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How does the fisheries and aquaculture value chains impact the climate?

Identifying pathways to mitigating the impacts of our activities: An Economic Perspective

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1. Role of economics in climate change

- Mitigation vs. adaptation → my focus mitigation
- Economists consider GHG emissions as an externality

  "An activity on one entity that affects the welfare of another entity in a way that is outside the market mechanism"

  - An unpaid negative effect on others
- Solution: Make prices right – let the polluter pay
  - Give incentives for reducing GHGs
- How much and how fast shall we react to reduce climate change?
  - View 1: The Stern 2006 Review *"The Economics of Climate Change"* – called for immediate action to fight climate change
  - View 2: Nordhaus – Stern use unrealistic low discount rates

    → less need for immediate action
  - Economists agree on action needed – not on speed.

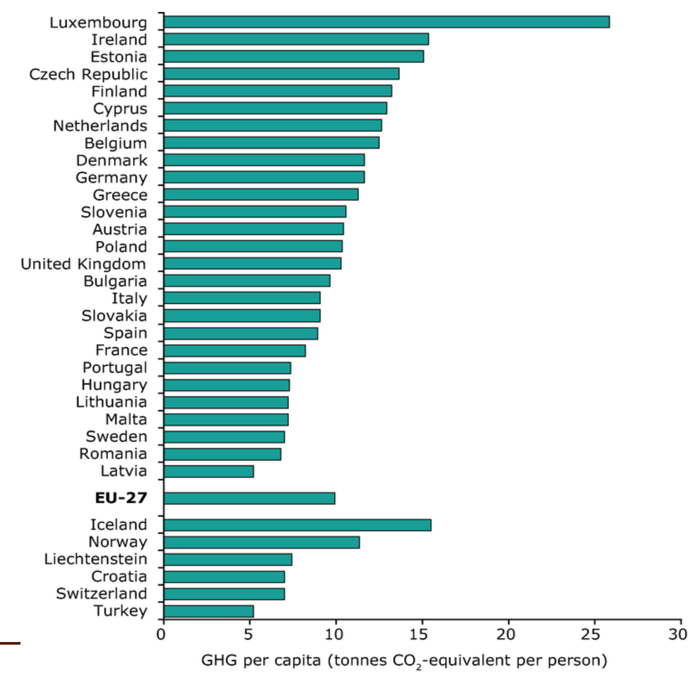
1. Role of economics in climate change

- The COP26 Agreement strives at avoiding > 1.5 degree C by
  - Asking countries to introduce ambitions 2030 goals on GHG reductions to reach net zero emissions 2050
- Nordic countries ambitions on carbon neutrality
- Political discussions
  - Not on how much and that it must be fast
  - But on how and exactly how fast.
- Mitigation is a huge task with large costs
  - The core role of economics is to identify how to act cheapest, cost-effectively.

2. GHG emissions and regulation

- Global GHG emissions 2017 ~ 37 Billion tons CO_2e
  - CO_2 76%, Methane 16%
  - Largest GHG emitting sectors, electricity/heating, transport, agriculture, manufacturing, construction, e.g. shipping 3%, aviation 2.5%
  - Nordic countries ~200 Million tons CO_2e and EU28 3.5 Billion tons
- Nordic per capita CO_2e emissions
- European Trading System of CO_2 quotas
  - Regulate ~ 45% of emissions
  - Include EU countries, Norway and Iceland
  - Agriculture, cars and houses not covered
- Some countries have emission taxes.

GHG emissions as tons CO_2e per person



3. GHG emissions fisheries and aquaculture

Global fisheries

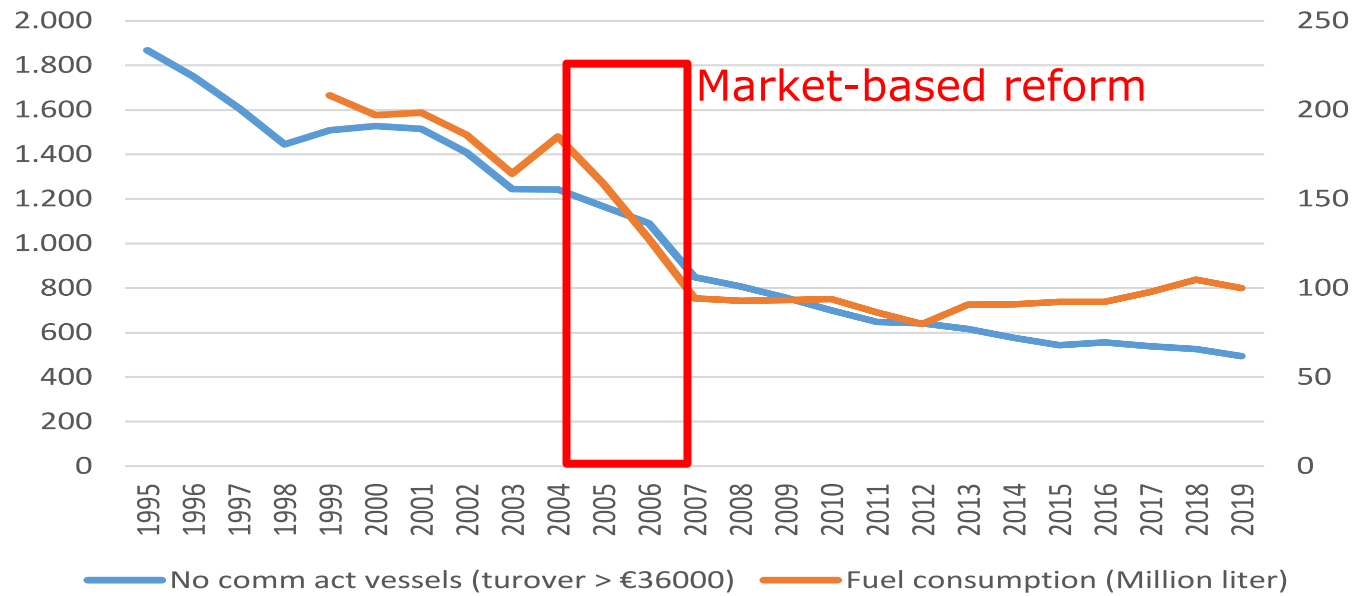
- GHG emissions comes from
  - Fuel use
  - Swirling of CO_2 by bottom trawling to surface waters and maybe to the atmosphere
- Fuel use induce 178-207 Million tons ~ 0.5% globally

Fuel use in Danish fisheries – an example

- Commercial active fleet use 100 Million liter fuel in 2019 ~264,000 tons CO_2 and 0.8% of Danish emissions.
- Development over time
  - Reliable data not available 1990-1998

3. GHG emissions fisheries and aquaculture

- Emissions commercial active Danish vessels 1999-2019 – two phases



- Phase 1: Total fuel use reduced 62% 1999-2012 with fleet size due to market-based reform/technological development – not by purpose
- Phase 2: Fuel use increase 2012-2018 30% totally, 60% on average – partly due to increasing vessel size
- 48% of the 2030 70% reduction target fulfilled, although not accounting for fisheries.

3. GHG emissions fisheries and aquaculture

- Indicators for fuel consumption in Danish fisheries 2019

2019 Vessel group3.2	Fuel cons. (Mil liter)	Fuel use liter per			EBIT (% assets)
		kg. fish caught	€ sold fish	€ invested (assets)	
1. Net (<24 m)	3	0.403	16	3.5	-0.2
2. Seiners (12-15/18-24 m)	1	0.333	17	3.1	-0.1
3. Trawl (<24 m)	17	0.312	32	4.9	1.1
4. Trawl consumption (24-40)	25	0.546	47	8.1	2.1
5. Trawl reduction (>40 m)	13	0.82	36	6.7	4.2
6. Seiners/trawl (>40 m)	27	0.93	23	3.0	5.5
7. Other	13	0.195	33	5.1	0.6
Total	100	0.158	31	4.7	3.2

Updated calculations from Nielsen, M. and L Ståhl (2012), Aspects of green transition in Danish fisheries (in Danish). Retrieve at: https://static-curis.ku.dk/portal/files/44835493/FOI_udredning_2012_20.pdf.

- Results
  - Seiners/trawl >40 m cannot be separated statistically
  - Over 80% of fuel used by trawlers and seiners/trawl >40 m

3. GHG emissions fisheries and aquaculture

- Results
  - Fuel use per kilo fish smaller for large than small vessels
  - Small vessels <24 m: Fuel use per € sold/invested around half for net/seiner fishing than trawlers
  - For large vessels >24 m: Fuel use per € sold/invested around half for seiners/trawlers >40 m than for pure trawlers
  - Fuel efficient vessels: Net/seiners fishing <24 m and seiners/trawlers >40 m
  - For small vessels, trawlers have better economy than netters/seiners
  - Seiners/trawlers >40 m fuel efficient and with good economy – but separation not possible

- Results accounts for other Nordic fisheries
  - Market-based management ICE, DEN, GR shrimp, SW/FIN/FAR pelagic
  - MBFM in NOR – more transferability between vessel groups can reduce fleet/CO_2
  - Options of reducing fleet/CO_2 in demersal fisheries such as at FAR and in GR Greenland halibut fishing.

3. GHG emissions fisheries and aquaculture

Swirling of CO_2 by bottom trawling globally

- 2021 *Nature* study by Eric Sala et al *Protecting the global ocean for biodiversity, food and climate*
- Marine sediments the largest carbon pool on the planet
- Disturbance by bottom trawling affect bottom fauna, reduce the carbon buffering capacity and potentially add to atmospheric CO_2
- Emissions may potentially reach same level as global aviation ~ five times CO_2 emissions from fuel use in fisheries
- If correct, pressure to stop bottom trawling prevail. But
  - It is obvious that the effect exist
  - It is one study, representativeness to be controlled
  - Not known how much adds to atmospheric CO_2
  - Not known whether the effect depends on sea floor/water depth
- Our knowledge limited ➡ but fishery reforms reduce activity and fuel use in many countries – also swirling.

3. GHG emissions fisheries and aquaculture

Aquaculture

- Aquaculture the fastest growing animal food producing sector worldwide ➡ CO_2 emissions increasing
- Nordic Aquaculture
  - Marine salmon farming Norway/Faroe Islands
  - Pond/cage farming of trout Denmark/Finland
  - Recirculation increasingly used



3. GHG emissions fisheries and aquaculture

Aquaculture

- Literature review of LCA studies identify CO_2 emissions of one kilo of fish to 1.8-7.0 kilo for salmon and 0.7-13.6 kg. for trout (Nielsen and Nielsen 2020)
- CO_2 emissions of farmed salmon and trout the same as of wild caught cod, less than for beef and pork meat
- Feed induce the largest CO_2 emissions, both fish- and plant based ingredients - share of plant-based ingredients rising
- CO_2 emissions from recirculated aquaculture highest ➡ CO_2 can be reduced using more green energy.

4. Mitigation fisheries and aquaculture

- CO_2 reduction in fisheries and aquaculture likely – or inevitable
- Targets/regulations not decided yet – may be taxes, tradable permit or in other incentives
- Important that measures are cost-effective – cheapest

Potential measures

- Increase incentive for net/seiners instead of trawling
  - Economy negatively affected
  - Done in the Danish coastal arrangement for vessels <17 m
- Increase fuel efficiency of fishing gears e.g. by developing trawl with less water resistance and bottom contact.

4. Mitigation fisheries and aquaculture

Potential measures

- Increase fuel efficiency of vessels
  - Shipping in Europe expected in ETS → Action necessary → Fishery can learn
  - Studies finds that shipping can reduce CO_2 50% by investing/operational changes *without extra costs ~ fuel savings* by cold ironing, solar cells, optimization of the hull/propulsion/light, less ballast water, slow sailing (Eide et al 2011; Schwartz et al 2020).

- Develop clean propulsion of vessels
  - Electricity-driven vessels – mainly small vessels with short trips?
  - Hybrid driven vessels
  - Methanol/hydrogen/bioethanol driven vessels
  - Technically possible but also expensive
  - To be broadly used, they must be cheaper or incentivized
  - Many initiatives logically start outside fishing.

5. Conclusions

Fisheries

- Market-based management reforms efficiently reduced CO_2 from fisheries – but not by purpose
- More may be needed such as increasing fuel efficiency and considering the net/trawl balance –important to do it as cheap as possible
- Many initiatives such as on low carbon propulsion logically start in shipping – fisheries can apply their technologies developed.

Aquaculture

- Feed necessary and feed conversion ratio can be reduced, but CO_2 reductions depend on fishing for reduction/farming of soy
- Recirculation – CO_2 reductions depend on availability of cheap green energy.