Impact assessments of human uses on ecological integrity and the provision of ecosystem services

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Impact assessments of human uses on ecological integrity and the provision of ecosystem services

- Theoretical background
- Application in case studies
- Conclusions
How to assess and model human-environmental interrelations?

- **Contextual constraints**
  - social change
  - political change
  - technological change
  - cultural change

- **Drivers**
  - socioeconomic
  - sociopolitical
  - demographic
  - technological
  - cultural/religious

- **Decision process**
  - formation of opinions
  - governance
  - participation

- **Response**

- **Human well-being**
  - basic supply
  - health
  - social security
  - education

- **Land use**
  - spatial (structural)
  - intensity (functional)

- **Ecosystem services**
  - Provisioning
  - Regulating
  - Cultural

- **Supporting functions resp. ecological integrity**
  - structural
  - functional

- **Pressure**

- **State**

- **Contextual constraints**
  - external environmental changes
How to indicate human-environmental interrelations?
How to indicate human-environmental interrelations?

Drivers

Contextual constraints
- social change
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Impact
- demography
- health
- norms & values
- social relations
- science & technology
- education
- social politics
- freedom of choice
- economic globalisation
- resource & energy demand
- inst. & cultural globalisation

Reference state 2008 = 100 %

Alternative state 2025
How to indicate human-environmental interrelations?

- Formation of opinions
- Laws
- Regulations
- Participation
- Decision making
- Resource management
- Land use planning
How to indicate human-environmental interrelations?

Contextual constraints
- social change
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Human well-being
- basic supply
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- regulating
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Supporting functions resp. ecological integrity
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Decision process
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Response
- formation of opinions
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Pressure
- state

Impact
- formation of opinions

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Land use
- spatial (structural)
- intensity (functional)

Contextual constraints
- external environmental changes

Hypothetical development Schleswig-Holstein

Reference state 2008 = 100%

Alternative state 2025

Forestry

Agriculture

Energy conversion

Tourism

Industry

Nature protection

Raw material exploitation

Infrastructure

Military

Other land use

Forestry

Agriculture

Energy conversion

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How to indicate human-environmental interrelations?

Hypothetical development Schleswig-Holstein

Ecological Integrity

Pressure

State

Impact

Drivers

Decision process

Response

Drivers

Land use

Supporting functions resp. ecological integrity

Contextual constraints

Human well-being

Ecosystem services

Reference state 2008 = 100 %

Alternative state 2025
How to indicate human-environmental interrelations?

- **Contextual constraints**: social change, political change, technological change, cultural change

- **Drivers**: socioeconomic, sociopolitical, demographic, technological, cultural/religious

- **Human well-being**: basic supply, health, social security, education

- **Ecosystem services**: provisioning, regulating, cultural

- **Land use**: spatial (structural), intensity (functional)

- **Supporting functions**: ecological integrity, structural, functional

- **Decision process**: formation of opinions, governance, participation

- **Response**: decision process, formation of opinions, governance, participation

- **Drivers**: socioeconomic, sociopolitical, demographic, technological, cultural/religious

- **Ecosystem services**: provisioning, regulating, cultural

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- **Drivers**: socioeconomic, sociopolitical, demographic, technological, cultural/religious

- **Economic development**: 0, 50, 100, 150

- **Progress**: 0, 50, 100, 150

- **Employment**: 0, 50, 100, 150

- **Spending power**: 0, 50, 100, 150

- **Autonomy**: 0, 50, 100, 150

- **Efficiency**: 0, 50, 100, 150

- **Accommodation**: 0, 50, 100, 150

- **Response**: decision process, formation of opinions, governance, participation

- **Decision process**: formation of opinions, governance, participation

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- **Drivers**: socioeconomic, sociopolitical, demographic, technological, cultural/religious

- **Economic Welfare**

- **Hypothetical development Schleswig-Holstein**

- **Reference state 2008 = 100 %**

- **Alternative state 2025**
How to indicate human-environmental interrelations?

Social Welfare

Hypothetical development Schleswig-Holstein

Reference state 2008 = 100 %

Alternative state 2025

Drivers
- socioeconomic
- sociopolitical
- demographic
- technological
- cultural/religious

Drivers
- socioeconomic
- sociopolitical
- demographic
- technological
- cultural/religious

Ecosystem services
- Provisioning
- Regulating
- Cultural

Supporting functions
- resp. ecological integrity
- structural
- functional

Land use
- spatial (structural)
- intensity (functional)

Response
- formation of opinions
- governance
- participation

Decision process
- formation of opinions
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- participation

Decision process
- formation of opinions
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Pressure

State

Impact

Contextual constraints
- social change
- political change
- technological change
- cultural change

Contextual constraints
- external
- environmental changes

Personal well-being
- 150

Demography
- 100

Health
- 50

Leisure
- 0

Social security

Education

Culture

Nutrition

Welfare
How to assess linkages between the human and environmental system?

**Landscape state/integrity**
- biotic diversity
- abiotic heterogeneity

**Ecosystem functions**
- energy balance
- water balance
- matter balance

**Ecosystem structures**
- biotic diversity
- abiotic heterogeneity

**Regulating services**
- climate regulation
- water purification
  ...  

**Provisioning services**
- food
- fuels
  ...  

**Cultural services**
- inspiration
- genetic resources
  ...  

**Social well-being**
- health
- social security
- education
- nutrition
- accommodation
- leisure
  ...  

**Economy**
- employment
- spending power
- infrastructure
- progress
  ...  

**Supporting functions**
- spatial (structural)
- intensity (functional)

**Drivers**
- socioeconomic
- sociopolitical
- demographic
- technological
- cultural/religious

**Decision process**
- formation of opinions
- governance
- participation

**Response**

**Ecosystem services**
- Provisioning
- Regulating
- Cultural

**Provision**
- ecosystem services
- food
- fuels

**Cultural**
- inspiration
- genetic resources

**Economy**
- employment
- spending power
- infrastructure
- progress

**Contextual constraints**
- social change
- political change
- technological change
- cultural change

**Land use**
- spatial (structural)
- intensity (functional)

**Human well-being**
- basic supply
- health
- social security
- education
How to indicate human-environmental interrelations?

Hypothetical correlations:

- Ecological integrity
- Provision of ecosystem goods and services
- Land use intensity
- Human well-being
- Provision of ecosystem goods and services

Drivers:
- Socioeconomic
- Sociopolitical
- Demographic
- Technological
- Cultural/religious

Decision process:
- Formation of opinions
- Governance
- Participation

Ecosystem services:
- Provisioning
- Regulating
- Cultural

Supporting functions:
- Ecological integrity
  - Structural
  - Functional

Land use:
- Spatial (structural)
  - Intensity (functional)

Contextual constraints:
- Social change
- Political change
- Technological change
- Cultural change

Human well-being:
- Basic supply
- Health
- Social security
- Education
How to assess dynamics in human-environmental systems?

- Storage
- Pioneer stage / Exploitation
- Maturity / Conservation
- Connectedness
How to assess dynamics in human-environmental systems?
Application in case studies

Reindeer Management *RENMAN* (EU 2001 – 2004)
Changing Landscape Management in Rural Finland *CLMRF* (Suomen Akatemia & DAAD 2007-2008)

Integrated Coastal Zone Management *ICZM*  
*Zukunft Küste - Coastal Futures* (BMBF 2004 – 2010)
Application in case studies I

Problems related to land use changes in northern Finland with special focus on reindeer herding and forestry

Methods:
- field surveys
- GIS, models, remote sensing data
- interviews
- ecological and socio-economic indicators
- comparison current states and future scenario states
connectedness

storage

Reindeer management today

conservation

release

FINNISH REINDEER HEARDING AREA AND HEARDING COOPERATIVES 2000–2001

Particular area for reindeer herding

Home area of Sami people

10,000 Highest allowed number of reindeer

connectedness

storage
Reindeer management today
Reindeer management scenario „business as usual“ (BAU)
Reindeer management scenario „business as usual“ (BAU)

- Connectedness
- Storage
- Re-organization
- Release
- Exploitation
- Conservation

Reindeer management today
Reindeer BAU

storage

connectedness
Reindeer management scenario „intensification“

- Reindeer management today
- Reindeer intensified ecological

Connectedness

Storage

Exploitation

Conservation

Reindeer management today
Reindeer management scenario „intensification“

- **Storage**
- **Connectedness**

Ecological Integrity

Exergy capture
Exergy dissipation
Storage capacity
Biotic diversity
Abiotic diversity
Nutrient loss
Biotic waterflow
Metabolic efficiency

Reindeer management today
Reindeer intensified ecological

Conservation
Release
Reindeer management scenario „intensification“

- Reindeer intensified socio-economic
- Reindeer intensified ecological

Conservation

Reindeer management today

Storage

Connectedness

Personal well-being

- Employment
- Spending power
- Accommodation
- Efficiency & autonomy

- Reindeer herding

Efficiency & autonomy

- Infrastructure
- Progress

Economic Welfare

- Economic Welfare
- Economic Welfare

Personal well-being

- Health & nutrition
- Leisure
- Social security
- Ethnic identity

Women's situation

Demography

Education & culture

Social Welfare

Information on the page includes a radar chart with various aspects such as employment, spending power, accommodation, efficiency, and sustainability, among others. The chart illustrates the current state of reindeer management and compares it to intensified socio-economic and ecological scenarios.
Application in case studies II

Integrated Coastal Zone Management ICZM
Zukunft Küste - Coastal Futures (BMBF 2004–2010)

Case study Offshore Wind Power (OWP) installation in the German North Sea

Future scenarios of OWP installations
year 2066
Case Study Offshore Wind Power in the German North Sea

Three hypotheses of impacts of offshore wind park installations on the state of marine and coastal ecosystems:

A) artificial reef systems  B) resilient system  C) degradation

A) artificial reef system  B) resilient system  C1) degraded system  C2) continuous degradation

Stage of offshore wind park development

Orientor / indicator (biomass storage, organization, productivity, diversity ...)

Reference state  Construction phase  Operation phase
Case Study Offshore Wind Power (OWP) in the German North Sea
Case Study Offshore Wind Power (OWP) in the German North Sea

1) North Sea OWP pre-construction

2) North Sea OWP construction

3 A) North Sea OWP operation, artificial reefs

conservation

storage

re-organization

exploitation

release

connectedness
Case Study Offshore Wind Power (OWP) in the German North Sea

1) North Sea
OWP pre-construction

2) North Sea
OWP construction

3b) North Sea
OWP operation, degradation

conservation
re-organization
release
storage
exploitation
connectedness
Case Study Offshore Wind Power (OWP) in the German North Sea

![Graph showing performance metrics related to connectedness, exploitation, and storage. Metrics include exergy capture, entropy production, nutrient cycling, nutrient loss, biotic diversity, abiotic heterogeneity, organization, and storage capacity. The graph compares construction, operation, and reference scenarios.]
Hypothetical linkages to further concepts

connectedness

integrity

re-organization

release

conservation

exploitation

connectedness
Hypothetical linkages to further concepts

- Regulating Services
- Provisioning Services
- Cultural Services

Key terms:
- Conservation
- Re-organization
- Release
- Exploitation
- Connectedness

Provision of ecosystem goods & services
Conclusions

Systems analytical concepts and tools are suitable to describe impacts of human activities on environmental systems.

Dynamics are very topic-related (socio-economy vs. ecology), observer influenced and scale dependent – averaging is difficult.

The provision of ecosystem goods and services is usually highest on development stages between exploitation and conservation.

→ Reasonable management has to take into account the impacts of human action and will always be some kind of compromise.

Thanks for listening.