Systems Approach Framework
Introduction-2

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Systems Approach Framework

External forcings eg. climate change

External socio-economic changes eg. crisis

Change in ecosystem

Change in human activity

Policy change

International directives
Systems Approach Framework (SAF)

ESE - assessment

Changes in user relationship

Issue Identification
System Design
Sys. Formulation
System Appraisal
System Output

Change in ecosystem

Change in human activity

Implementation

Policy change

External forcings eg. climate change

External socio-economical changes eg. crisis

Changes in public perception & awareness

International directives

Bonus Baltcoast
The SAF Virtual System domain with major Components and Interactions.

Each Ecological-Social-Economic (ESE) component has differing dynamics and function, types of information, and spatial-temporal scales. Need to be simulated as interacting components.

Forth component – Policy Control is not simulated but output of ESE simulation is the information input for Policy.

Tom Hopkins, Spicosa
Do we need to run an ESE assessment?

Problem made of multiple interconnecting elements?

Is solving the problem of high priority?

Is there a high risk?

Can the problem be solved with existing knowledge of the system?

Are you sure? Identify management strategy to implement a solution

You have begun the ESE in the Systems Approach Framework

Exit! ESE not needed

NO

YES

NO

YES

NO

YES

NO
ESE assessment

Identifying the Policy Issue(s)
Mapping stakeholders
Institutional mapping
DPSIR, CATWOE

Conceptual models
System boundaries

Generating systems model
Calibration and validation
Preparing scenarios

Linking ESE model components
System simulation of scenarios

Running scenarios
Presenting to stakeholders
Evaluation
Example of SAF with ESE assessment
Limfjord Denmark

Dinesen, Støttrup et al. 2011
Timmermann, Dinesen, Støttrup et al. 2014
The Problem:
Eutrophicated fjord
Implementation of Water Framework Directive
Systems Approach Framework

Issue Identification
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System Output

Stakeholder mapping
Institutional mapping
Stakeholder forum

Stakeholder meeting.
Concerns
Who is concerned about what relative to the problem?
Discussioning the problem,
Identifying the Issue
Prioritising the Issues at a Stakeholder forum.
Policy Issues decided upon in this example

1) regulation of nutrient effluents to reduce eutrophication;
2) closure of the mussel fishery due to national implementation of international directives
3) resolve resource conflicts between mussel fishers and mussel farmers.
DIPSIR and CATWOE

For that Issue identified:
Identify the Drivers and Pressures of the system, who is involved etc.:
DIPSIR
CATWOE
System Design

- System Definition
- Conceptual Model
- Data and Methods
- Problem Scaling
System definition

- Define Virtual System (boundaries)
- Define Administrative boundaries
- Define linkages between the three ESE components
Conceptual model

The first attempt at a conceptual model
SYSTEM DESIGN - conceptual model developed
**System Formulation**

- **Issue Identification**
- **System Design**
- **Sys. Formulation**
- **System Appraisal**
- **System Output**

Developing sub models
Calibration and validation
System formulation

Ingestion of phytoplankton by the $i$-te group of mussels

$$I_i = T \cdot I_{\text{max}_i} \cdot \left( \frac{D_i \cdot PB}{D_i \cdot PB + K_{1/2}} \right) \cdot M_i$$

- Temperature
- Max. ing. rate
- Phytoplankton concentration

Mussel fishery – profit function

$$\pi = pY - C_f - C_v$$

- Price - 1000 € Ton$^{-1}$
- Yield - Tons
- Fixed costs
- Variable costs - 1000 € day$^{-1}$

Timmermann et al., submitted
Model validation – primary production, Skive Fjord

Algal growth mg C m\(^{-2}\) month\(^{-1}\)

- Measured
- Model

(from Markager et al.)
Timmermann et al. 2014
System Appraisal

- Generating systems model
- Calibration and validation
- Preparing scenarios
Bio-economic model with the links between sub-models established for mussel farming and mussel fishery.
Scenario simulations

Issue Identification
System Design
Sys. Formulation
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1) reductions of Total N and P
2) closure of the wild mussel fishery
3) introduction of line-mussel culture
RESULTS of Scenario 1. Reductions of total N and P loadings

Reductions in N alone to WFD target (47% level) showed:
1. Minor decrease in phytoplankton biomass
2. Decrease (~25%) of shallow and deep water mussel biomass
3. Decrease (~50%) of mussel fishery profit
RESULTS of Scenario 1. Reductions of total N and P loadings

Reductions in N and P to the 47% level would result in:
1. Minor decrease in phytoplankton biomass (~20%)
2. Decrease (~50%) of shallow and deep water mussel biomass
3. Almost collapse of mussel fishery
RESULTS of Scenario 2. Closure of wild mussel fishery

1. a $>10$ fold increase in hitherto fishable mussel biomass
2. a $>10$ fold decrease in shallow-water and medium-sized deep-water mussel biomass
3. an annual profit loss of $\sim €6.2$ million
RESULTS
Scenario 3. Introduction of line mussel culture

had little impact on wild mussel fishery
had little impact on shallow-water mussel biomass
Scenario simulation results provided

- both recognizable and unexpected results, which stimulated discussion among stakeholders
- credible overview of the ecosystem they were familiar with
- cognition of a higher ecosystem complexity than hitherto understood
- changes in stakeholder perceptions

The SAF seems well qualified for developing a common understanding of the needs and consequences of change as part of the public consultation process and merging public and scientific information.
Systems Approach Framework (SAF)

- Change in ecosystem
- Change in human activity
- Policy change
- Implementation
- Changes in user relationship
- Issue Identification
- System Design
- Sys. Formulation
- System Appraisal
- System Output
- Changes in public perception & awareness
- Systems Approach Framework
Example of a SAF application without quantitative modelling within the ESE assessment.

Eel management plan

Different eel fishers (recreational and commercial) also with different gear types and fishing customs.

4-5 management options set up by Ministry and ministerial advisors.

Traditionally an option would be chosen and open consultation takes place with possibility of adjustments but also risk of public outcry and/or heavy opposition.

Stakeholder discussions on management options resulted in all options being openly discussed but also alternative management options being suggested.

The option chosen by Ministry was one of the resulting options from the meeting. This resulted in higher compliance and no public outcry.
• Systems Theory is about understanding complex and large-scale interactions based on our perceptions of the world.

• It requires broad multi-disciplinary experience as it represents a mixture of scientific knowledge and intuition needed to understand the behaviour of complex systems (Hopkins et al. 2011).

• It also involves good communication skills at all levels
Sustainable ICM is grounded in principles of good governance

- Accountability
- Transparency
- Openness

SAF provided the Framework for a sustainable ICM process.
Questions?