




# Fuzzy Decision Support



William Silvert  
Mallorca, 7 May 2007

# Task Description

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- I am working on the “Development of a [fuzzy] rule-based system for selection of models to be used in site evaluation.”
- This is known as a Decision Support System (DSS).
- This presentation will give you a rough idea of how this will work and what inputs will be needed to complete it.

# Site Characterisation

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- Sites will be characterised in terms similar to those we normally use:
  - Lagoon
  - Estuary
  - Fjord
    - With sill
    - Without sill
- A fjord with a low sill might be described as 60% with sill and 40% without.

# Additional Characteristics

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- Sites will be further classified as much as seems necessary:
  - Warm/Cold
  - Deep/Shallow
  - Oligotrophic/Eutrophic
- These descriptors will correspond to the indicators which are selected during the ECASA project.

# Special Characteristics

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- Some characteristics will only apply for a subset of sites.
  - The presence of *Posidonia* is an important indicator for sites in the Med but not in northern Europe.
- A decision tree will have to be defined to determine which indicators are used in which locations.

# Production Characteristics

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- The type of production and proposed level(s) are important indicators.
- These can be numerical (100 mt/y) or fuzzy (“high finfish production”).
- Polyculture fits well into the fuzzy representation, e.g., “60% salmon and 40% mussels”.

# Extensibility

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- These characteristics can be extended to areas beyond the scope of ECASA, including infrastructure and socioeconomic aspects of aquaculture.
- The availability of good transportation (roads, distances, etc.) is a decisive factor in deciding whether to produce fish for the fresh fish market – that sort of thing.

# Modelling

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- Based on the characteristics, a set of models will be selected to carry out the site evaluation.
- In most cases only a few of all the possible models will be needed for a given site.
- The choice of models will depend on the results of the modelling work package.

# Modelling Fuzzy Inputs

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- Since the input characteristics can be fuzzy, different models may be required.
- If a fjord with a low sill is described as 60% with sill and 40% without, then the models will have to deal with both cases.
- If  $BCL_{\max}$  for a fjord with a sill is  $0.5 \text{ g-C/m}^2/\text{d}$  and for one without a sill is  $1.0 \text{ g-C/m}^2/\text{d}$ , then for the fjord with a low sill the critical value could be  $0.7 \text{ g-C/m}^2/\text{d}$ .

# Triage

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- It is increasingly common for sites to be classified according to the triage concept, rather than just accepted or rejected.
- The site classifications are thus:
  - Totally unacceptable
  - Acceptable as
    - Risky (frequent monitoring)
    - Reasonable (standard monitoring)
    - Safe (low level of monitoring)

# Site Evaluation

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- After the various characteristics have been run through the appropriate models, the decision support program will prepare a report evaluating the suitability of the site and providing advice to management.
- This report can consist of text pasted together from “boiler plate” as well as graphic representations.

# Boiler Plate

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- It is relatively easy to generate a report in common language by pasting together phrases like:
  - “This porridge is
    - too hot.”
    - too cold.”
    - just right, and I am going to eat it all up!”

# Portability

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- The output text will be stored in a separate file so that different languages can be implemented easily:
- “Ce gruau
  - est trop chaud.”
  - est trop froid.”
  - n’est pas mal pour un plat écossais.”

# Graphic Output

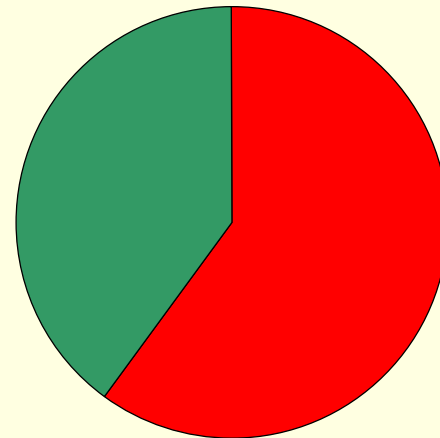
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- In presenting complex results to groups of stakeholders with different backgrounds, it helps to use easily understood graphics.
- Traffic lights are a common way of representing model output and will be included in the DSS.
- Traffic lights can be crisp or fuzzy.

# Traffic lights

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- Crisp traffic lights are **RED**, **GREEN** or **YELLOW**. There are just these three possibilities.
- Fuzzy traffic lights can be intermediate colours like **ORANGE**, or they can be a mix of colours like **THIS** or like a pie chart.



# Work Plan

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- This is an ambitious project and cannot be fully implemented in the time available.
- The basic framework will be developed and a subset of indicators and models will be included.
- The result will be a toolkit with some of the tools missing, like a set of wrenches with 5, 12, 16 and 22 mm sizes only.

# Completion

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- To complete this project would require a comprehensive list of indicators with full information on where they apply and how they relate to models.
- It would also require a full set of models in a form that can be integrated with the other components of the DSS.
- Finally the graphical output part would benefit from professional polishing.

# Implementation

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- To implement a DSS requires first of all extensive testing, both to see if the results are valid and to see if the use and particularly the output is acceptable to stakeholders and other users.
- Finally its use in the EU will require that the material be translated, and that operators be trained.