Marine aquaculture Greece

Implementation case study

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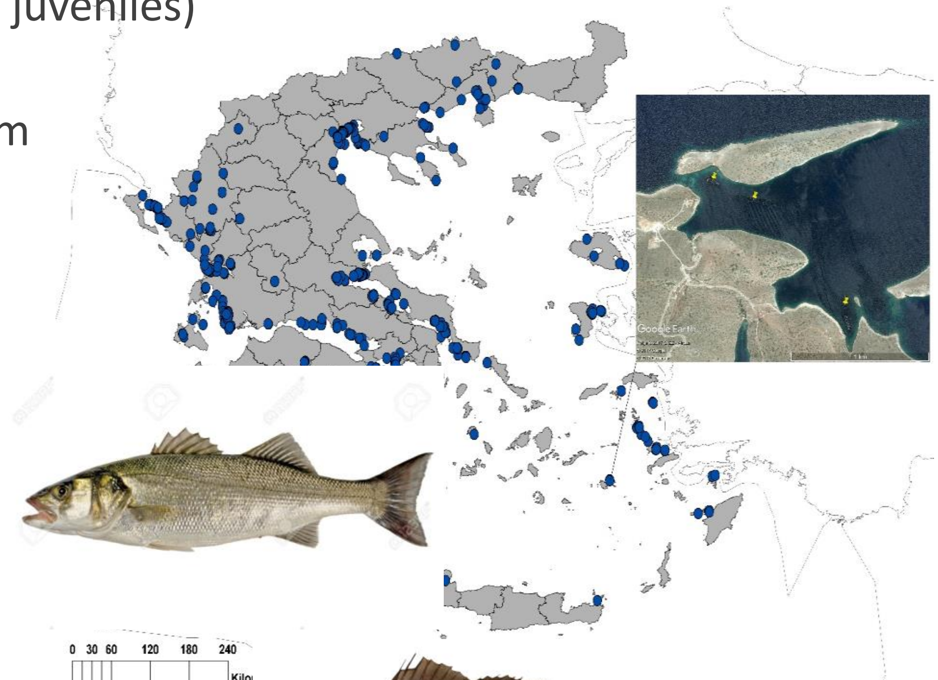
Greek case study: Marine aquaculture

- Importance of the marine aquaculture sector
  - over 63% of national products
  - >530 M € in 2017 (625 M € including juveniles)
  - 318 finfish farms (63 companies)
  - European sea bass, gilthead seabream

- Goal: develop forecasting models
  - simulate and analyse the CC (i.e. T) effects on aquaculture production

- Targeted fish species
  - European sea bass (established)
  - meagre (emerging)



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Our Stakeholders

Federation of Greek Maricultures
Panhellenic Association of Small and Medium Aquaculture Enterprises
Farmers (Andromeda S.A.)
Fish Feed Industry (Irida S.A.)
Min Energy and Climate Change **DG Environmental Policy, Direction for Climate Change and Atmosphere quality**
Min Agriculture and Food **DG Fisheries and Aquaculture**
International Centre for Research on the Environment and the Economy (ICRE8)
WWF Hellas

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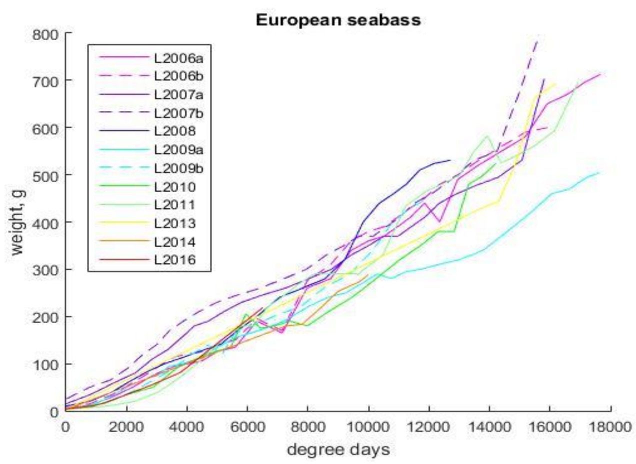
What do we know?

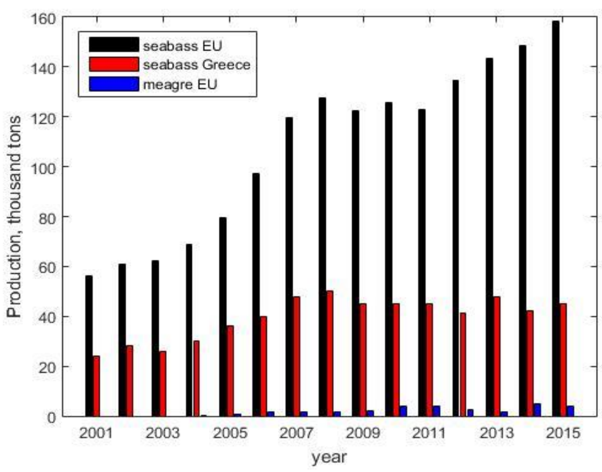
Knowledge gap analysis

- significant gaps for all major CC drivers (temperature, acidification, deoxygenation, extreme events, combination of stressors, long term studies)

Empirical analysis: Historical effects of CC (i.e. T) on aquaculture production

- growth – inconclusive (husbandry/ domestication can mask T effects)
- production – no effect (socioeconomic rather than environmental drivers)





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Biological forecasting

Modeling – General approach

Available data

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

What can we model?

- Temperature (explicitly)
- Extreme weather events ?…

Climate Change

Temperature

Acidification

Oxygen availability

Extreme weather events

HABs

…

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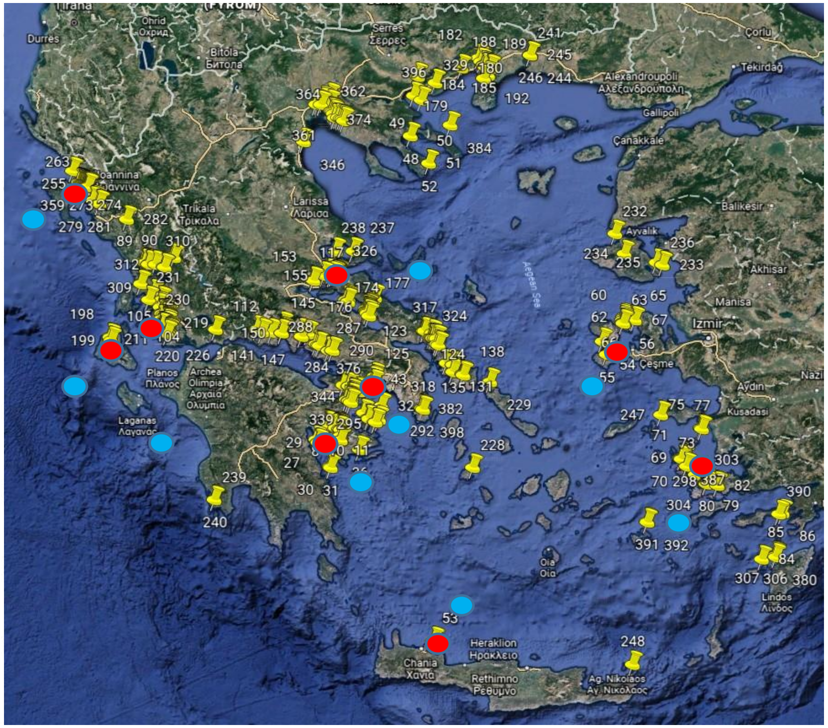
Modelling a “unit” farm

- DEB model for “T-effect” on individual fish
  - Fish groups with inter-individual variability
- A model farm
  - 3 stockings (March, June, September)
  - Capacity up to 3x500K juveniles
- 9 locations (major administrative regions)
- **Inshore** and **Offshore**
- Time scale
  - Short term (2015-2025)
  - Mid term (2025-2035)
  - Long term (2045-2055)



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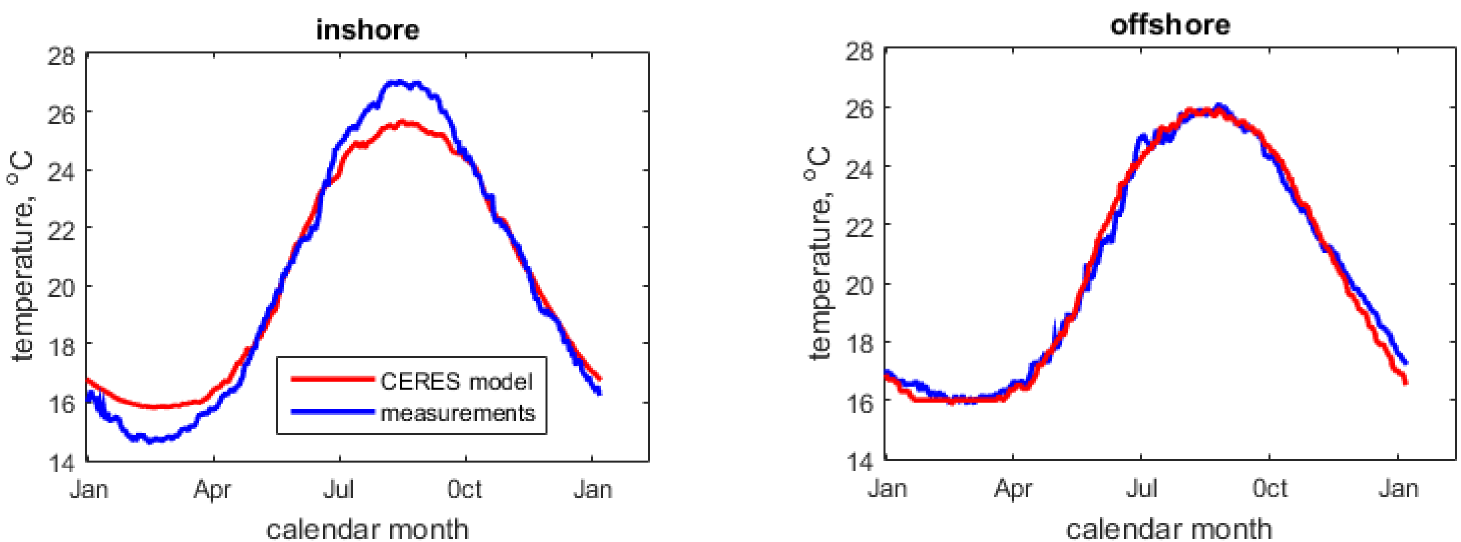
Climate data – temperature correction

- climate model insensitive to high – low temperatures in coastal areas
- application of region-specific “bias correction” using temperature data from farms



10-year temperature average

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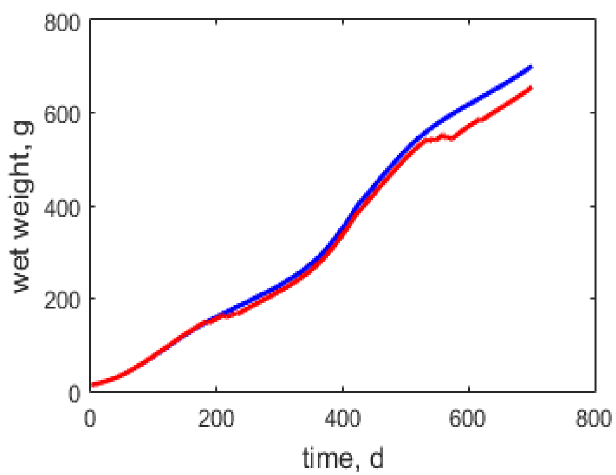
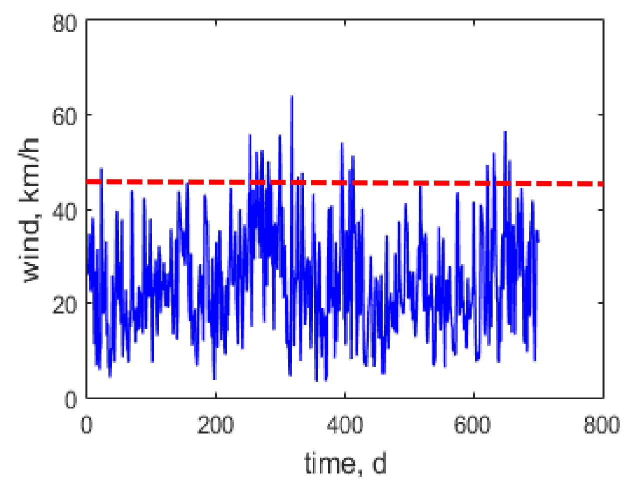
Modeling – not only temperature

extreme events : specified wind or temperature threshold

- **no feeding** days

no feeding example for an offshore farm





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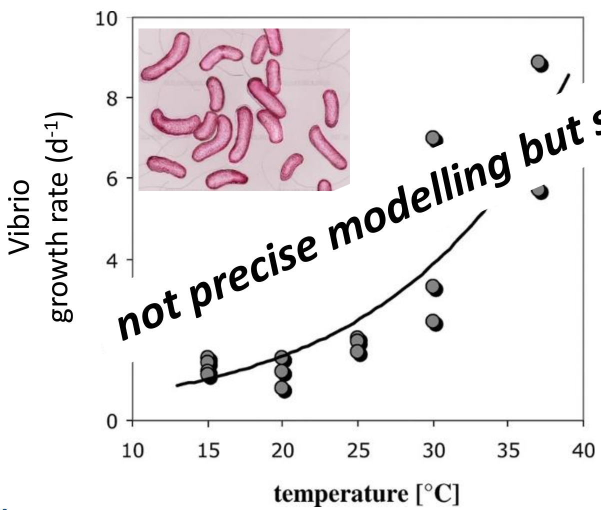
Modeling – not only temperature

extreme events : specified wind or temperature threshold

- **no feeding** days
- additional **mortality**
  - temperature (disease outbreaks)
  - wind (cage damage – escapees)

not precise modelling but still useful for detecting trends



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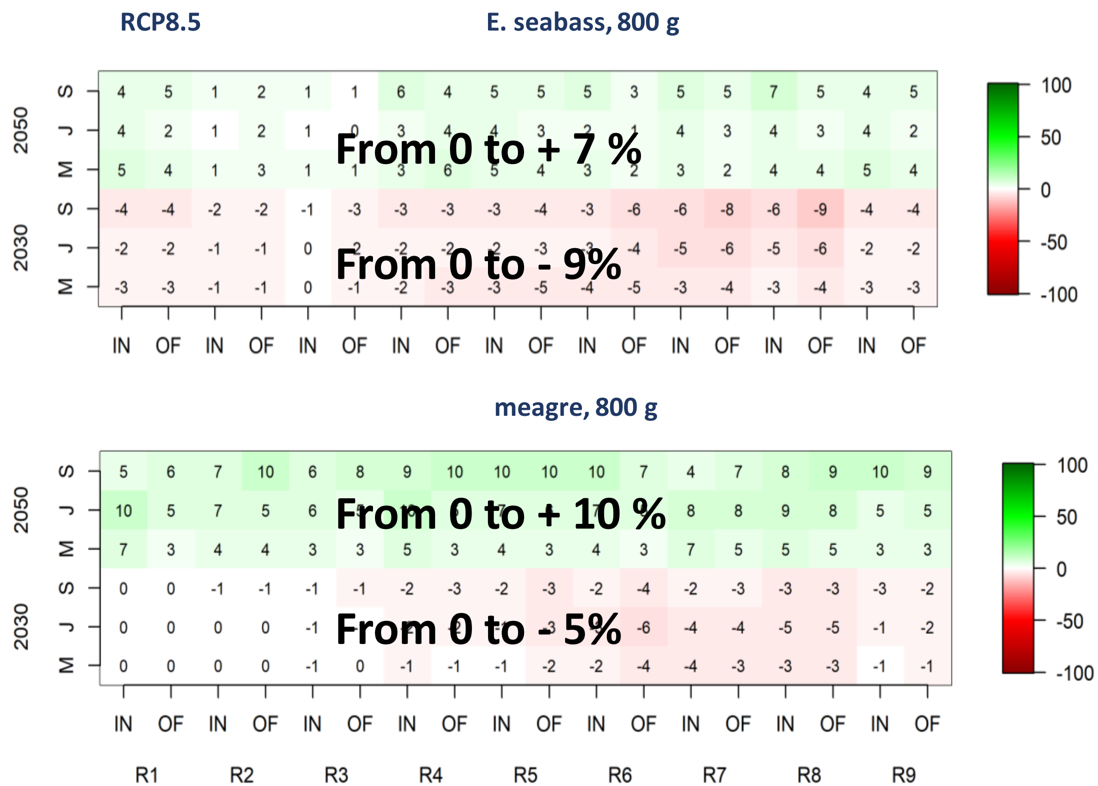
Results – Effects at the individual level (1)

Relative growth

- 2030: no – negative effect
- 2050: positive effect

- the positive effect is higher for meagre



relative change in days to reach harvest size (stocked in March, June and September)

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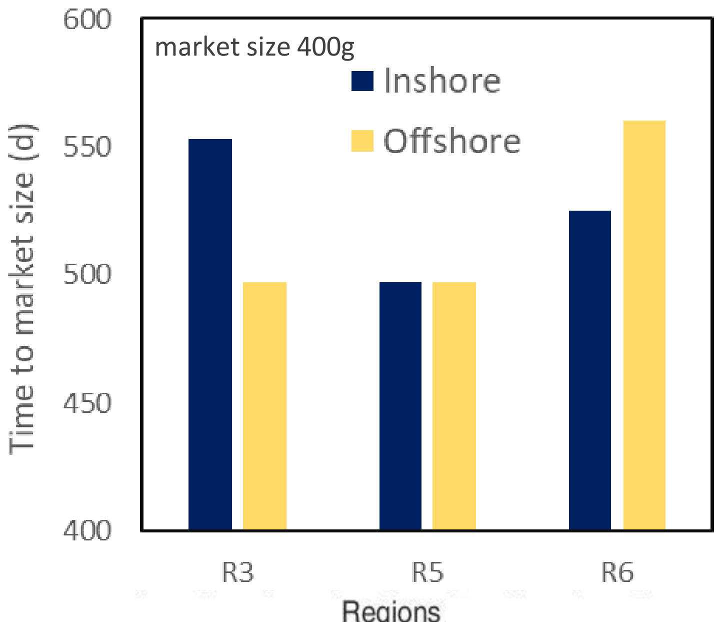
Results – Effects at the individual level (2)

Relative growth

Husbandry is important too



E. seabass

managerial drivers

- site selection (regions)
- stocking month
- inshore/offshore

The effect of husbandry on growth is higher than that of temperature and wind velocity

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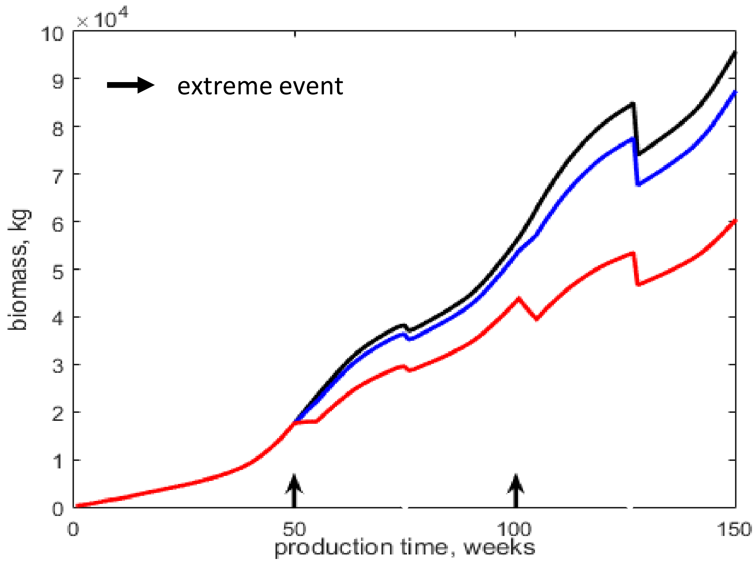
Results – Effect at the farm level (1)

extreme events

- higher mortality rates
- negative effect on biomass production

extreme event example



mortality

– **0%**
– **2%**
– **5%**

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Results – Effect at the farm level (2)

Biomass example – E. seabass

- 3x300K juveniles
- Market size: 800g

mortality for extreme events

E. seabass, 800 g

1%

		R1 IN	R1 OF	R2 IN	R2 OF	R3 IN	R3 OF	R4 IN	R4 OF	R5 IN	R5 OF	R6 IN	R6 OF	R7 IN	R7 OF	R8 IN	R8 OF	R9 IN	R9 OF
2050	S	-7	-12	-15	-15	-14	-16	-13	-15	-14	-16	-14	-15	-14	-17	-15	-16	-15	-16
2050	J	-6	-11	-15	-15	-15	-16	-14	-16	-15	-14	-14	-14	-14	-18	-14	-16	-15	-14
2050	M	-5	-11	-15	-18	-16	-18	-15	-17	-16	-17	-14	-17	-15	-17	-14	-17	-15	-17
2030	S	-3	-4	-2	0	-2	-1	-2	0	-1	-1	-2	-2	-7	-6	-7	-5	-3	0
2030	J	-4	-4	-6	-2	-6	-1	-8	-2	-5	-2	-3	-7	-6	-8	-6	-6	-5	-3
2030	M	-4	-3	-7	-9	-7	-9	-8	-10	-9	-10	-8	-10	-8	-10	-8	-11	-7	-9

5%

		R1 IN	R1 OF	R2 IN	R2 OF	R3 IN	R3 OF	R4 IN	R4 OF	R5 IN	R5 OF	R6 IN	R6 OF	R7 IN	R7 OF	R8 IN	R8 OF	R9 IN	R9 OF
2050	S	-32	-48	-57	-59	-57	-59	-56	-58	-56	-59	-56	-59	-57	-60	-57	-59	-57	-59
2050	J	-28	-48	-57	-57	-57	-57	-55	-57	-54	-57	-54	-57	-57	-62	-57	-61	-54	-56
2050	M	-24	-46	-57	-64	-58	-64	-57	-63	-57	-63	-56	-64	-57	-64	-57	-64	-57	-63
2030	S	-18	-19	-10	-4	-10	-5	-10	-4	-9	-5	-10	-6	-27	-24	-24	-19	-11	-4
2030	J	-19	-19	-27	-10	-27	-9	-28	-10	-16	-10	-18	-27	-27	-28	-27	-27	-16	-10
2030	M	-20	-19	-32	-38	-32	-38	-32	-39	-32	-39	-32	-39	-33	-40	-33	-40	-31	-38

RCP8.5

relative changes in biomass

- Some regions resilient mid-term
- Severe effects in all regions by 2050

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Risk assessment
Adaptation measures

Stakeholders have a say!

2 stakeholder meetings:
Athens, April 2018, June 2019

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Risks and Opportunities

Rating	Impact	Category	Climate Change Driver
Severe risk	Seasonal changes in growth and stocking timing	Biological	Increased water temperature
	Increase presence of pathogens		Increased water temperature
	Increase of mortality		Increased water temperature and extreme weather events
Major risk	Increased size variability	Biological	Increase water temperature and extreme weather events
	Shift of thermal window suitable for growth*		Increase water temperature
	Increased use of antibiotics	Ecological/ environmental	Increased water temperature
	Water quality deterioration, risk for anoxic conditions		Changes in currents and water circulation
	Infrastructure damages		Extreme weather events
	Increase of HABs and fouling		Increase water temperature, changes in currents and water circulation
	Suitability of farm sites	Production	Extreme weather events
	Increase of feed prices		Increased water temperature
	Higher fluctuation of feed prices		Extreme weather events
Transformative opportunity	Increase of biomass and production capacity	Biological	Increased water temperature
Major opportunity	Shift of thermal window suitable for growth*	Production	Increased water temperature
Moderate opportunity	Increase of employment	Socio-economic	Increased water temperature

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Adaptive measures

In total 24 adaptive measures/ actions identified on 4 levels

- Technical/ Industry
- Research and knowledge building
- Policy and Regulation
- Funding

Contribution to a sectoral Adaptation Plan
at Regional and EU level

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Technical/ Industry

- Increased monitoring activities further to farm level (Aquaculture Zones)
  - fish performance
  - pathogens/ outbreaks
  - T, DO, pH, …
- Adaptive production planning
  - stocking /harvest time
  - feeding strategies
  - marketing plans
- New technologies, materials
  - new material resilient to fouling
  - automation, offshore technology
- Breeding programmes for more resilient species

Policy and Regulation

- Flexible legal framework
- Integration of aquaculture in M.S.P.
  - further establishment of Aquaculture Zones

Funding

- Support the technological adaptation of farms
  - breeding programmes
  - farming technologies

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Research and knowledge building

- Understand the biological mechanisms implicated in response to CC stressors (high temperatures, acidification, etc) and to their combinations
  - breeding programmes

- Higher resolution climate models
  - focus on coastal areas relevant for aquaculture

- Better feeds for the new conditions

- New rearing technologies
  - precision aquaculture (monitoring, early warning, …)
  - offshore technologies
  - RAS /closed containment systems

- Study new infections and diseases
  - disease outbreaks patterns
  - development of prevention methods/ vaccines

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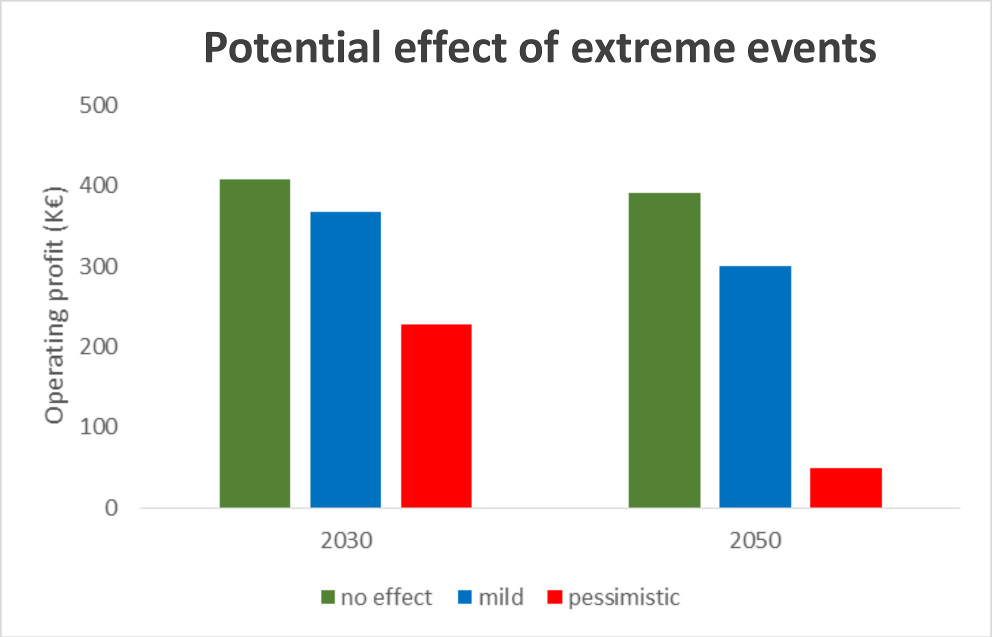
Socioeconomic analysis

- Predicts changes in the profitability of farms according to climate scenarios
- With **current farming technology**
  - despite better fish growth
  - extreme events will cause decline c
    value added



- No assumptions for adaptations of current farming technology that may radically alter the observed trends
- **The output** is sensitive to the input variables (financial and mortality attributed to extreme events) and **should be interpreted with caution**

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Towards a national Climate Adaptation Plan

- Industry
  - increase collaboration between farms in a wider organizational level (zones of development)

- Research community
  - understand the biological mechanisms implicated in response to various climate change drivers

- Administration
  - establish a flexible legal framework for the operation of the farms and designation of new sites
  - support research and innovation

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Thank you for your attention!

(npap@hcmr.gr)

References

- CLIMEFISH Deliverable 1.2 Knowledge gap analysis
- CLIMEFISH Deliverable 3.3 Production-biomass and distribution scenarios for simulation and implementation case studies
- CLIMEFISH Deliverable 4.2 Socio-economic assessment for case studies for a range of IPCC scenarios
- CLIMEFISH Deliverable 4.3 Climate-related Risks and Opportunities for Fisheries and Aquaculture in Europe
- Orestis Stavrakidis-Zachou, Nikos Papandroulakis, Astrid Sturm, Panagiotis Anastasiadis, Frank Wätzold, Konstadia Lika, 2019. Towards a computer-based Decision Support System (DSS) for aquaculture stakeholders in Greece in the context of climate change. Int. J. of Sustainable Agricultural Management and Informatics. https://doi.org/10.1504/IJSAMI.2018.099235
- Orestis Stavrakidis-Zachou, Nikos Papandroulakis, Konstadia Lika, 2019. A DEB model for European sea bass (*Dicentrarchus labrax*): Parameterisation and application in aquaculture. Journal of Sea Research 143, 262–271 https://doi.org/10.1016/j.seares.2018.05.008

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