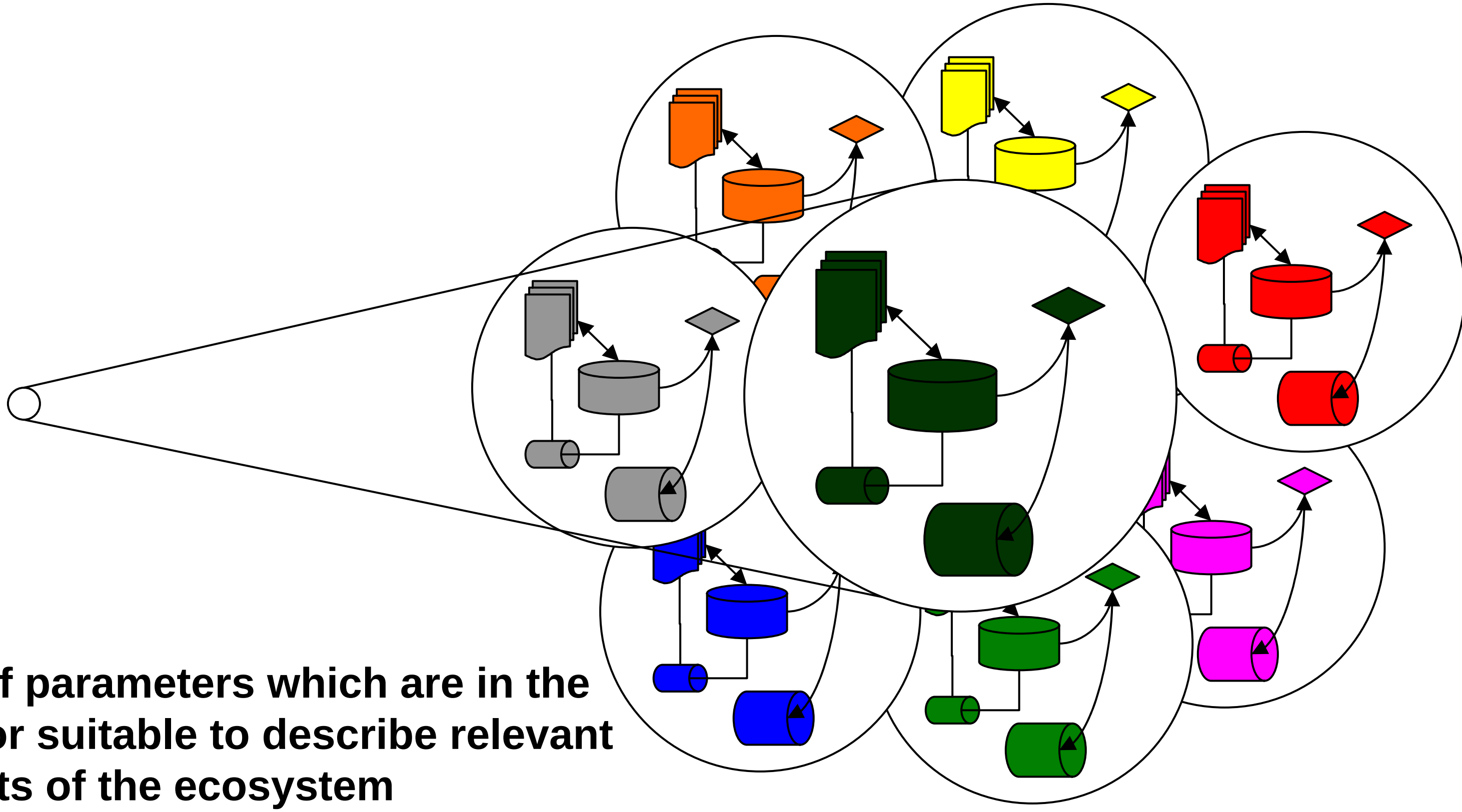
Yes, but only if we are able to communicate the full amount of information. But as this is normally not feasible, we have to look for substitutes to be communicated.

The main purpose of indicators is to enhance communication about complex systems.

Or in other words to allow communication about the state and the development of complex systems.

So, what happens in the process of indicator development?

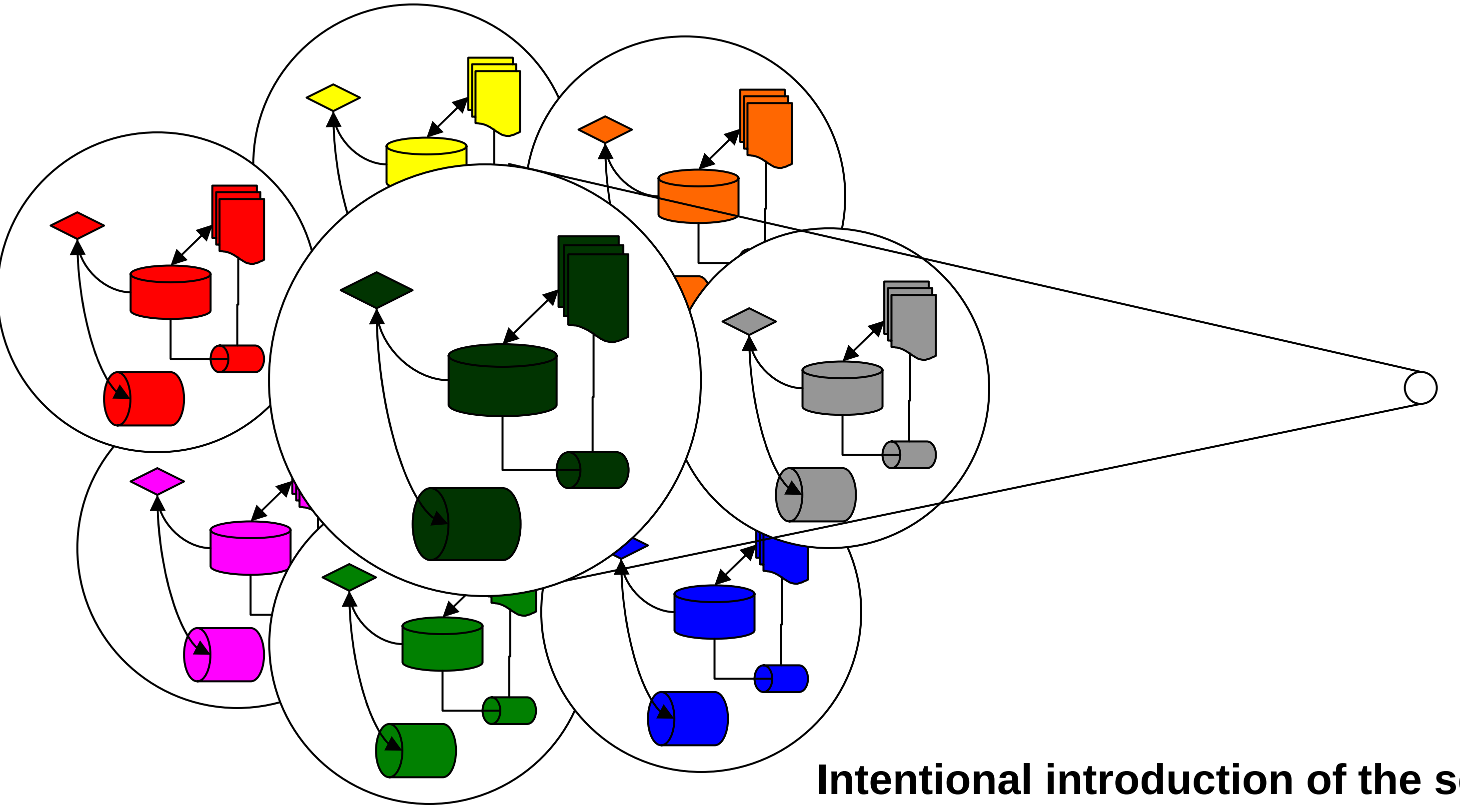
Ecosystem in the coastal zone



Intentional selection of parameters which are in the eyes of the investigator suitable to describe relevant state and developments of the ecosystem

and what happens in the process of indicator application?

Process of evaluation and decision making



Intentional introduction of the selected indicators into societal perspectives and actions

So, what do we have to take into account?

The developer as well as the user of indicators have to communicate about the their „world view“ and their intentions in this process in order to be able to identify the possibilities and limitations of the selected indicator.

As a consequence the development and/or identification of suitable and acceptable indicators needs a sufficient common understanding concerning the following questions:

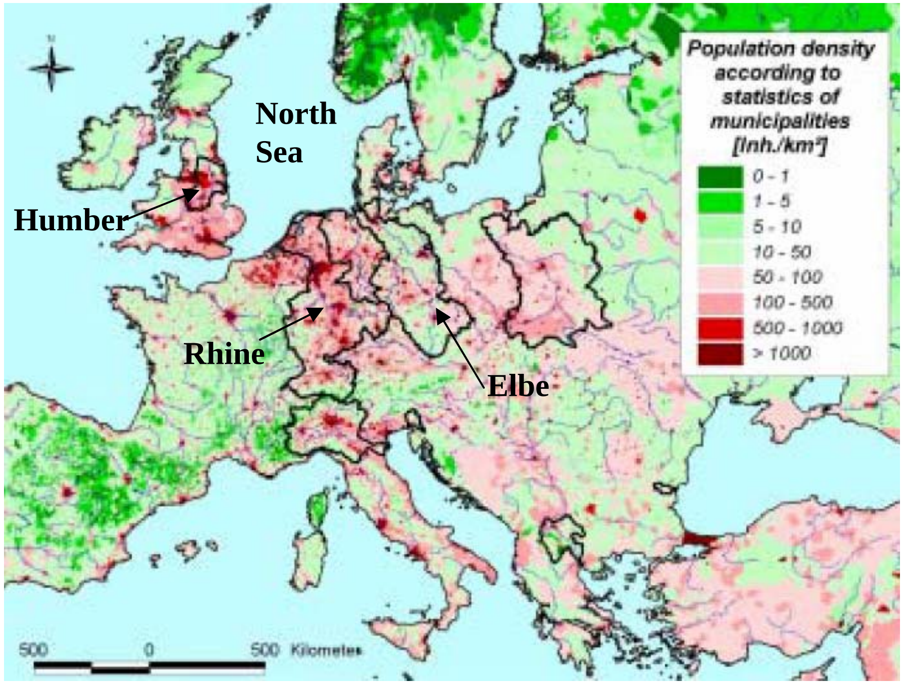
- Which is the system of concern and how can it be described ?
- Which are the components of the systems relevant to the issue of concern?
- How are the selected components to be valued?
- Which indicator values are decisive?
- How is the decisive indicator value embedded in the decision process?

Based on Deppert & Theobald 1999

Thus, indicators have to meet the following requirements and should:

- be relevant for the selected issue of concern
- be easy to observe
- be predictable
- be scientifcally based
- be reproducible
- mirror a defined section
- be able to represent spatial and time dependant changes
- be sufficient sensitve

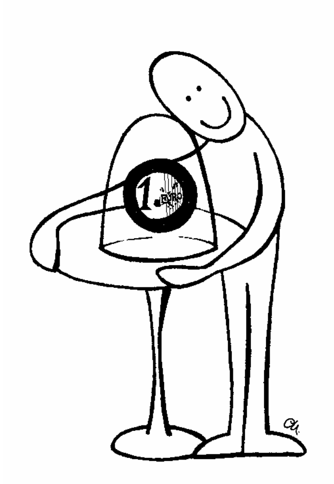
North Sea catchment area:
707500 sq.km
EUROCAT investigated catch. area:
357810 sq.km



Source: Behrendt 2004

Data by Behrendt 2004 and Cave et al. 2004	Unit	Elbe	Humber	Rhine
Basin Area	km2	148270	24240	185300
subbasins		185	6	423
length of river	km	1090	690	1320
mean disch.	m3/s	708	250	2388
tot. pop	1000 inh.	24611	13668	57256
pop. dens	inh/km2	166	564	309
urban area	%	5,9	12,3	7,9
agric. area	%	61,4	72,8	51,8
arable land	%	54,7	43,8	35,6
pasture	%	6,8	29,0	16,2
forest	%	30,5	13,7	37,2
connections to sewers	%	79,3		93,9
connections to wwtps	%	71,4	79,0	92,4

Global Markets



Free, unfettered world markets.
Priority: economic growth.
People: short-term planners, no risk aversion.

Strong EU

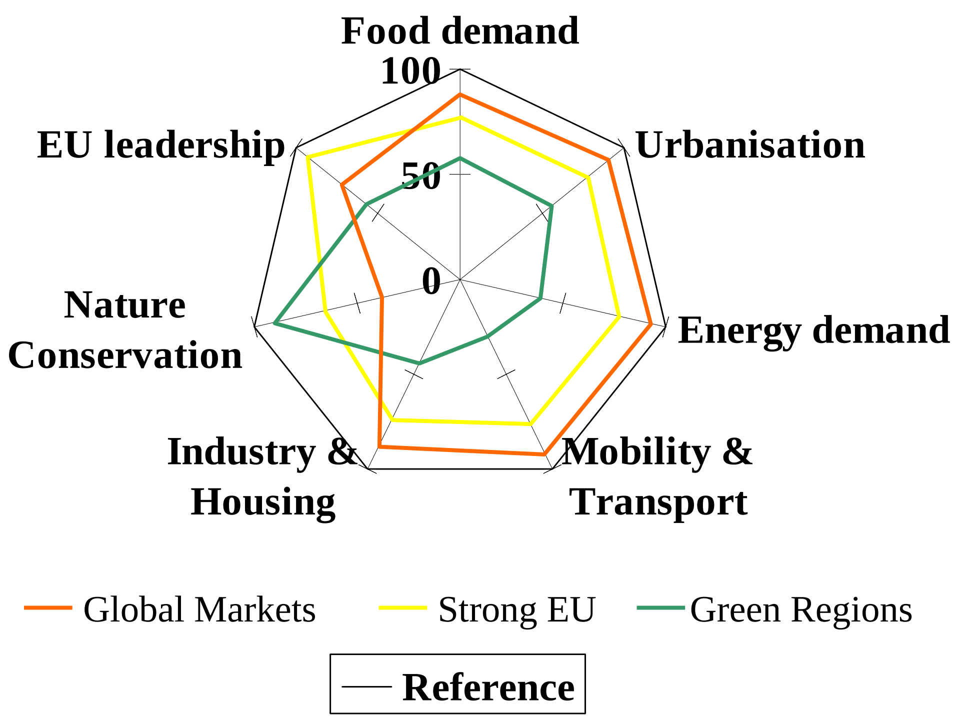
Strong EU leadership.
Regulated economy towards sustainability.
People: mid-term planners, risk averse to some degree.

Green Regions

Priority: environment, self-regulation.
Strong sustainability.
People: long-term planners, absolutely risk averse.

Drivers and Pressures

Socio-economic Drivers



Possible reference values:
maximum value, average value, recent or former situation, wanted situation, expected situation, scenario situation, etc.

Pressures*

Catchment
(MONERIS-INPUT)

Agriculture:
- Fertiliser use
- Nutrient surplus
- (Pesticide use)
- (Yields)
- etc.

Coastal Zone
(Scenario-Settings)

Riverine input
(MONERIS output)

Atmospheric Input
....

Structural Change
....

Fisheries
....

Offshore Industry
....

* complete list in: Colijn et al. (2002), EUROCAT D 2.1

Ecological Impact on Coastal Waters

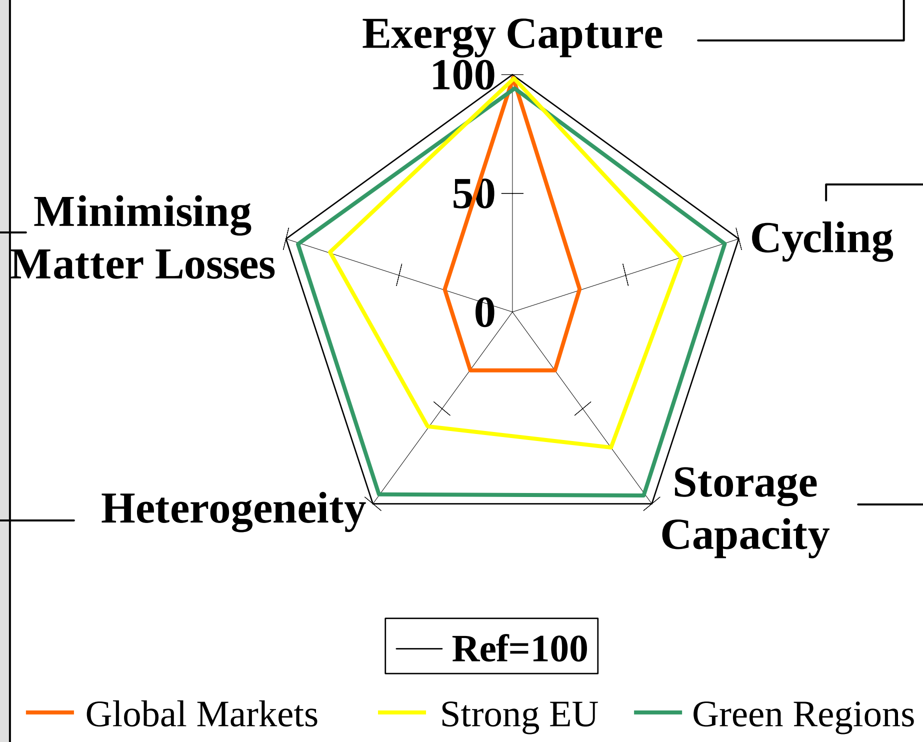
Indication based on ERSEM

State indicators

Matter losses into ERSEM adjacent boxes (organic & inorganic)

Diatom/No-diatom ratio

Ecosystem Integrity
(based upon Self-organising capacity)



State indicators

Net primary production
Inorganic & organic riverine input
Inorganic & organic input bordering ERSEM boxes

Turnover of nutrients
Bacterial uptake
Phytoplankton feeding on organic detritus
Uptake from inorganic nutrients

Sediment Input/Output

Scenarios: Measures for Reducing Nutrient Emissions

BAU		
Catchment	Description	Measures
Elbe	present trends are maintained	no additional measures
Humber		300 ha due to realignment
Rhine		no additional measures
PT		
Catchment	Description	Measures
Elbe	Reduction of inputs from the catchment (point and diff. Sources), implementation of the Nitrate Directive (good agr. Practice) and of the Urban Waste Water Directive	Farm measures, WWTP update,tile drainage reduction up to 10% of arable land
Humber		20% reduction of riverine loads (point sources + Nitrate Directive implementation), realignment area of 1321 ha
Rhine		Farm measures, WWTP update,tile drainage reduction up to 10% of arable land
DG		
Catchment	Description	Measures
Elbe	Over-compliance with Environmental Directives and standards	Farm measures, WWTP update, tile drainage reduction up to 20% of arable land
Humber		50% red in point sources + Nitrate Directive implementation, realignment area of 7400 ha
Rhine		Farm measures, WWTP update, tile drainage reduction up to 20% of arable land

Sources: Cave et al., 2003 (Humber); Lise et al., 2003, 2004 (Rhine and Elbe)

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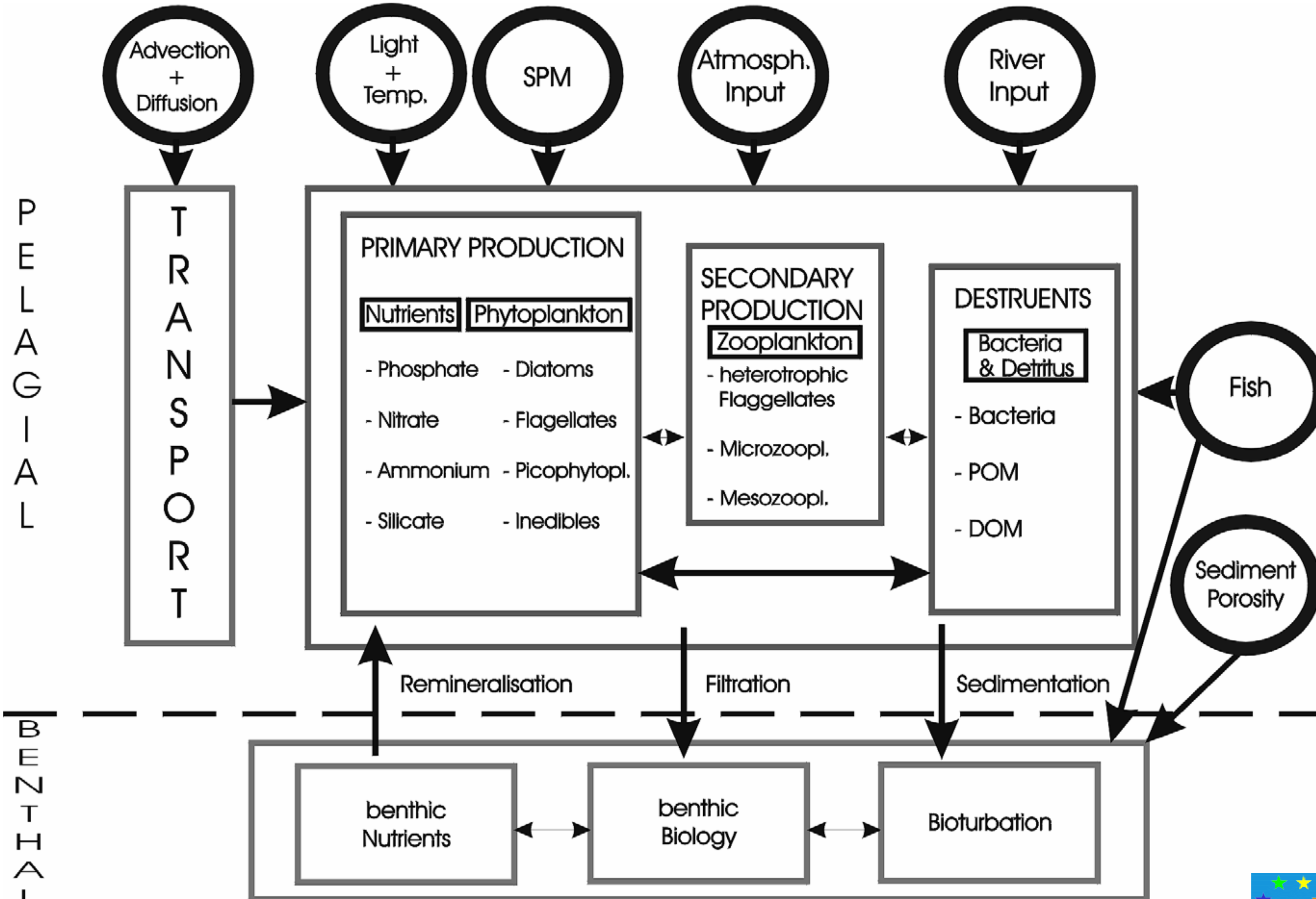
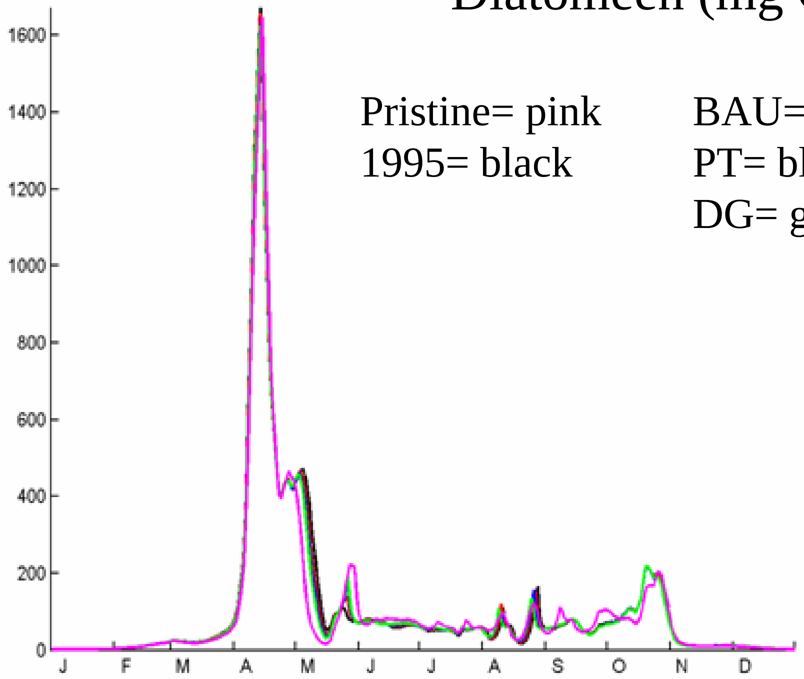


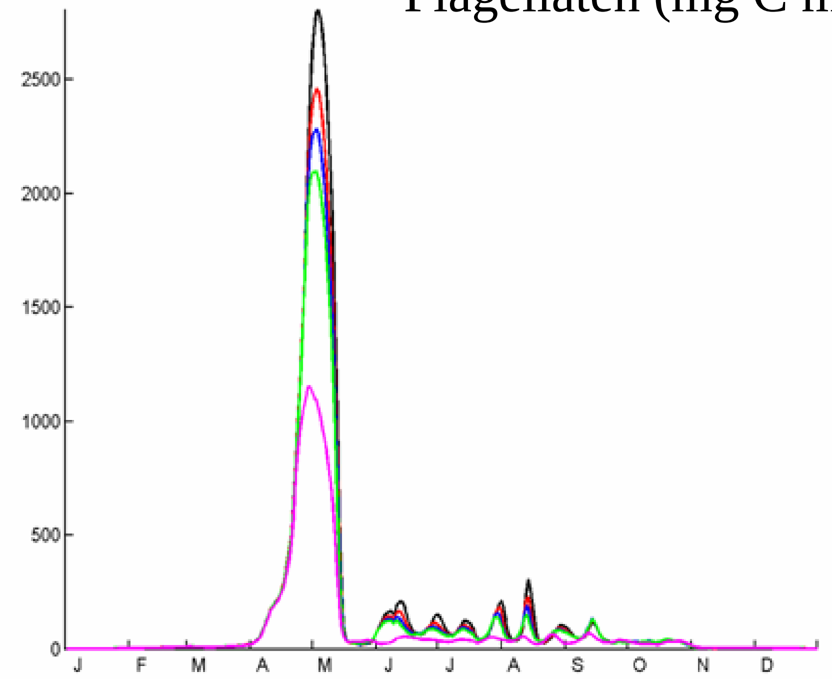
Source: Lenhart 1999

Time series of Diatoms and Flagellates for box 78 (Elbe) for the standard scenario

Diatomeen (mg C m^{-3})

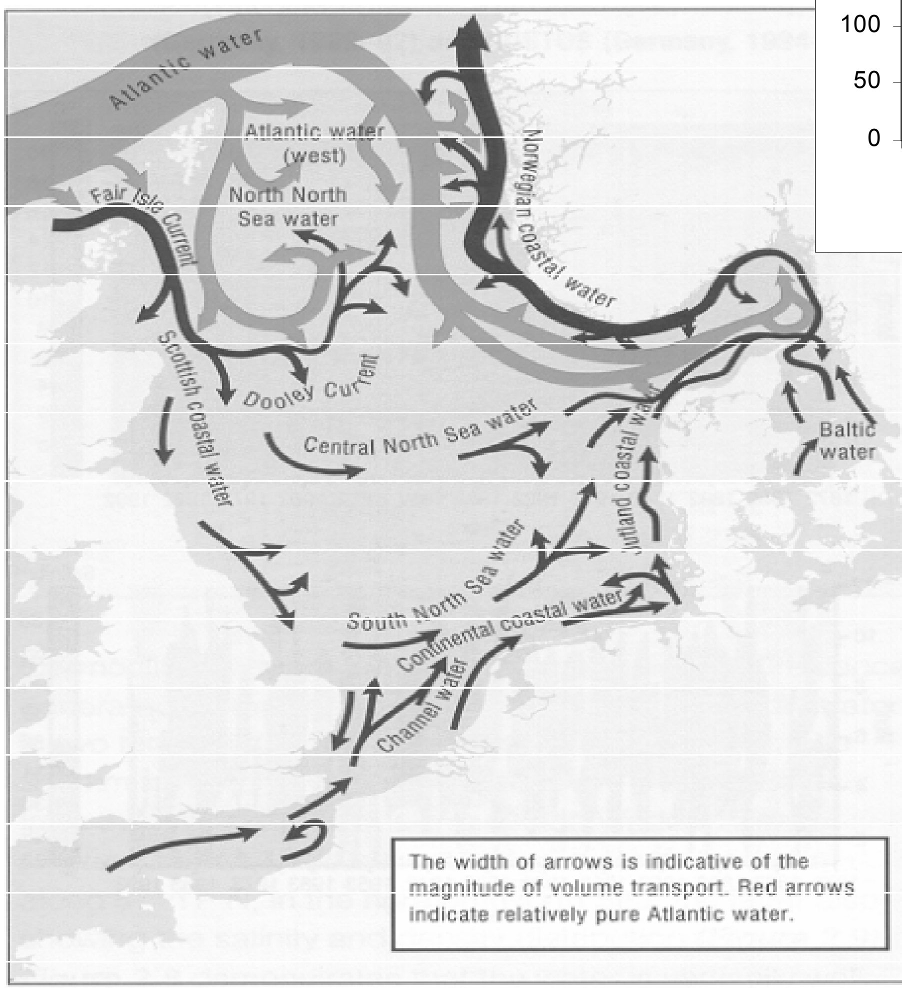


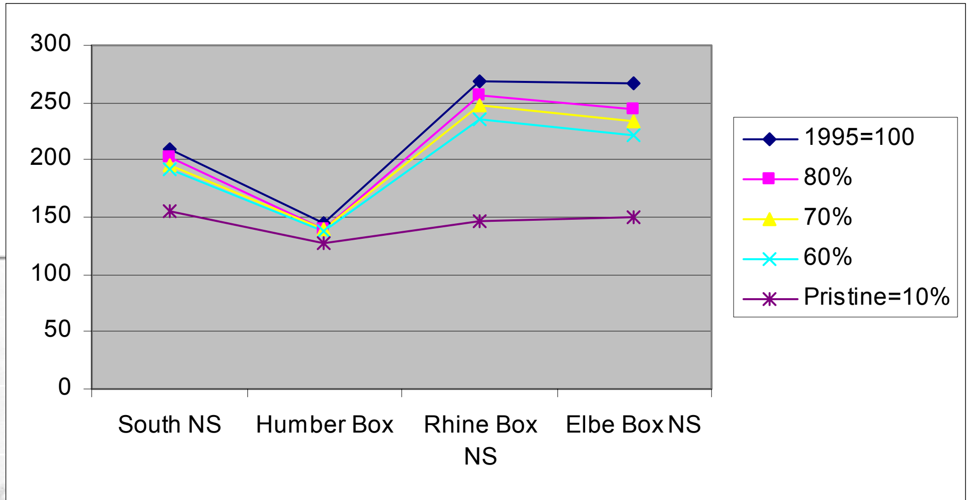
Flagellaten (mg C m^{-3})



Source: Lenhart, 2003

North Sea circulation patterns





Net primary production (g C m^{-2} a^{-1})

Self-organsing Capacity Processes

ERSEM indicators

Exergy Capture

Capability of enhancing the use of incoming energy
Indicated by: primary production, light supply, external nutrient load, Nutrient availability
Ind. Net primary production

Matter Losses Minimisation

Export of matter and energy (especially of scarce nutrients).
Indicated by:
matter losses into adjacent ecosystems (offshore)
Ind. Nutrient losses into adj. ERSEM Boxes (org + in.)

Cycling

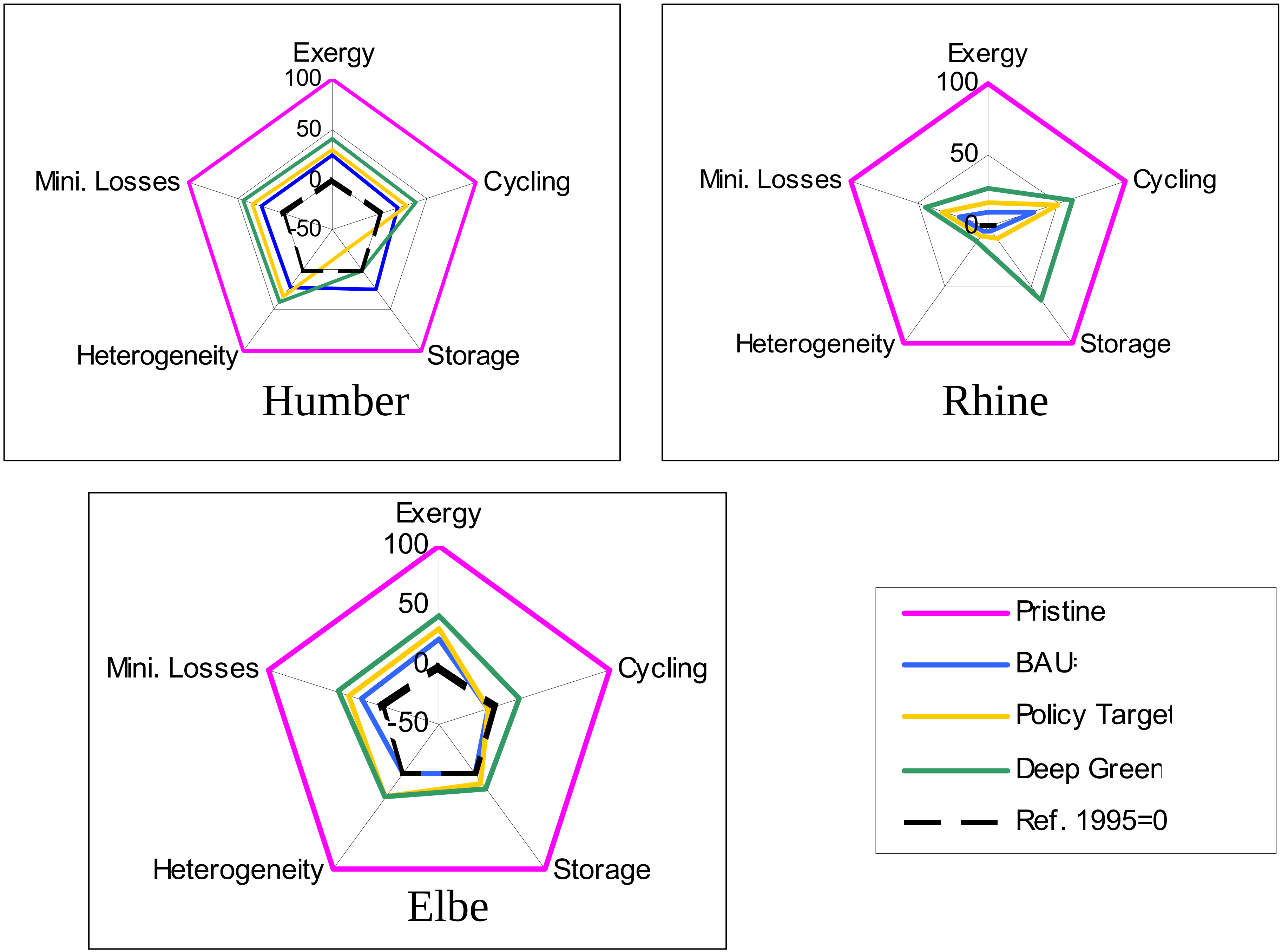
Of energy and matter through the trophic structure
Indicated by: trophic structure, turnover of w. nutrients
Ind. Turnover of winter nutrients

Heterogenity

Of structures (both biotic and abiotic patterns) is essential for resilience and adaptive capacity Indicated by: species composition, spatial sediment distrbution
Ind. Diatom/nonDiatom ratio

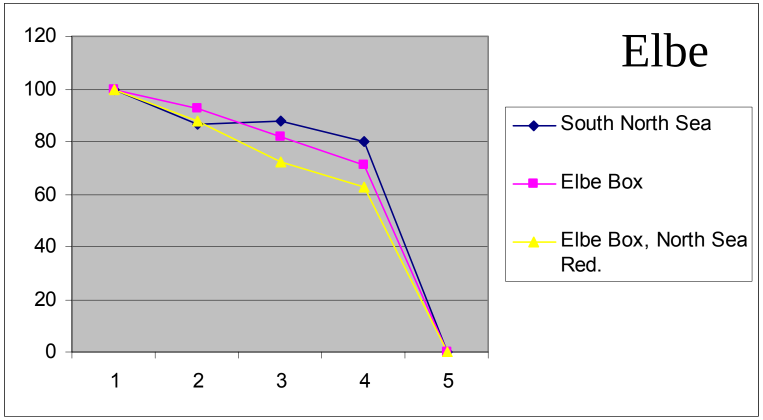
Storage Capacity

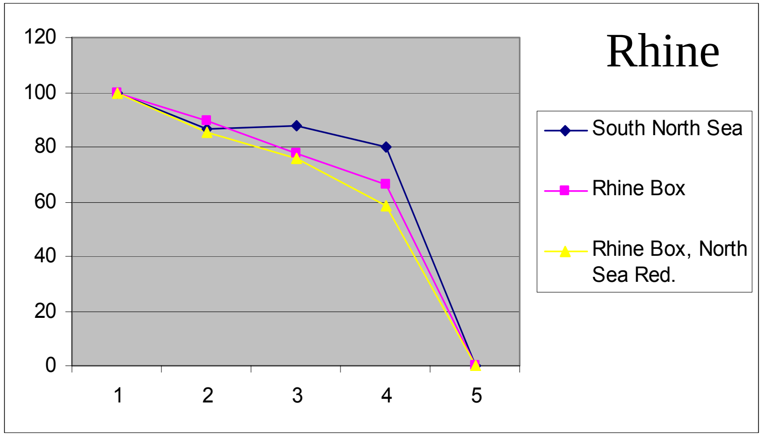
Of energy, nutrients and toxic compounds
Indicated by: Particular Organic Matter Sediment (amount & quality)
Ind. Sediment in/output

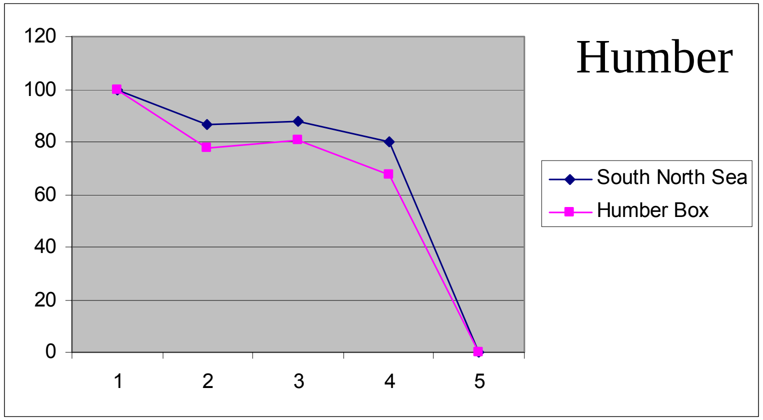

Exergy
100
50
0
-50
Cycling
Storage
Heterogeneity
Mini. Losses
Humber
Exergy
100
50
0
Cycling
Storage
Heterogeneity
Mini. Losses
Rhine
Exergy
100
50
0
-50
Cycling
Storage
Heterogeneity
Mini. Losses
Elbe
Pristine
BAU
Policy Target
Deep Green
Ref. 1995=0

Ecological risk:
The ecological risk of 1995 is normalised to 100, the pristine is normalised to 0, the ecological risk of the considered scenarios are normalised between 0 and 100.

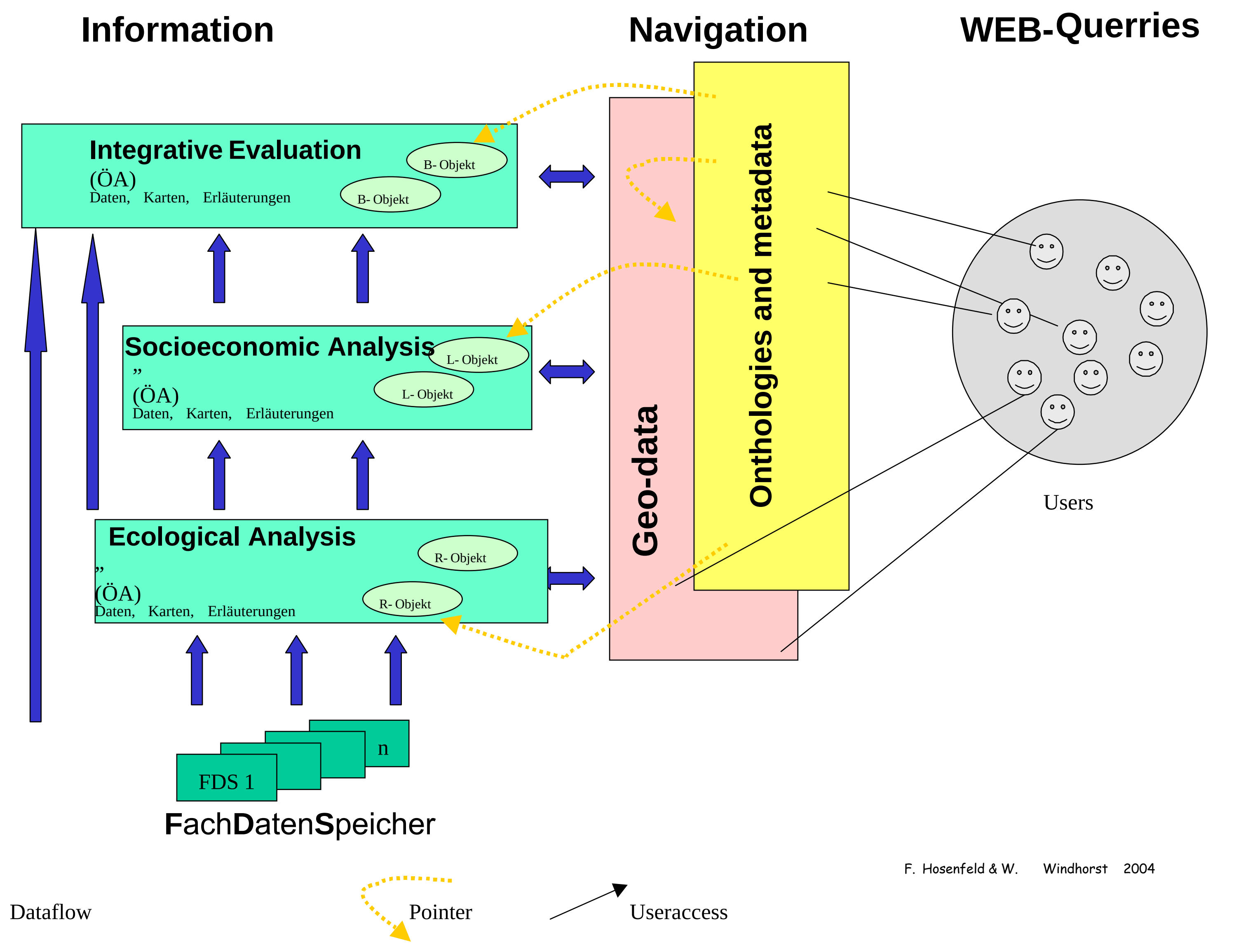
Ecological risk is computed as the average of normalised values (1 to 100) of ecosystem integrity indicators for each scenario.



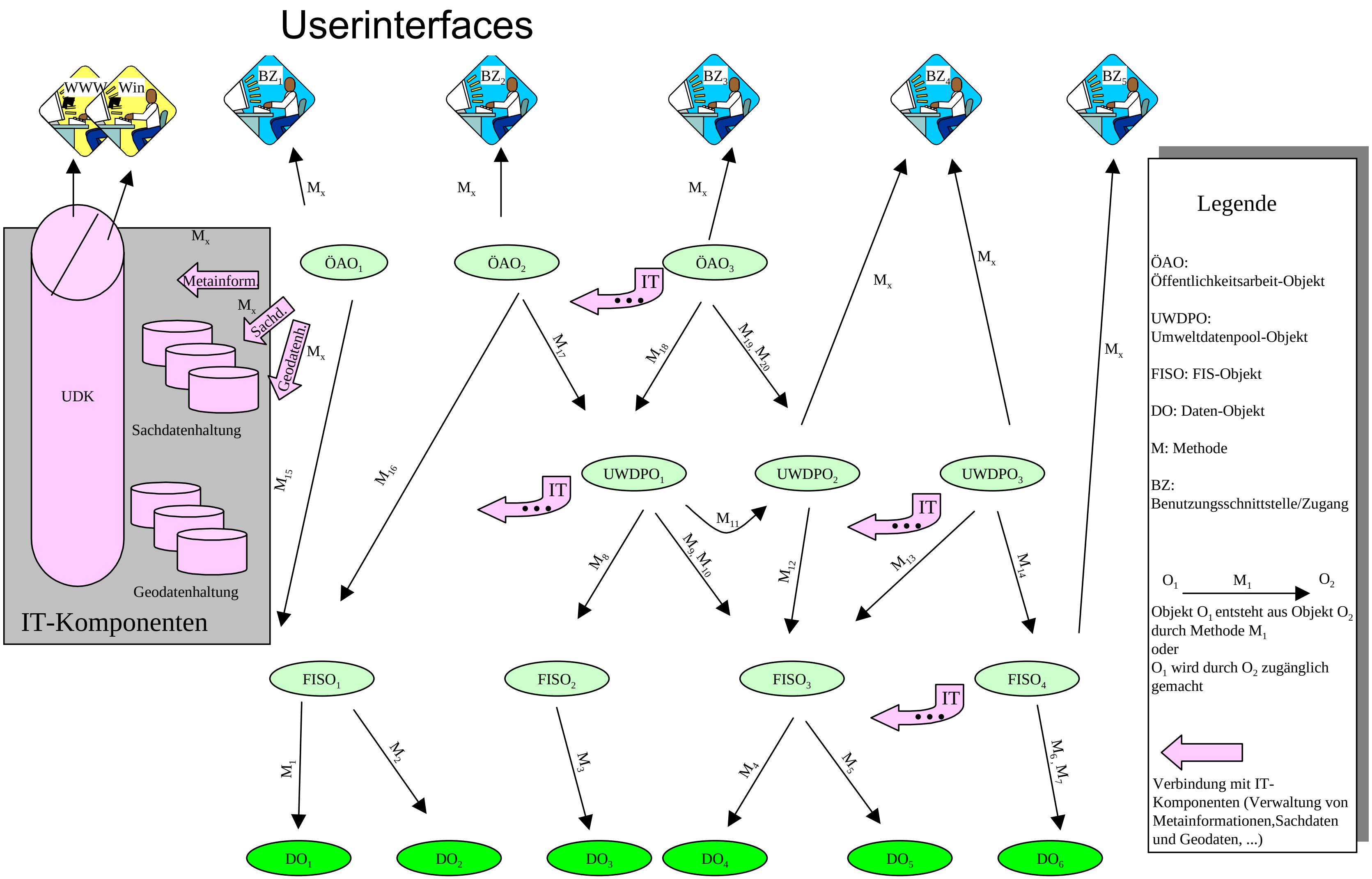




Conceptual structure of the virtual centre of competence, under development by the R&D project „Coastal Futures



Relations between data objects



Hosenfeld & W. Windhorst 2004


Thank you for your attention