Sustainable management of mussel farming activity in the area of Chalastra, Thermaikos gulf, Greece. SSA 16 of the SPICOSA project

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1. Coastal area & policy issue

The sea area of Chalastra is located NW of the inner Thermaikos Gulf. The city of Thessaloniki is at the NE side of the area and the estuaries of Axios-Loudias-Aliakmonas Rivers are at the NW. The surface of the sea area where the mussel farms are located is approximately 1.350.000 m^2, with minimum depth of 4m and maximum of 20m. At the land boundary of the system multiple cultivations are located and the channel of the WWTP of western Thessaloniki is located 4,8 km from the area. Due to the systems' water circulation the agricultural run-offs, the output of the WWTP and the estuarine inputs

The last decade the operation of the WWTP of Thessaloniki altered the nutrient balance in Thermaikos gulf. At the same time, due to institutional and management failures, 60% of the owners of long-line mussel farms are operating illegally: the activity is under no official institutional control, having as a consequence illegal and extreme mussel farming techniques, in order to maximize production and profit. Nevertheless the mussel production is declining annually, causing economical and social pressure to the local community, as the activity is supporting an important percentage of the population.

are affecting the area. Approximately 55 long-line mussel farm establishments and more than 250 pole mussel farm establishments.

2. Approach & design

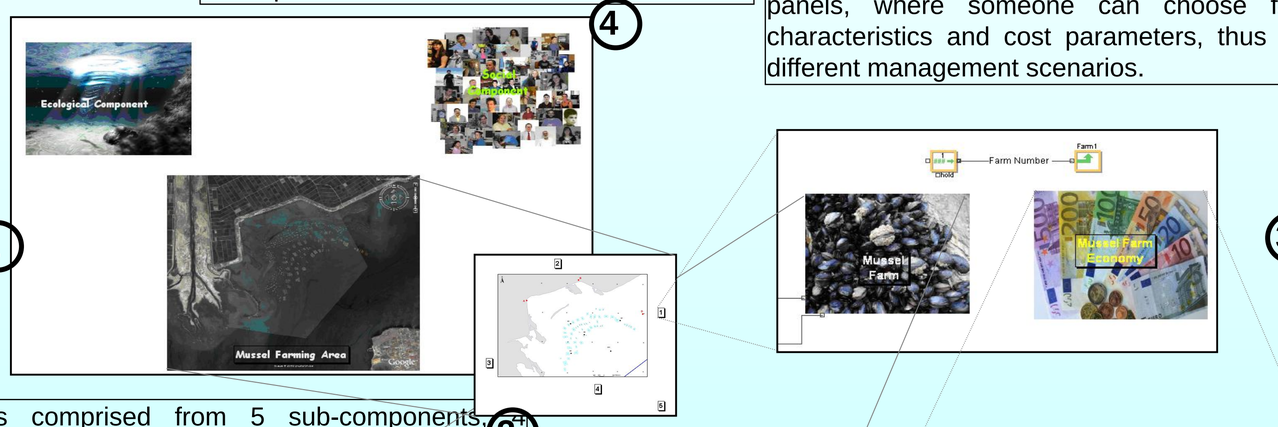
- Individual interviewing of policy makers and major stakeholders in order to gain system knowledge and identify social interconnections.
- Identification of data needs & availability.
- Realising the narrow availability, effort was made to approach the issue simply but addressing matters of great importance for the stakeholders.
- Achieved that by representing the farming procedure in an individually farm level.
- Major goal was to present in a quantitative and efficient way several management points under discussion during the last years as the cultivation techniques, HAB occurrence and legislation failures.
- Realising that SPICOSA would be just an initial opportunity, effort was made to stimulate the stakeholders interest in the use of integrated methodologies for the coastal management of the area.

3. Formulation

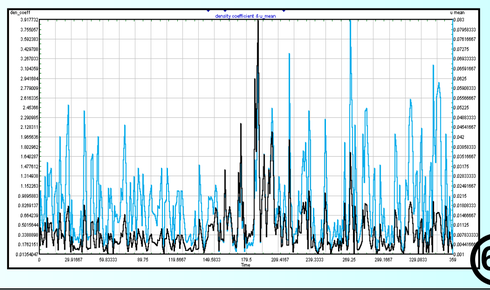
The highest hierarchical level of the model demonstrates the three major components: ecological (inorganic nitrogen, phytoplankton, circulation patterns), mussel farming area (incorporating both the ecology & economy of the mussel farm) and social (management & "social welfare"). The three components can be managed individually, enabling the development or the alteration of each one, if required.

The social component is an on/off switch for the management "enforcement" & an accumulator of the profits.

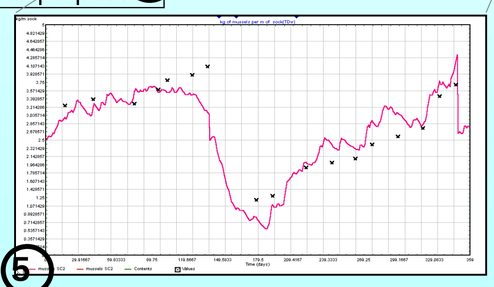
Both the ecological and the economical component of the mussel farm provide user friendly choice panels, where someone can choose farming characteristics and cost parameters, thus testing different management scenarios.



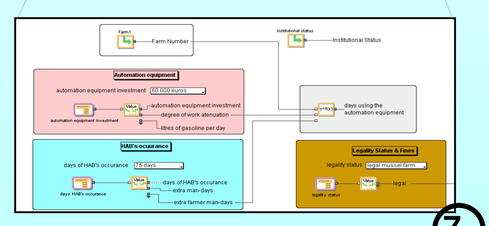
The "mussel farming area" component is comprised from 5 sub-components, demonstrating sub-areas of mussel farming and a reference area, for comparison purposes.



Mussel growth is depended on a) the availability of food (phytoplankton & TOC, b) the environmental conditions (temperature & circulation) and c) the farm characteristics influencing the density of the farm.



The mussel growth sub-model produces values that are presenting satisfying adaption to the filed data collected from the mussel farming sub-areas. The figure shows the observed values of mussels at the mussel farm representing sample stations M1 compared to the values produced by the model.



The economical sub-model is contacting a Cost-Benefit analysis for the individual mussel farm. The profits are then aggregated to produce a prospect for the amount of money entering the local community, as an indicator of the "social welfare".

The "density coefficient" is related both to the farm characteristics & to the water velocity in the area, thus comparing the required water velocity for the feeding of the mussels to the current one. As shown in the figure, this coefficient is most of the times >1.

4. Scenarios & results

1. Mussel farm unit level management
How and how much is the productivity of an individual long-line mussel farm unit affected from the layout and the characteristics of the farm?

2. Mussel farm area level management
How and how much is the productivity of the whole long-line mussel farming area is affected from the characteristics of the units?

3. Legal framework and social prosperity
In which way is the economical robustness and retributive benefits of the local community going to be affected from the maintenance and from the improvement of the present legal framework?

4. Environmental constraints and mussel farm unit economy
How much are the costs of a unit being affected from the increase of the days where environmental constraints are imposed in the area (days of HAB's occurrence)?

Area management	Sub-area 1	Sub-area 2	Sub-area 3	Sub-area 4
Number of lines	13	15	12	14
Line distance (m)	8	7	9	8
Sock distance (m)	0.4	0.6	0.4	0.5
Sock length (m)	3.5	4.5	3.0	3.5
Mussel dry weight (kg/m of sock)	11.9	14.5	11.9	13.8
Total production (tn)	89.1	107.4	70.7	89.5
Individual profit (€)	10,300.00	16,500.00	3,900.00	9,900.00

The distance between cultivation socks & the length of the sock are parameters influencing critically the production of a mussel farm.

The weight of mussels/m of sock is considered as a growth and quality index as the number of individuals/m is averagely the same.

The profit of the illegal establishments is approximately 40% less than the legal ones. Every year, up to 300.000 euros are escaping the local economy for the payment of legality fines.

Severe HAB events can cause up to 31% profit reduction.

Area management	Sub-area 1	Sub-area 2	Sub-area 3	Sub-area 4
Number of lines	10	10	10	10
Line distance (m)	10	10	10	10
Sock distance (m)	0.5	0.5	0.5	0.5
Sock length (m)	3.0	3.5	4.0	4.5
Mussel dry weight (kg/m of sock)	18.1	17.6	16.9	18.5
Total production (tn)	71.7	81.6	89.4	110.4
Individual profit (€)	5,525.00	8,900.00	12,000.00	19,200.00

5. Stakeholders deliberations & future planning

During the dissemination period, 2 major stakeholder forums were contacted both with satisfying stakeholder & policy maker attendance. Highly promising was the fact that in both meetings, representatives of the Ministry of Environment, the highest level of implicated public authority and responsible for the legal regulation of the activity were present.

The first forum was dedicated in presenting the project, the model and the results of the chosen scenarios. Time was invested in questions and suggestions and a preliminary effort of evaluating the procedure from the stakeholders point of view was made. The participants were carefully chosen: the heads of the public authorities and the major representatives of the 4 mussel farmers associations, as well as scientists with experience in the area of interest were invited. A very skilled and experienced facilitator participated in order to help in creating a collaborative atmosphere. The outcome of the meeting was satisfying as i) the Ministry representatives were committed to take immediate action in pressing legislation issues and ii) Municipality of Chalastra and the Authority for Protection and Management of the Delta Area agreed in co-organizing the next stakeholder forum in order to promote communication and collaboration.

The second forum was organised serving alternative goals, so the presentation was kept in highlighting the most important scenario results and identifying the necessary material in order to explore more policy options. Main objective of the forum was to contact stakeholder deliberations and to create a "stakeholder working group", i.e. a core team of people, comprising from mussel farmers, local managers and scientists, that will meet in a regular bases in order to discuss problems, policy options and developments of the activity, in order to create a mechanism of direct communication and collaboration between them.

The "stakeholder working group" has contacted it's first official meeting shortly after it's creation and will soon meet again, supported by the SSA 16 scientific team.

Additionally the SSA 16 team of AUTH is developing an expansion of the managing effort contacted through SPICOSA.

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