

A Decision Support Software for the Greek Aquaculture

Implementation case study

Nikos Papandroulakis

2020 International Forum on the Effects of Climate Change on Fisheries & Aquaculture
25-26 February 2020, Rome

Aim

to develop a DSS for the Greek Marine Aquaculture stakeholders

How

by simulating the effects of CC on aquaculture production and associated socio-economic indicators

Use

beyond the project time



Target species

- European sea bass (established)
- Meagre (emerging)



Type of data available (1)

Climate data

- Sea Surface Temperature, wind velocity
- from CERES project, (POLCOMS – ERSEM)
 - **10 km x 10 km** resolution

Biological forecasting

Production Data

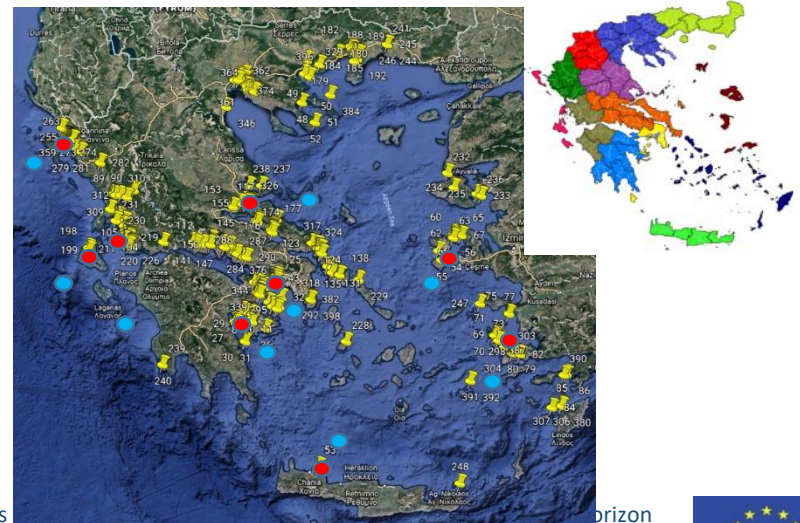
- Growth to Market size
- Duration of the on growing period
- Biomass produced
- Feed required (feeding rate and FCR)

Time scale

- Short term (2015-2025)
- Mid term (2025-2035)
- Long term (2045-2055)

The model Farm

- 3 stockings (March, June, September)
 - Capacity: 3x500K juveniles
 - 9 locations, (administrative regions)
- **Inshore** and **Offshore**



This research and innovation action under grant agreement no. 677039



ClimeFish



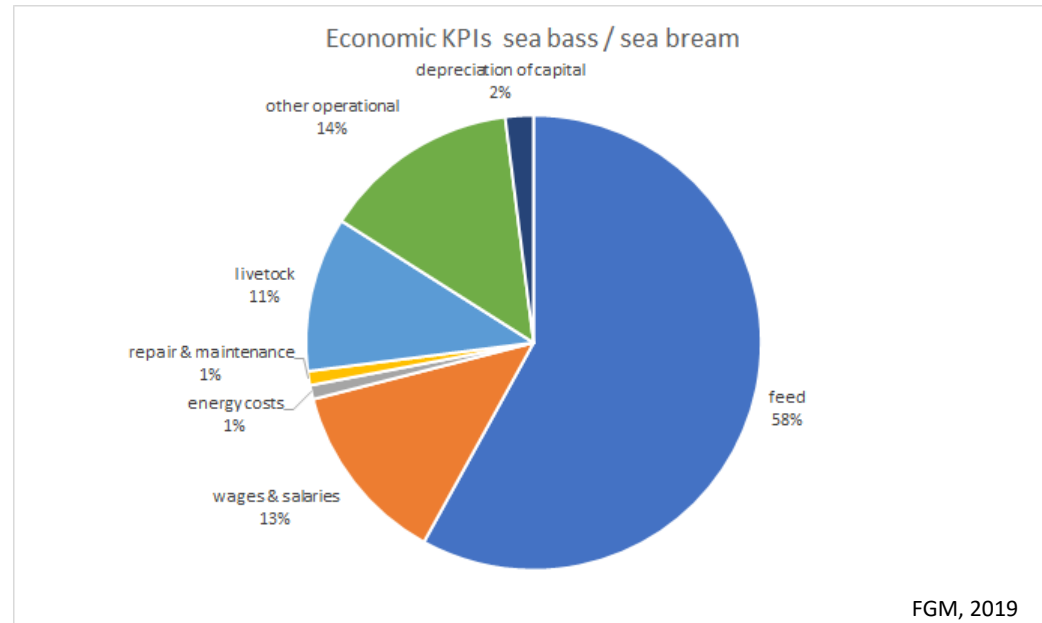
Type of data available (2)

Business economics model

- income
- feed costs
- cost of juveniles
- labour costs
- annual depreciations
- accumulated debt



- interest
- total costs
- profit
- GVA



Type of data available (3)

Vulnerability assessment & Adaptive measures (WP5)

- **Impact Categories**
 - Biological
 - Production
 - Ecosystem/ environmental
 - Socio-economic

What users?

- Farmers (old and new)
- Administrators of Zones for Organized Development of Aquaculture
- Administrators of producers organizations
- Regional/ National authorities
- Other stakeholders

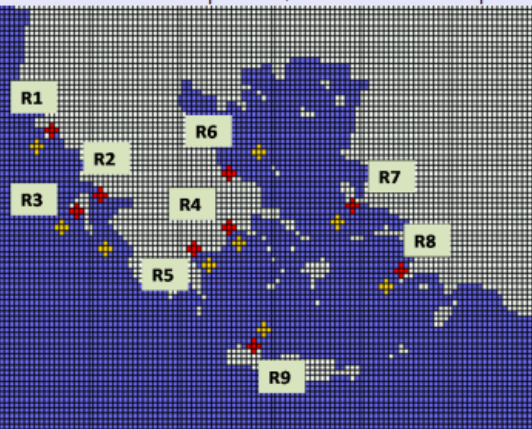
Greek administrative regions



A description of the DSS

Aquaculture in Greece

risk assessment compare RCP / inshore -offshore optimize seeding



economic simulation graphs

1. Seeding
2. Seeding
3. Seeding

@climefish

save graph

select simulation

climate scenario spec

define farm

select farm location

year seeding starts natural mo

mortality from heatwaves in % (1-100) mort

Please select seeding scheme

seeding scheme

1. seeding month March

2. seeding month June

3. seeding month September

calculate bio. result

economic simulation

Please enter for the economic calculations the following medium value for standard farm

Feed price

Species sales price /market price

Prices of juveniles

Price of labour

calculate business economics based on user input

calculate costs / profit

Total costs for selected market size

Profit for selected market size

Biological model:

Individual growth and reproduction was modeled with the application of the Dynamic Energy Budget (DEB) theory, a theory that provides the conceptual and quantitative framework to study individual metabolism throughout the entire life cycle of an organism. Models for E. seabass and meagre were developed using physiological data from all life stages and where validated against production growth performance data obtained from farms. The bioenergetics of the individual are simulated as a function of temperature and food availability which in turn allows for the prediction of measurable quantities such as weight, growth rate and feed consumption. The results are then extrapolated to the farm level for a population of fish. Population variability is introduced by subdividing the population into cohorts that differ in their initial body weight and in the values of specific parameters.

Economic model:

The economic model calculates the business economics of the farm for the selected climate scenario and management options based on the input values for the various prices and costs.

extreme events:

extreme events such as thunderstorms and heat-waves are modelled as effects on mortality, additionally to the natural mortality. The rationale is that thunderstorms can damage the cages and cause equipment failure, thus, leading to escapee events, while prolonged high temperatures are tied to disease outbursts, both of which are incorporated as mortality losses.

thunderstorms:

Defined here as wind velocity > 50 km h⁻¹ for more than 4 days in a week.

heatwaves:

Defined here as T > 29°C for more than 4 days in a week.

climate data:

The simulations use projections of daily Sea Surface Temperature (°C) and wind velocity (m s⁻¹) from the Global Climate Model ICHEC-EC-EARTH downscaled at 10x10km via the coupled POLCOM-ERSEM (Proudman Oceanographic Laboratory Coastal Ocean Modelling System and the Plymouth Marine Laboratory European Regional Seas Ecosystem Model) ecosystem model.

Background

ze in g

seeding 2. seeding 3. seeding

seeding 2. seeding 3. seeding

seeding 2. seeding 3. seeding

1. seeding
2. seeding
3. seeding

@climefish

save graph

OK

This project has received funding from the European Union's Horizon 2020 research and innovation action under grant agreement no. 677039



ClimeFish

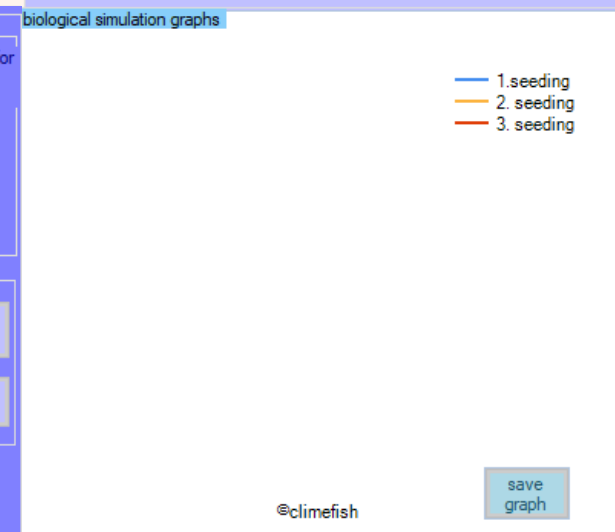
- **User defined parameters**

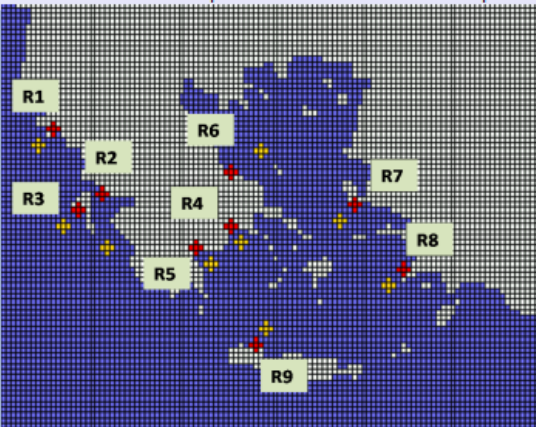
- ## Agriculture in Greece

- location and type

- Starting year
- Stocking time - Stocking number
- Market size
- Mortality rates

- Feed cost (€/Kg)
- Market price (€/Kg)
- Price of juveniles (€/individual)
- Labor (€/day)
- Maintenance cost (€/day)
- Depreciation cost (€/day)
- Interest rate (%)





select simulation
climate scenario species

define farm
select farm location ☒ inshore ☐ offshore

year seeding starts natural mortality in % (1-100)

mortality from heatwaves in % (1-100) mortality from storms in % (1-100)

Please select seeding scheme

seeding scheme

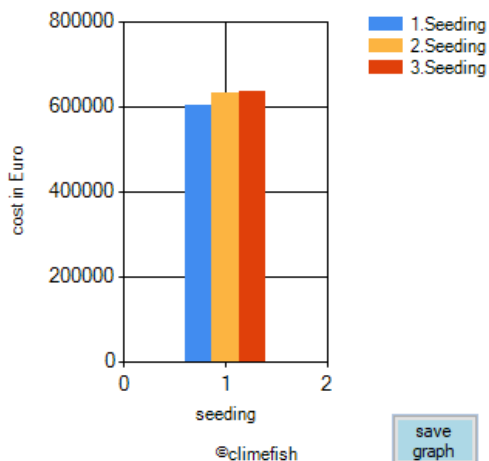
| seeding month | stocking population |
|---|-------------------------------------|
| 1. seeding month <input type="text" value="March"/> | <input type="text" value="250000"/> |
| 2. seeding month <input type="text" value="June"/> | <input type="text" value="250000"/> |
| 3. seeding month <input type="text" value="September"/> | <input type="text" value="250000"/> |

bio. production results

please fill in desired market size in g

| time to market size in weeks | 1. seeding | 2. seeding | 3. seeding |
|---|--|--|--|
| <input type="button" value="show graph"/> | <input type="text" value="123"/> | <input type="text" value="117"/> | <input type="text" value="117"/> |
| feed required in kg | 1. seeding | 2. seeding | 3. seeding |
| <input type="button" value="show graph"/> | <input type="text" value="432,206.5"/> | <input type="text" value="451,773.9"/> | <input type="text" value="440,719.6"/> |
| total biomass in kg | 1. seeding | 2. seeding | 3. seeding |
| <input type="button" value="show graph"/> | <input type="text" value="194,067.6"/> | <input type="text" value="189,730.8"/> | <input type="text" value="187,783.4"/> |

Costs per selected market size



economic simulation

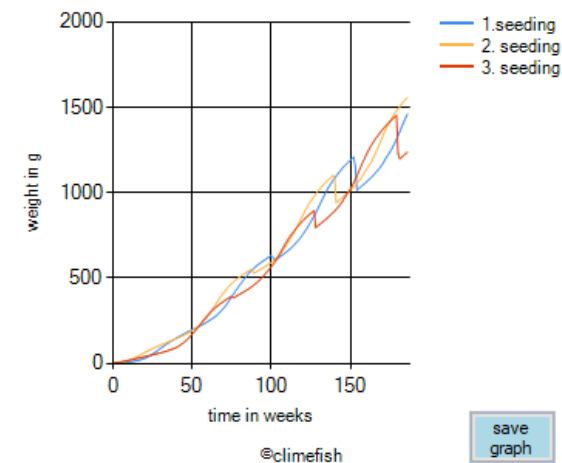
Please enter for the economic calculations the following prices / cost.

| | medium value for standard farm | medium value for standard farm |
|---|------------------------------------|------------------------------------|
| Feed price | <input type="text" value="1.05"/> | <input type="text" value="1.15"/> |
| Species sales price /market price | <input type="text" value="6.0"/> | <input type="text" value="6.44"/> |
| Prices of juveniles | <input type="text" value="0.23"/> | <input type="text" value="0.23"/> |
| Price of labour | <input type="text" value="37.41"/> | <input type="text" value="37.41"/> |
| Other costs (maintenance and other costs) | <input type="text" value="47.5"/> | <input type="text" value="47.5"/> |
| Cost of depreciations (the equipment, buildings, storage, | <input type="text" value="8.73"/> | <input type="text" value="8.73"/> |
| Interest rate in % (1-100) | <input type="text" value="2"/> | <input type="text" value="2"/> |

calculate business economics based on user input

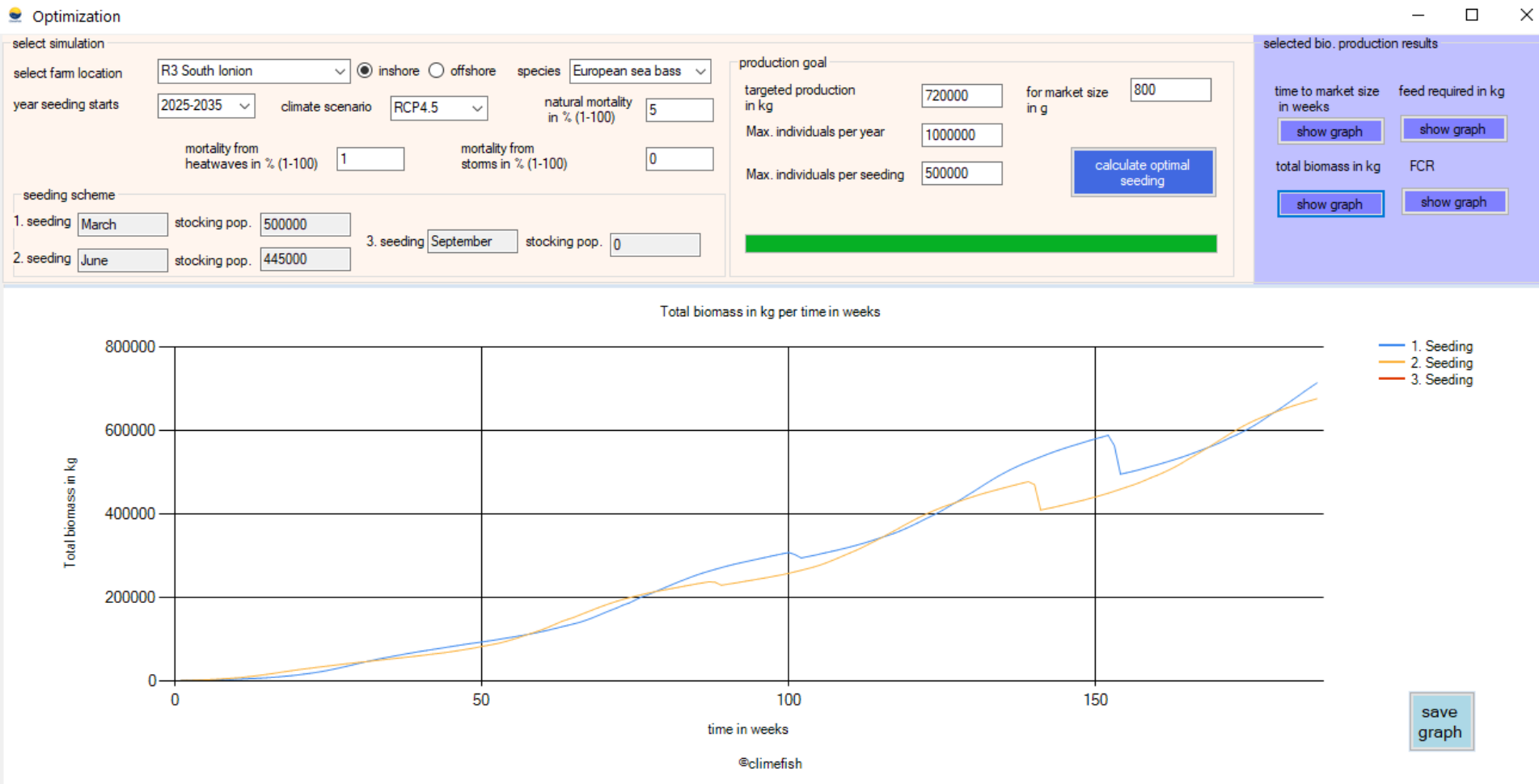
| | | | |
|---|--------------------------------------|--|--|
| <input type="button" value="calculate costs / profit"/> | Total costs for selected market size | <input type="text" value="1,870,791.9"/> | <input type="button" value="show graph (costs/market size)"/> |
| | Profit for selected market size | <input type="text" value="1,558,698.7"/> | <input type="button" value="show graph (profit/market size)"/> |

Mean Individual weight in g per time in weeks



Some more tools...(1)

- Seeding optimization



Some more tools... (2)

- Compare RCP scenarios



Some more tools... (3)

- Presentation of the risk assessment

riskassessment

— □ ×

Please choose time and climate scenario first

Climate Scenario: RCP4.5 Time frame: 2030

Category: Biological Climate Change Driver: Increase water temperature

Risks

| Potential and related impacts | Score | Rating |
|--|-------|--------|
| 1.2. Seasonal changes in growth and stocking timing <ul style="list-style-type: none">1.4. Inhibition of growth1.7. Increased size variability1.8. Increase of mortality4.3. Increase in variability of market prices | 6 | Major |
| 1.3. Inhibition of growth and increase of mortality | 6 | Major |
| 1.6. Increase presence of pathogens | 7 | Severe |

Potential adaptation measures

Biological
Socio-economic
Production
Ecological/environmental

Opportunities

| Potential and related impacts | Score | Rating |
|--|-------|--------|
| 1.1. Increase of biomass and production capacity <ul style="list-style-type: none">2.4. Increase of organic discharge2.4. Increase of organic discharge3.2. Suitability of farm sites | -6 | Major |
| 1.2. Seasonal changes in growth and stocking timing <ul style="list-style-type: none">1.7. Increased size variability1.8. Increase of mortality4.3. Increase in variability of market prices | -6 | Major |

Potential adaptation measures

- Funding and operation of breeding programmes for improved and more robust fish
- Adaptive stocking planning
- Adaptation of feeding strategies in line with monitoring results
- Investments in developing and adopting new offshore technologies
- Develop marketing plans
- Update of marine spatial planning framework (Integrate aquaculture spatial planning into the existing framework)
- Research on feed consumption and efficiency in higher temperatures
- Development of models for forecasting growth at the shifted temperature regime
- monitoring and mapping infections and diseases
- Development of vaccines for emerging new pathogens and of alternative preventive treatments to avoid establishment

Next steps

- On line version
- Include model for gilthead seabream
- Update model / results with more CC drivers

Thank you for your attention!

npap@hcmr.gr

<http://136.144.228.39:8080/climefish>



ClimeFish

This project has received funding from the European Union's Horizon 2020 research and innovation action under grant agreement no. 677039

