MARISPLAN
Marine Spatial Planning in a Changing Climate

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FICCA Final Symposium 2.12.2014

MARISPLAN WPs

Investigations on climate induced changes in...

1. Physical environment FMI Jari Haapala
2. Watershed processes SYKE Freshwater Centre Bertel Vehviläinen
3. Agriculture MTT Agrifood Research Heikki Lehtonen
4. Baltic Sea ecosystem SYKE Marine Res. Centre Maiju Lehtiniemi
5. Coastal fish and fisheries FGFRI Lauri Urho
6. Policy SYKE Env. Policy Centre Mikael Hildén
              Helsinki City Env. Centre J.-P. Pääkkönen
WP1: Marine physics

How will the habitat ranges of benthic species change in the Finnish coastal waters due to hydrographical changes?

WP4. Impacts of changing climate on the habitat ranges of benthic species

Elina Virtanen, Markku Viitasalo, Kirsi Kostamo, Markus Meier, Heikki Peltonen

The main study question

- How will the habitat ranges of benthic species change in the Finnish coastal waters due to hydrographical changes?

Spatial hydrodynamic projections

- Coupled atmosphere-ocean model (SMHI-RCAO)
- IPCC emission scenarios A1B and A2

Spatial species modelling

- MaxEnt
Precipitation and freshwater discharge will increase. Salinity is projected to decline. How much will the geographical distributions of species change?

How to estimate the magnitude of the geographical shift??
With spatial modelling!

Spatial modelling

Species inhabit a specific niche along each environmental gradient:
Environmental data supporting modelling

Spatial data layers
- Sea floor topography (depth)
- S, T
- Depth attenuated exposure
  - Describes wave exposure near sea bottom (Bekkby et al. 2008)

Biological data
- VELMU data: Species records from underwater surveys 2004–2015
- >40,000 points (video, scuba, sampling)

1. Drop video
2. ROV
3. Scuba

Bladderwrack Fucus sp.
Eelgrass Zostera marina
Field data: Bladderwrack Fucus vesiculosus
Coverage of bladderwrack in the GoF: VELMU video data 2005-2013

Model results: Bladderwrack
Current range of Fucus sp. 2005
Projected range of Fucus sp. 2095
Impacts of changing climate on the non-indigenous invertebrates

Reetta Ljungberg, Maiju Lehtiniemi, Markus Meier, Jan Albertsson, Elena Gorokhova, Jonne Kotta, Markku Viitasalo

The main study question
- How will the spatial distributions of NIS change in the Finnish coastal waters?

Spatial hydrodynamic projections
- Coupled atmosphere-ocean model RCO-SCOBI (Meier et al. 2012)
- IPCC emission scenarios A1B and A2
- Summer temperature and salinity in 2005–2009 and 2095–2099

Results: Which NIS will suffer and which benefit from declining salinity?

Zebra mussel

M. Viitasalo, FICCA Final Symposium 2.12 2014
Summary Part 1 – Biogeography

- Marine species will diminish, but remain in microhabitats
- Freshwater/brackishwater species and species whose reproduction has been limited by temperature will be favoured
- Some marine non-indigenous species may decline in numbers but new freshwater ones may be established
The main study question

- How will the hydrological variation and agricultural adaptation influence nutrient loading from different Finnish watersheds

Modelling

- Mean of 19 GCMs driven by A1B
- VEMALA - Operational, national scale, N and P loading models
- DREMFIA - Economic agricultural sector model (Lehtonen 2013)

### 2. Effect of CC and agricultural adaptation...

**DREMFIA agricultural scenarios for 2050**

**Little adaptation**
- Policies do not encourage investments; no increase in prices
- Yields decrease by 10%

**Moderate adaptation**
- Prices and policies do not change; Little subsidies are paid
- Moderate market prospects imply liming and drainage investments
- Yields increase by 10%

"**Successful adaptation**" (= most financial profit for farmers!)
- Policies imply effective adaptation, including new cultivars
- Prices: cereals +30%, milk products +10%, meat +15%
- Increased fungicide use, liming, drainage investments
- N fertilization increase by 30%.
- Yields: cereals, grasslands +30%, oilseeds, winter cereals +60%
Results: Changes in hydrology

- Total annual freshwater discharge (from Finnish rivers into the Baltic Sea) will increase by 4% by 2060.
- Large differences between watersheds:
  - Bothnian Bay: +1%
  - Gulf of Finland: +11%
  - Archipelago Sea: +15%

Results: Changes in agriculture

- Climate change will prolong growing season and potential crop yields will increase.
- The response of the farmers, and hence nutrient loading, depends on the level and means of adaptation.
Results: Changes in nutrient loading

- Total nitrogen load will increase by 10 to 33%.
- Climate change important.
- Level and types of agri-adaptation important for nutrient loads.

- Total phosphorus load will increase by 12-16%.
- Climate change a major driver.
- The current storage of P in soil needs to be cut down.

Results: Loading into the Gulf of Finland

- "Successful" agri-adaptation creates more TN load than moderate adaptation.

- TN load will increase by 10 to 33%.
- Climate change important.
- Level and types of agri-adaptation important for nutrient loads.

- TP load will increase by 12-16%.
- Climate change a major driver.
- The current storage of P in soil needs to be cut down.
Summary Part 2 – Nutrient loading

- Modelling each watershed separately reveals spatial differences in nutrient loading
- Combining agricultural adaptation scenarios with CC scenarios allow tailoring realistic farm level measures to diminish nutrient loading

How to diminish nutrient loading from agricultural land?

- **Decrease P storage in soils**: New cultivars, liming, better drainage and crop protection
- **Control erosion**: Change the steepest fields from annual crops to perennial vegetation (forest or pasture)
Human pressure index method: Example: Helsinki sea area

- **Impacts** of human pressures on ecosystem components
- **Expert assessment** (in two workshops)
- **Interviews** with an online mapping software
  - Activities
  - Conflicts
  - Impacts of the environmental change, including CC

Results: Average human pressures
MARISPLAN conclusions

- Possible to identify high pressure areas and biological hot spots
- Possible to assess CC induced changes in pressures

Uses of results:
- Direct linking to local management decisions
- Adaptive Marine Spatial Planning in a changing climate