Projekt: „Mudelite süsteemi ja töövahendi loomine mere ja maismaa pinnavete integreeritud haldamiseks“

Seminari päevakava

26. märts 2015 Tallinn Meriton Grand Conference & Spa Hotel Konverentsikeskus Peterson I saal

Aeg	Ettekandja	Teema
9.00 – 9.30	Registreerimine, tervituskohv	
9.30 – 9.40	**Rene Reisner** Keskkonnaministeerium, veeosakonna juhataja	Tervitussõnad
9.40 – 10.00	**Erik Teinemaa** Eesti Keskkonnauuringute Keskus OÜ, projektijuht	Projekti tutvustus
10.00 – 10.40	Akad. **Tarmo Soomere** Eesti TA president	Mere ja ranniku mudelite ning andmestike võimalusi ja kitsaskohti
10.40 – 11.20	**Tiit Kutser**, PhD Tartu Ülikool	Kaugseire ranniku- ja sisevete seisundi hindamisel
11.20 – 11.40	Kohvipaus	
11.40 – 12.20	**Robert Aps**, PhD TÜ Mereinstituut	Building common situational awareness for accidental oil spill emergency response
12.20 – 13.00	**Peeter Nõges**, PhD Eesti Maaülikool	Järvede seisundi hindamine keskkonnaandmete alusel

13.00 – 14.00	Lõuna	
14.00 – 14.40	**Mika Nieminen**, PhD Natural Resources Institute Finland	Calculation tools for N and P exports from forests/peatlands to waters in Finland
14.40 – 15.20	**Per Stalnacke**, PhD Norwegian Institute for Agricultural and Environmental Research	Nutrient fluxes from source to the sea
15.20 – 15.40	Kohvipaus	
15.40 – 16.20	**Johanna Tengdelius Brunell** MSc, Swedish Meteorological and Hydrological Institute	Reporting and classification by using the HYPE-model
16.20 – 17.00	Prof. **Toomas Tamm** Eesti Maaülikool **Ottar Tamm,** doktorant Eesti Maaülikool	SWAT-i kasutamiskogemus Eestis

Project: "Development of data- modelling system and decision support tool for the integrated marine and inland water management"

Agenda of the International Conference

March 26, 2015

Tallinn Meriton Grand Conference & Spa Hotel Conference Centre

hall Peterson I

Time	Lecturer	Topic
9.00 – 9.30	Registration and welcome coffee	
9.30 – 9.40	**Rene Reisner** Estonian Ministry of the Environment, head of the Water Department	Welcome
9.40 – 10.00	**Erik Teinemaa** Estonian Environmental Research Center, project manager	Introduction of the project
10.00 – 10.40	Acad. **Tarmo Soomere** President of the Estonian Academy of Sciences	Modelling and analysis of marine and coastal processes: opportunities and limitations
10.40 – 11.20	**Tiit Kutser**, PhD Tartu University	Assessment of marine and inland waters with remote sensing
11.20 – 11.40	Coffee break	
11.40 – 12.20	**Robert Aps**, PhD Tartu University Marine Institute	Building common situational awareness for accidental oil spill emergency response

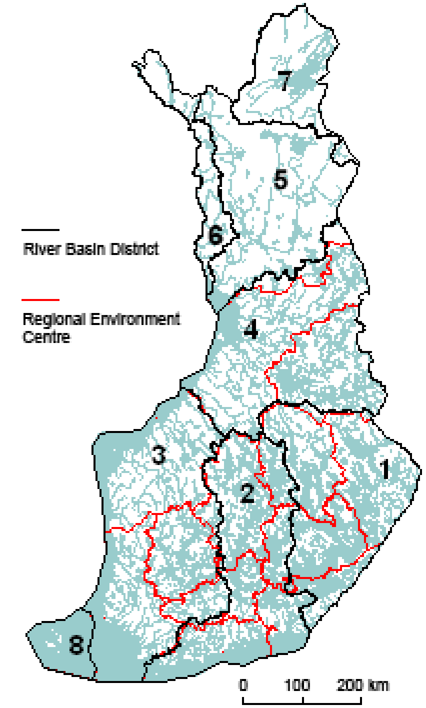
12.20 – 13.00	**Peeter Nõges**, PhD Estonian University of Life Sciences	Assessment of the status of lakes according to the environmental data
13.00 – 14.00	Lunch	
14.00 – 14.40	**Mika Nieminen**, PhD Natural Resources Institute Finland	Calculation tools for N and P exports from forests/peatlands to waters in Finland
14.40 – 15.20	**Per Stalnacke**, PhD Norwegian Institute for Agricultural and Environmental Research	Nutrient fluxes from source to the sea
15.20 – 15.40	Coffee break	
15.40 – 16.20	**Johanna Tengdelius Brunell** MSc, Swedish Meteorological and Hydrological Institute	Reporting and classification by using the HYPE-model
16.20 – 17.00	Prof. **Toomas Tamm** Estonian University of Life Sciences **Ottar Tamm,** McS Estonian University of Life Sciences	The experience of using SWAT model in Estonia

Calculation tools for N, P, and sediment exports from forests/peatlands to waters in Finland

- Mika Nieminen

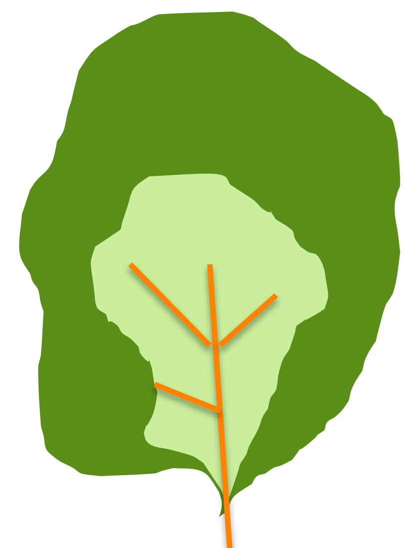
LUONNONVARAKESKUS

- KALLE-calculation tool (Scale: National estimates, River basin district areas of WFD)
- KUSTAA: KALLES extention, land-uses other than forestry



- FEMMA-process model (Scale: Forested catchment, hydrological processes (runoff) + empirical information on concentrations)

  -User-friendly calculation platform: FEMMAapes



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Basics of KALLE

Pros

Cons

Finér, L., Mattsson, T., Joensuu, S., Koivusalo, H., Laurén, A., Makkonen, T., Nieminen, M., Tattari, S., Ahti, E., Kortelainen, P., Koskiaho, J., Leinonen, A., Nevalainen, R., Piirainen, S., Saarelainen, J., Sarkkola S. & Vuollekoski, M. 2010. Metsäisten valuma-alueiden vesistökuormituksen laskenta. Suomen ympäristö 10/2010. 33 s. ISBN 978-952-11-3756-3 ISBN 978-952-11-3755-6 [url]

A method for calculating nitrogen, phosphorus and sediment load from forest catchments

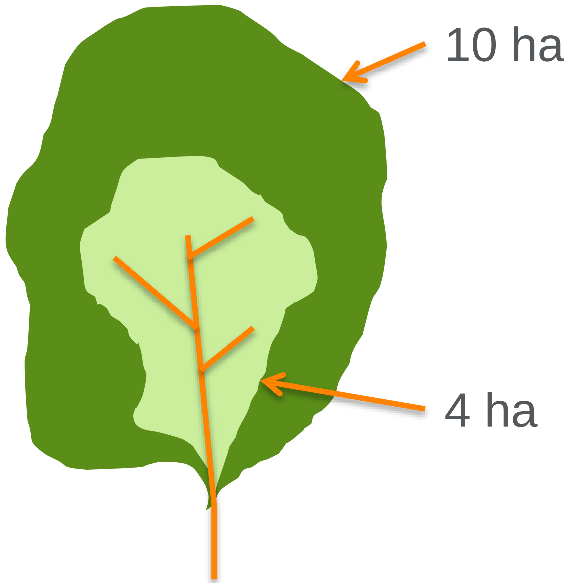
LUONNONVARAKESKUS

Data needs:

-Areas of forestry operations (ha)

-Specific loads for forestry operations (increase in load, kg/ha/a *per treated area*)

-Background loads



Catchment load = 2 kg/ha

Specific load = 10ha/4ha x 2 kg/ha = 5 kg/ha

The effect of forestry on N export for one forestry operation/treatment (clear-felling of mineral soil forests)

Scale=Finland, Year=2006

$$L_{ijk} = \sum_{m=j-9}^{j} k_{in} A_{ikm}$$

$$n = j - m + 1$$

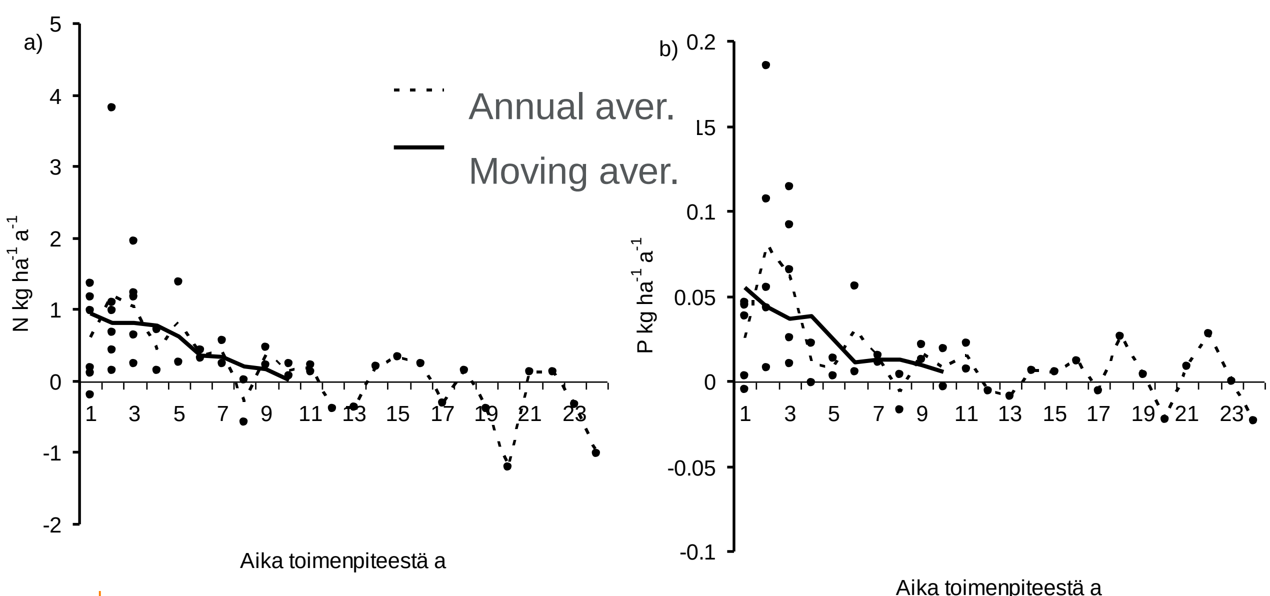
where L_{ijk} is treatment *i* induced load (kg a^{-1}) at year *j* at area *k*, A_{ikm} is the total area (ha)of treatment *i* at area *k* in year *m*, k_{in} is the specific load (kg ha^{-1} a^{-1}) for treatment *i* *n* years after treatment.

Year	Clear-felling (and soil preparation) in mineral soils in Finland, ha
1997	174556
1998	148499
1999	157265
2000	185332
2001	137601
2002	169727
2003	165468
2004	166543
2005	132921
2006	154232
Average	159214

The data for specific load comes from different empirical studies (Control area/calibration period)

Area	Control area	Calibration period (a)	Treatment period (a)	Treatment	Catchment area (ha) / Treatment area, (%) of CA
Kivipuro	Välipuro	4	24	CC + soil prep.	54 / 56
Koivupuro	Välipuro	4	24	CC + soil prep. + ditching	118 / 27
Murtopuro	Liuhapuro	4	24	CC + soil prep. + ditching	494 / 58
Kivennäisvaara	Porkkasalonpuro	3	11	CC + soil prep.	56 / 29
Iso-Kauhea	Porkkasalonpuro	3	11	CC + soil prep.	176 / 11
Lehmikorpi	Pehkusuonoja	4	3	CC + soil prep.	2,8 / 39
Porraskorpi	Pehkusuonoja	4	3	CC + soil prep.	2,1 / 40
Vanneskorpi	Pehkusuonoja	5	2	CC + soil prep.	13,1 / 40
Paroninkorpi	Jylisjärvi	3	3	CC + soil prep.	5,4 / 76

In the calibration period--control area method, similar catchments are monitored during a pre-treatment period. Thereafter, during a post-treatment period, one of the catchments is left as an untreated control while the other catchments are treated. Monitoring (runoff and nutrient export) is continued at all areas. The relationship during the calibration period between the control area and the areas to be treated is then used to predict the behavior of the treated catchment during post-treatment period as if it had not been treated. The treatment effect can then be determined as the difference between the actual measured values and the predicted background values during the post-treatment period.



akeskus

Total load caused by clear-felling (+ soil prep.) mineral soil forests was 800 tons or Mg in 2006 in Finland

Year from treatment	Forest clearfelling	
	Mineral soils	
1	0,95	
2	0,82	
3	0,82	
4	0,77	
5	0,62	
6	0,35	
7	0,33	
8	0,20	
9	0,16	
10	0,007	
Total	5,027	

Year	Clear-felling (and soil preparation) in mineral soils in Finland, ha	Specific load	Load, kg
1997	174556	0.007	12 219
1998	148499	0.16	23 760
1999	157265	0.20	31 453
2000	185332	0.33	61 160
2001	137601	0.35	48 160
2002	169727	0.62	105 231
2003	165468	0.77	127 410
2004	166543	0.82	136 565
2005	132921	0.82	112 983
2006	154232	0.95	146 520
			805 461

Load from all forestry operations vs. background load

Export load calculated similarly for all forestry operations (forest regeneration in mineral soils, forest regeneration in drained peatland forests, fertilization in mineral soil forests, fertilization in drained peatland forests, ditch network maintenance in drained peatland forests

Total load caused by forestry as a sum of the loads of different operations

Background load=Load without the impact of forestry

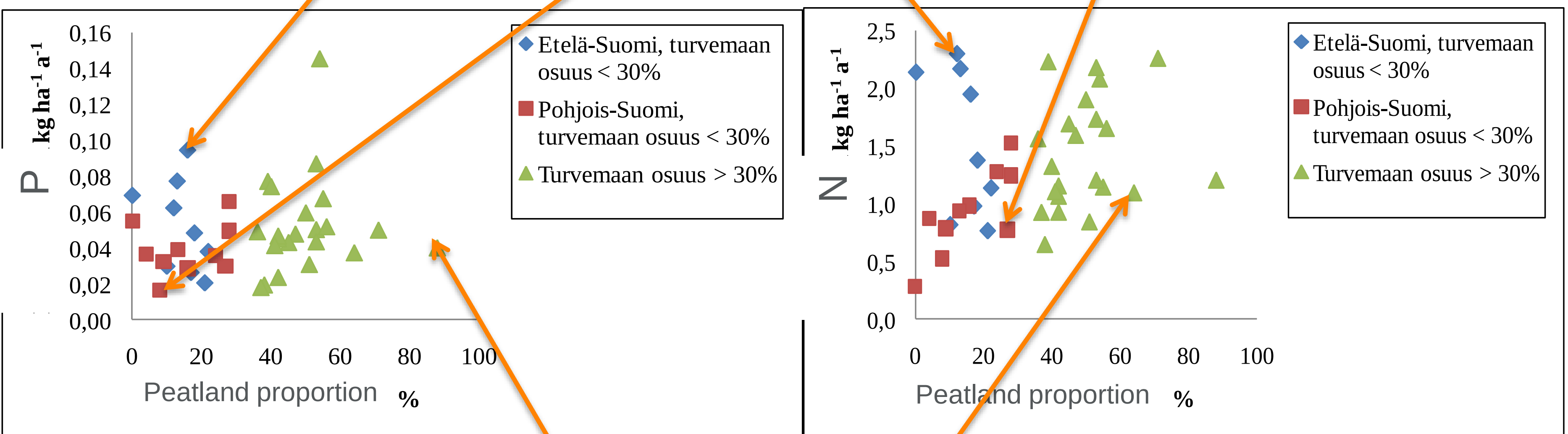
$$B_{jk} = b_k M_k$$

where B_{jk} is background load (kg a^{-1}) in year *j* at area *k*, b_k is average annual background load (kg ha^{-1} a^{-1}) at area *k, and* M_k is the area of forestry land at area k (ha).

Background loads

Southern Finland, peatlands<30%

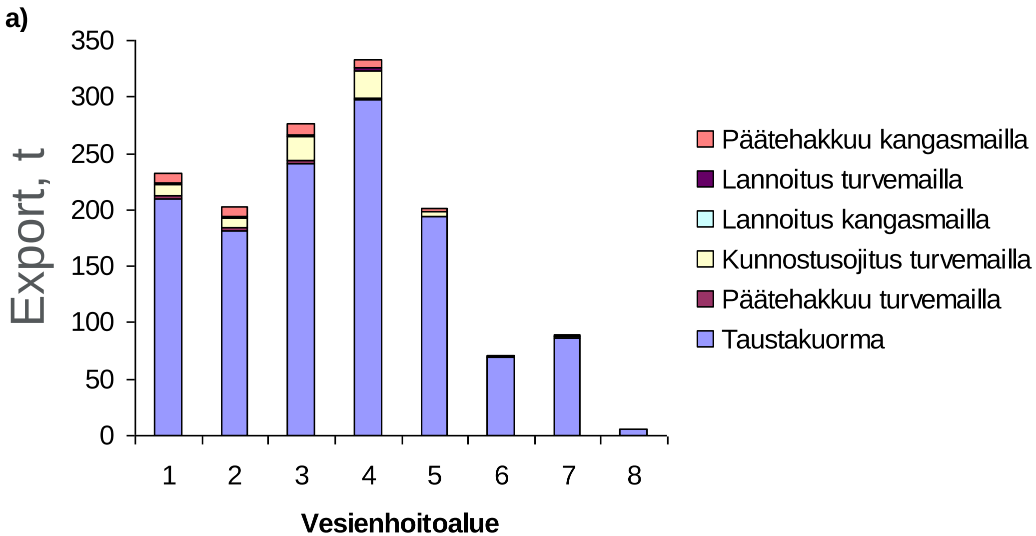
Northern Finland, peatlands <30%



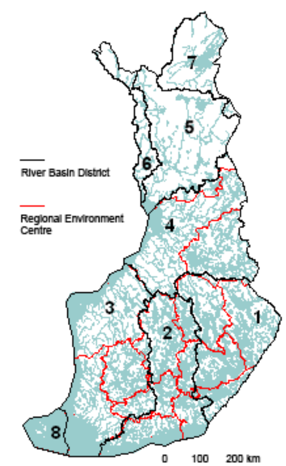
Peatlands>30%

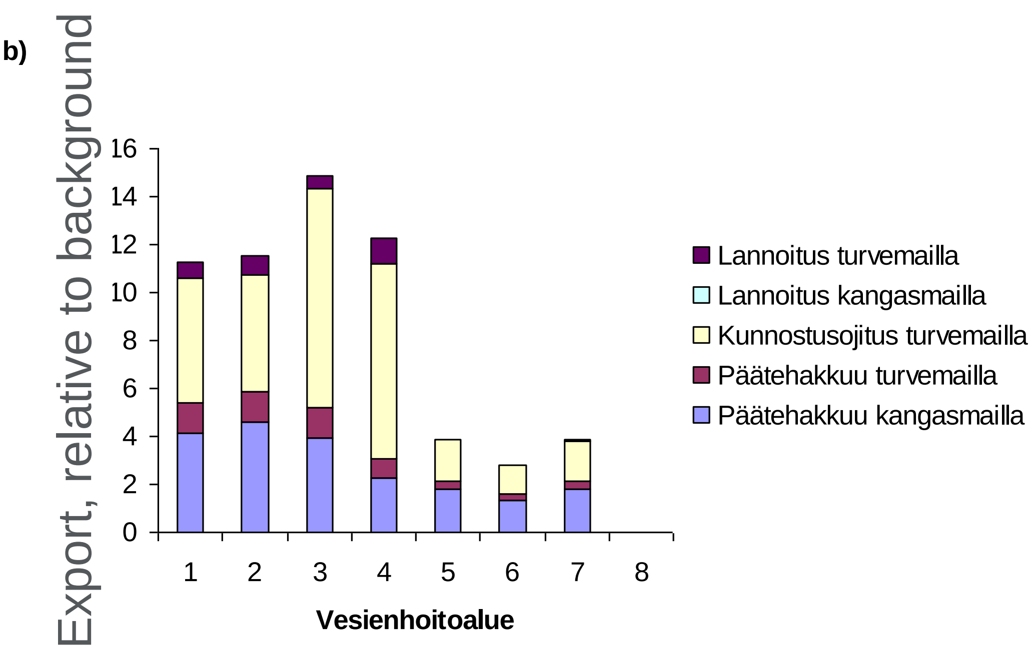
	N, kg/ha/a	P, kg/ha/a
Southern Finland, peatlands < 30%	**1,52**	**0,052**
Northern Finland, peatlands < 30%	0,93	0,039
Peatlands > 30%	1,44	0,053

P exports to waters in different RBD areas in Finland in 2006



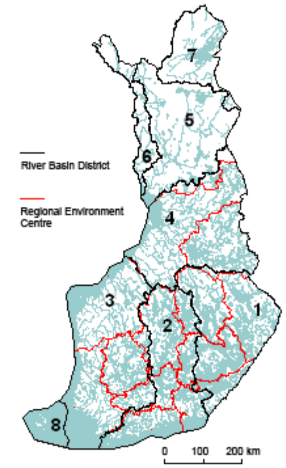
Forest regeneration, mineral soils
Fertilization, peat soils
Fertilization, mineral soils
Ditch network maintenance, peat soils
Forest regeneration, peat soils
Backgroung



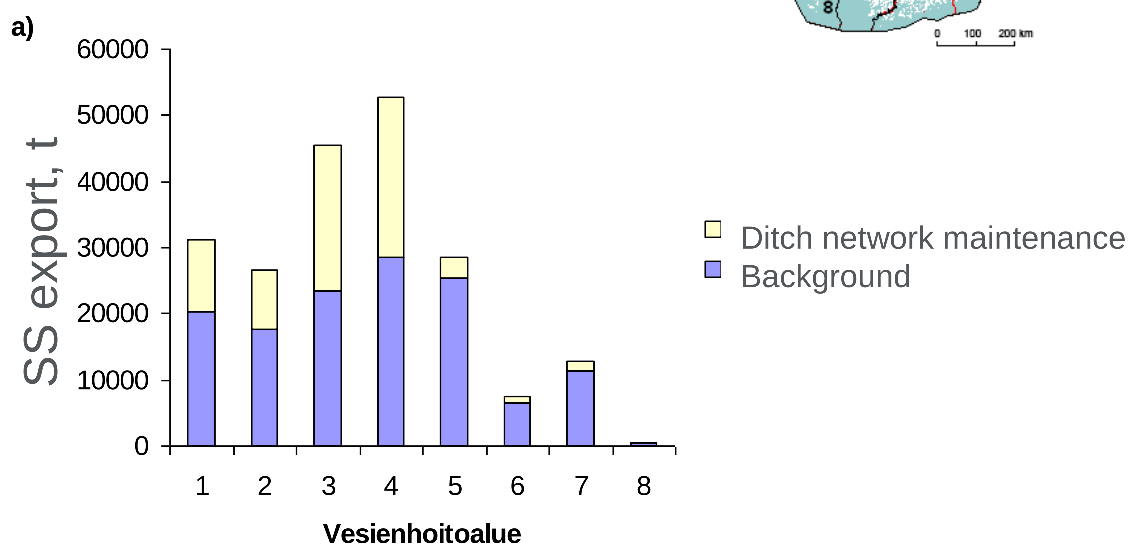


Fertilization, peat soils
Fertilization, mineral soils
Ditch network maintenance, peat soils
Forest regeneration, peat soils
Forest regeneration, mineral soils

Specific suspended solid (SS) loading caused by ditch network maintenance (kg ha^{-1} a^{-1}). A 30% reduction in loads due to sedimentation ponds.



Years since treatment	Ditch network maintenance
1	420
2	140
3	112
4	84
5	70
6	56
7	42
8	28
9	14
10	7
Total	973



DNM 50-70 000 ha/a

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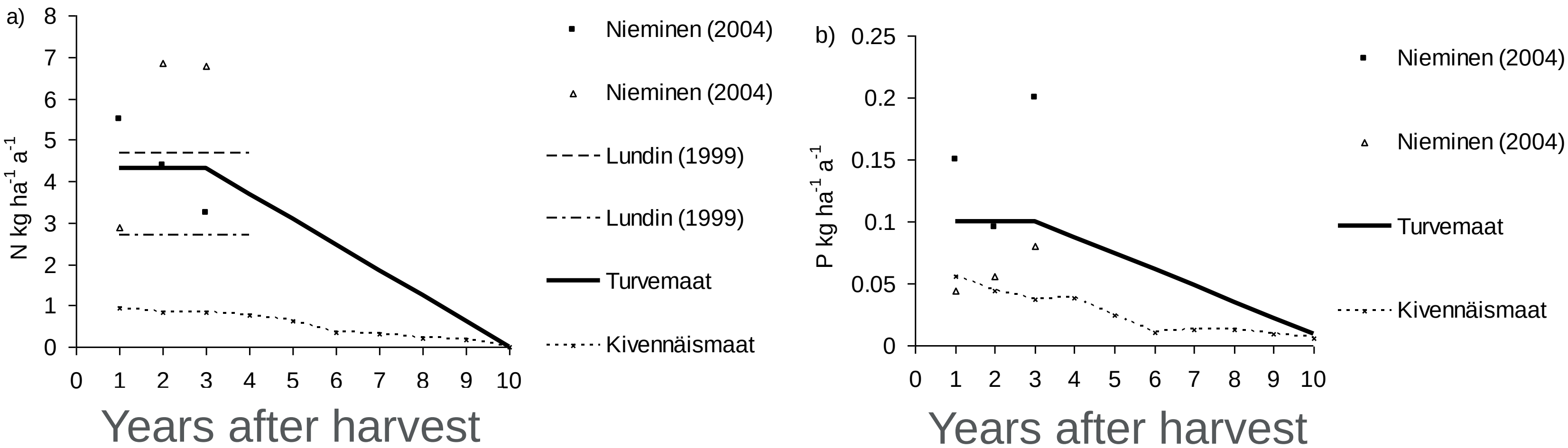
Shortcomings

Year-to-year changes in weather conditions (runoff) not considered

No data for reliable estimation of specific loads

Specific loads of harvesting on drained peatlands



Specific loads for fertilization in mineral soils come from one study, only.
Specific P loads of DNM: No increase in dissolved P due to DNM, suspended solids contain 0.1% of P

Years since treatment	Ditch network maintenance, SS kg//ha	Ditch network maintenance, P kg/ha/a
1	420	0.42
2	140	0.14
3	112	0.112
4	84	0.084
5	70	0.070
6	56	0.056
7	42	0.042
8	28	0.028
9	14	0.014
10	7	0.007
Total	973	0.973

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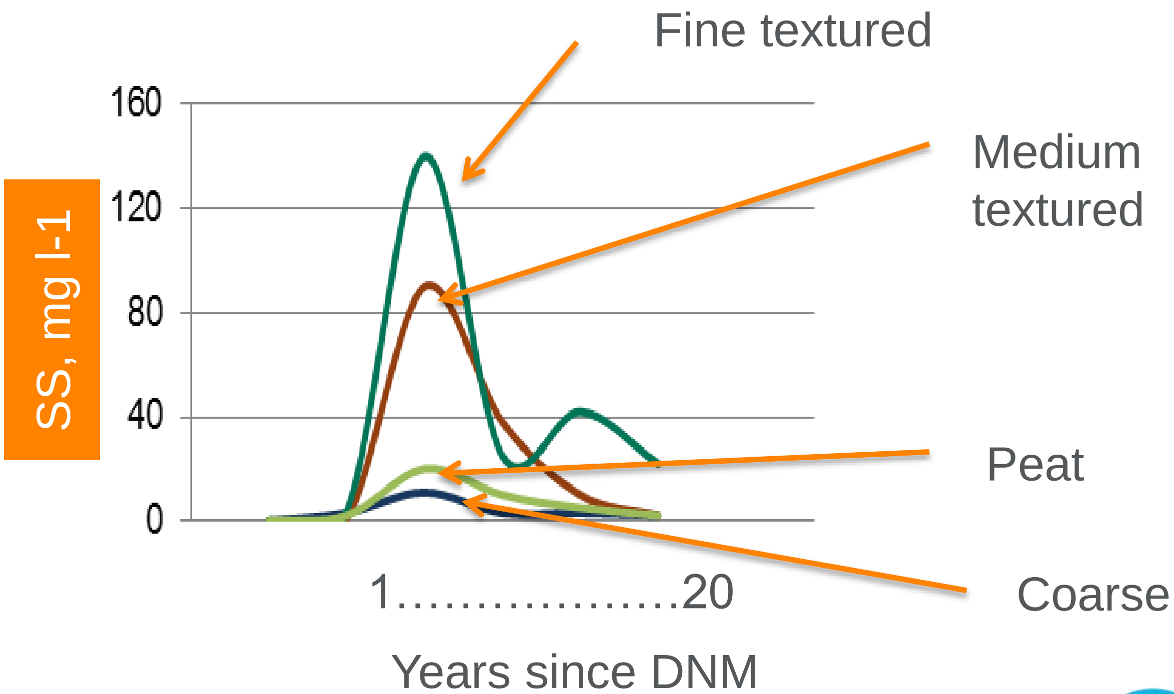
Years since treatment	Ditch network maintenance
1	420
2	140
3	112
4	84
5	70
6	56
7	42
8	28
9	14
10	7
Total	973



Loads return to background levels in 10 years, DNM in fine textured bottom soils?

Development of KALLE

More (and long-term) empirical data for DNM (particulate P and N), harvesting of peat soils, fertilization of mineral soil forests

More detailed statistics of forestry operations (Areas, ha):

Current statistics do not include:

Fertilization separately for min. and peat soils
Harvesting separately for min. and peat soils
Harvesting separately for drained Norway spruce and Scots pine forests
DNM for different types of bottom soils

Finnish Statistical Yearbook of Forestry

KUSTAA extends KALLE to all land-uses

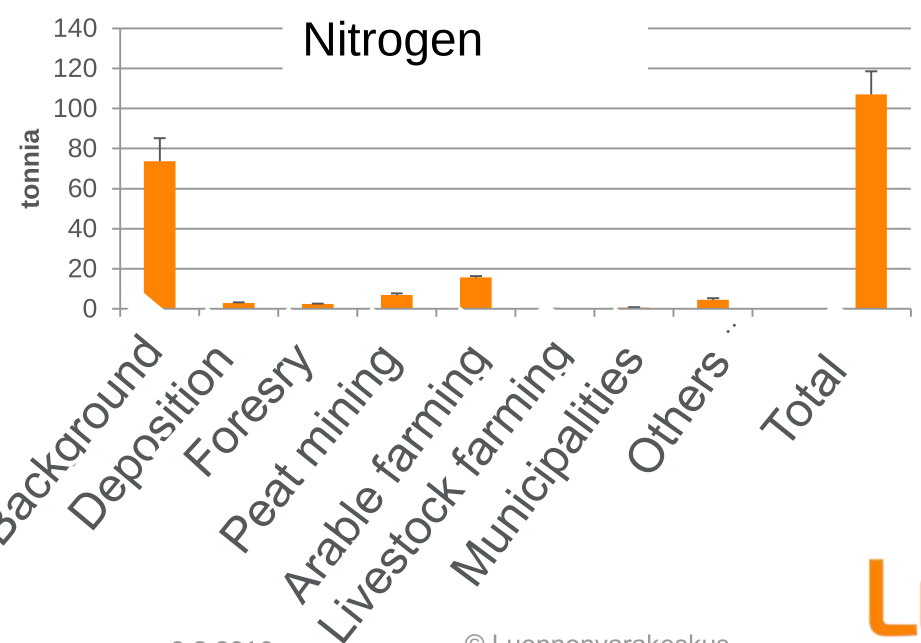
Calculation based on specific loads and areas of land uses, as in KALLE

Specific loads of land uses other than forestry differ in that they do not change with time

Specific N loads for agricultural land (n=21), kg/ha/a

Autumn plowing	15,95
Syyskyntö, turvemaa, lannoitettu	38,00
Nurmi, pysyvä	9,02
Nurmi, turvemaa	18,50
Canary reed	7,20
Potato	17,00
	9,50
Suorakylvö, syksy	9,90
Suorakylvö, kevät	9,90
Kultivointi	11,51
Sänkimuokkaus	9,90
Pasture	9,02
	46,30
Green fallow	7,20
Avokesanto	17,90
Karjanlannan levitys syksyllä	20,70
Kotieläimet	
Poultry	0,90
Nauta	121,00
Lihakarja	49,30
Pigs	23,30
Porotarha	0,38

A 6000 ha catchment area in south-west of Finland



Quantifying exports from forested catchments

Modelling hydrology (runoff) using FEMMA
Calculating exports as a product of simulated runoff and (empirical) **specific concentration data, mg/l/treated area**

FEMMA is a forest hydrological model that separates the processes of overstorey and understorey interception and transpiration, snow accumulation and melt, soil- and ground water interactions, and streamflow. FEMMA uses daily time series of air temperature, precipitation, relative humidity, wind speed, and downward short and long-wave radiation as an input. FEMMA has been applied in investigating how clear-cutting affects water and nitrogen fluxes in hillslopes comprising mineral up-slope and peat down-slope areas

Koivusalo, H., Ahti, E., Laurén, A., Kokkonen, T., Karvonen, T., Nevalainen, R. & Finér, L. 2008. Impacts of ditch cleaning on hydrological processes in a drained peatland forest. Hydrology and Earth System Sciences 12(5): 1211-1227.

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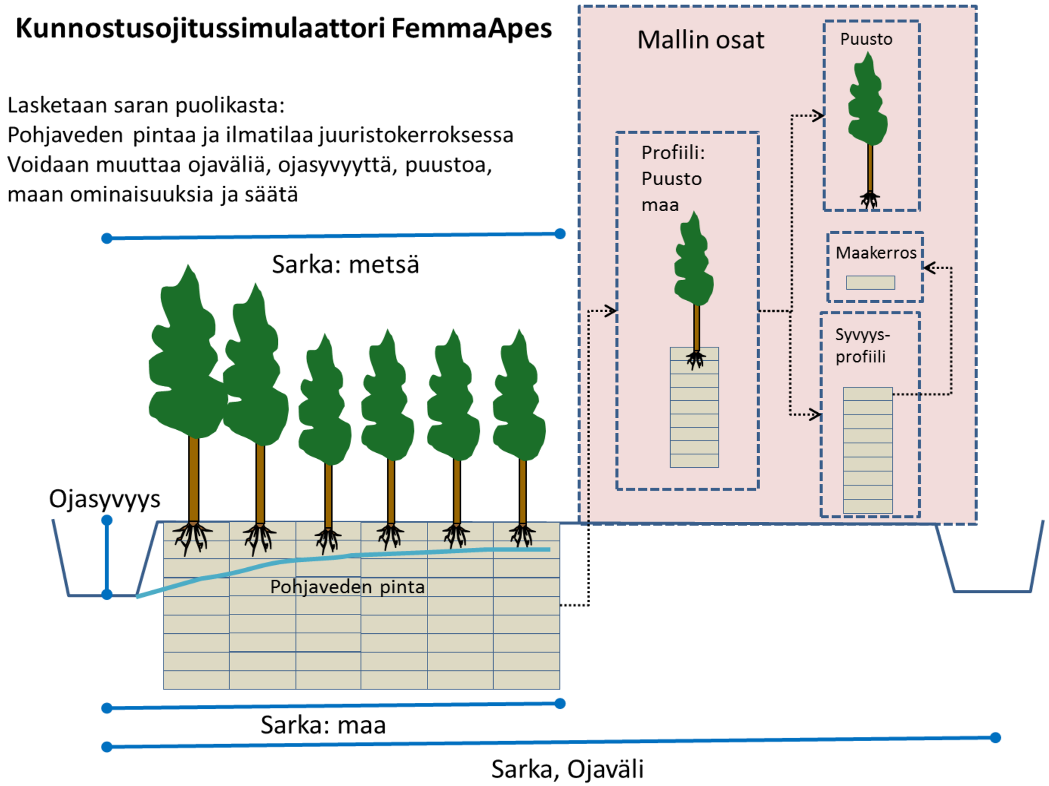
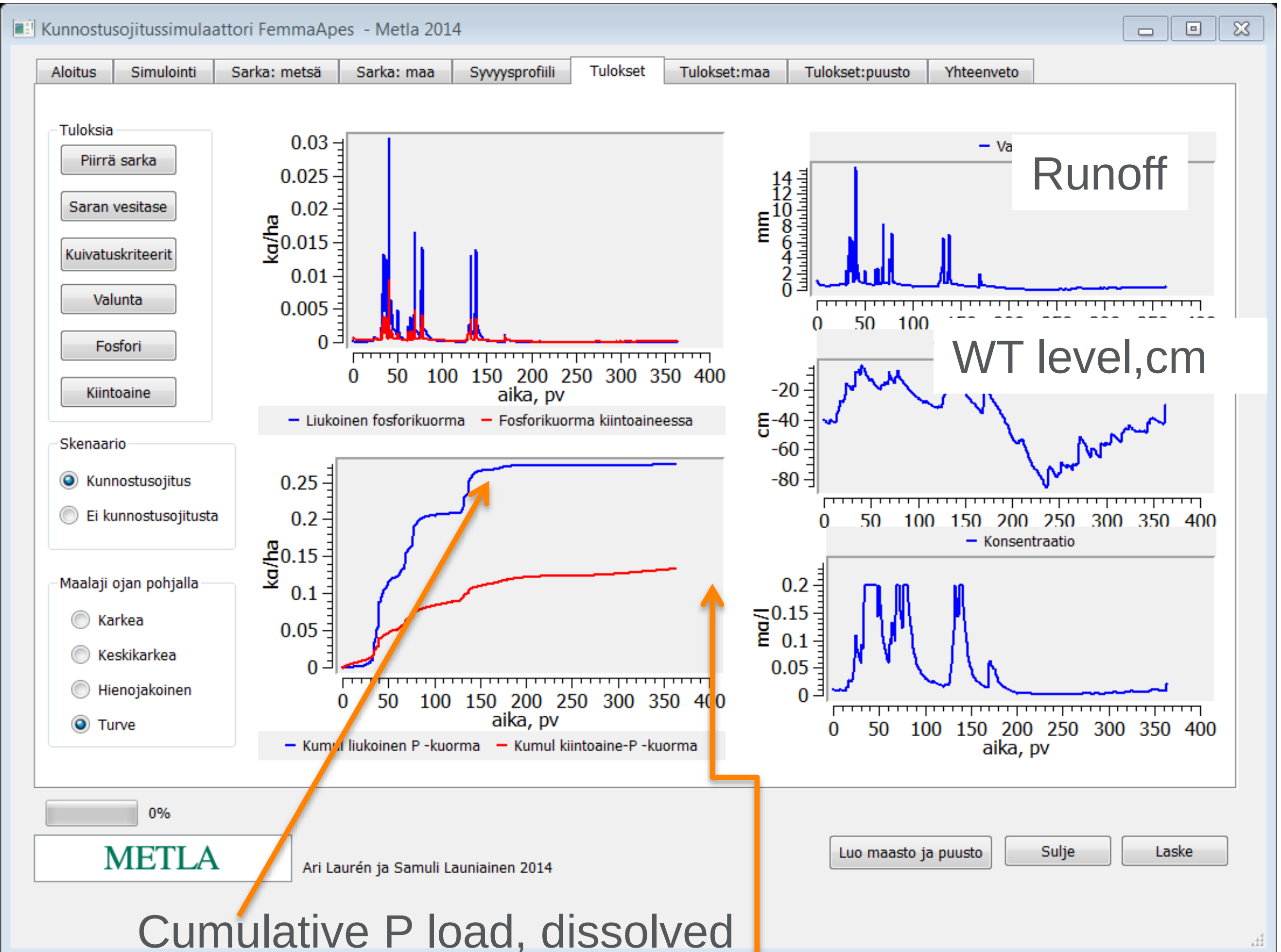
FEMMAapes a user-friendly calculation platform for the effects of DNM and harvesting on drained peatlands



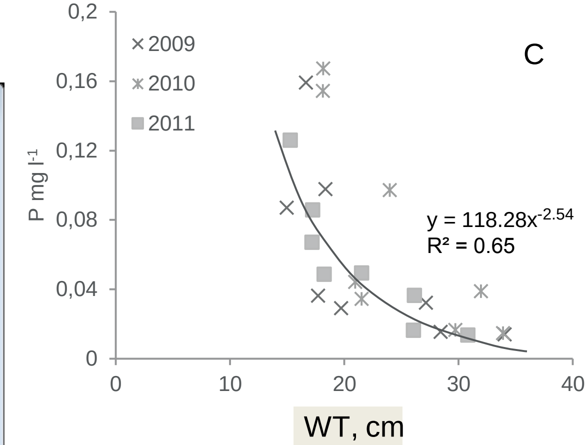
One can change
- ditch spacing
- ditch depth
} DNM
- tree stand characteristics
} Harvest
- weather data
- soil properties (hydraulic conductivity)

Harvesting and DNM (fine-textured soil)

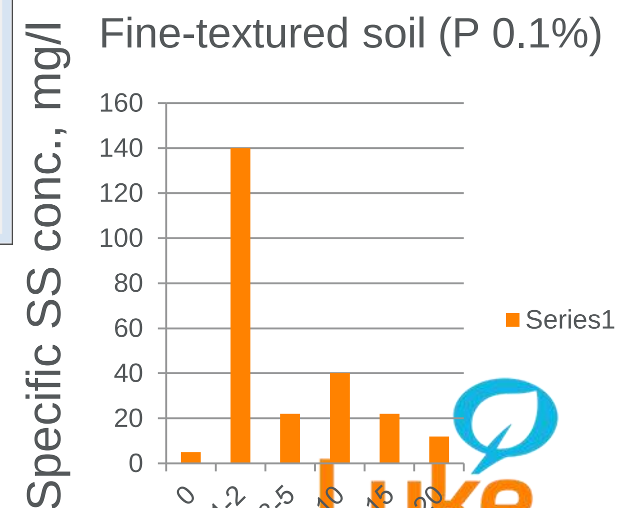


Cumulative P load, dissolved

Cumulative P load, particulate



Kaila, A., Sarkkola, S., Laurén, A., Ukonmaanaho, L., Koivusalo, H., Xiao, L., O´Driscoll, C., Asam, Z., Tervahauta, A. & **Nieminen, M.** 2014. Phosphorus export from drained Scots pine mires after clear-felling and bioenergy harvesting. Forest Ecology and Management 325: 99-107.



Joensuu, Ahti, E. & Vuollekoski, M. 1999. The effects of peatland forest ditch maintenance on suspended solids in runoff. Boreal Environment Research 4: 343-355.

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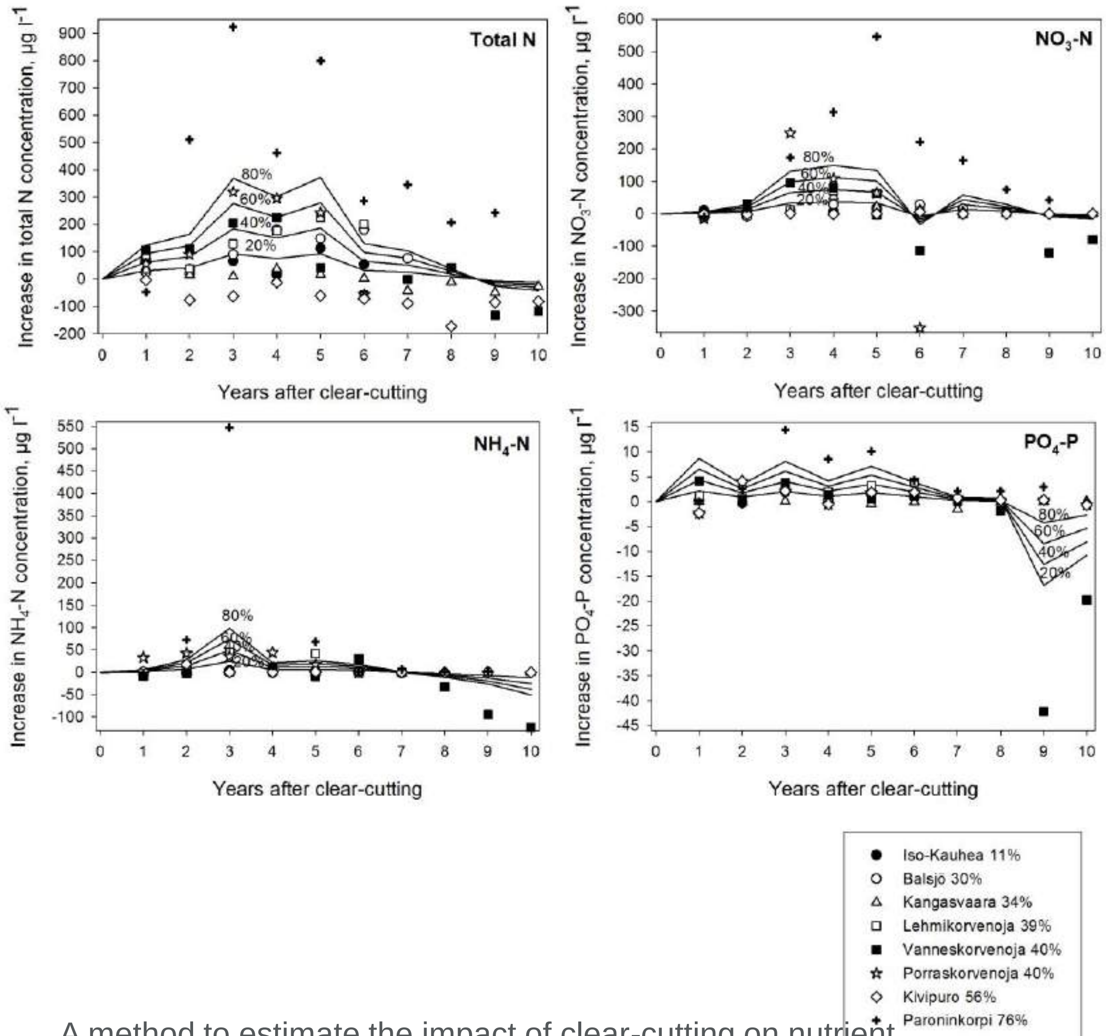


With the mathematic model presented in Palviainen et al. (2015), one can calculate specific concentrations for any chosen harvest area proportion

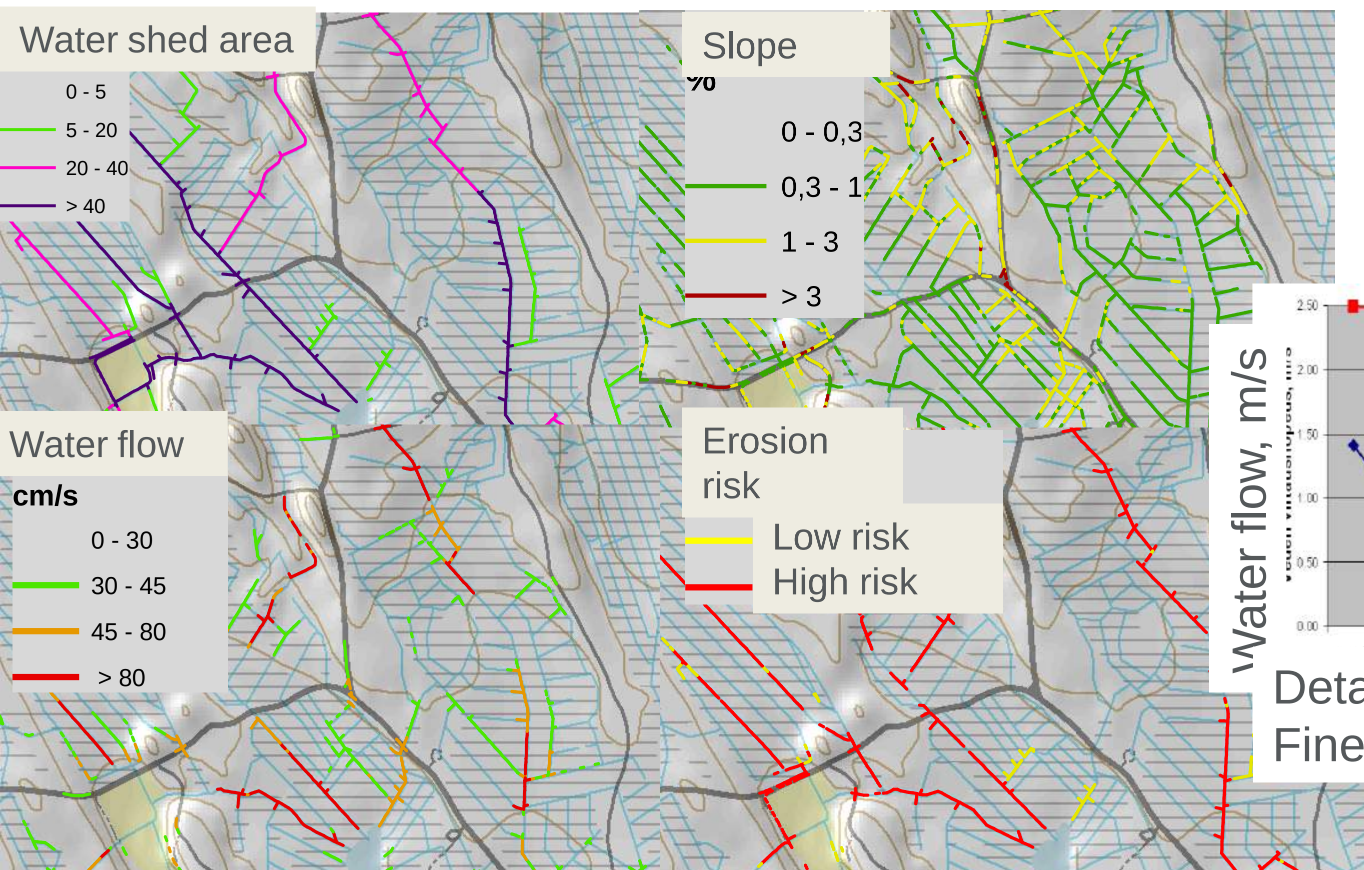
A method to estimate the impact of clear-cutting on nutrient concentrations in boreal headwater streams
Marjo Palviainen, Leena Finér, Ari Laurén, Tuija Mattsson, Lars Högbom

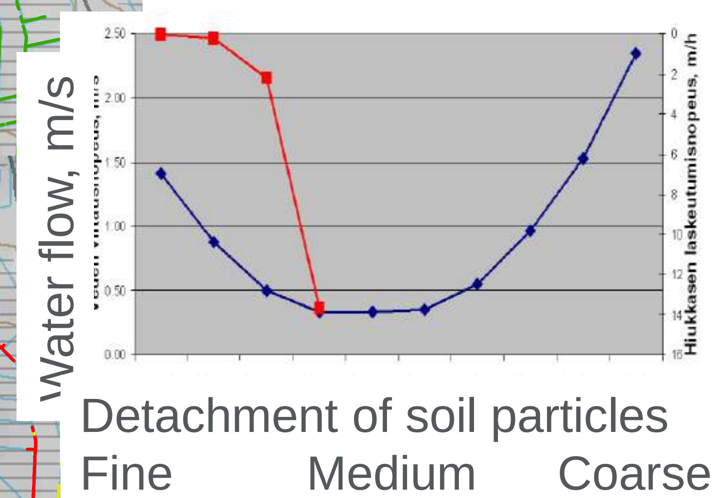
AMBIO 2015
DOI 10.1007/s13280-015-0635-y

Erosion is the most harmful impact of forestry in Finland, avoid easily erodable channels in DNM

Practical tools to decrease erosion based on a RLGIS-tool

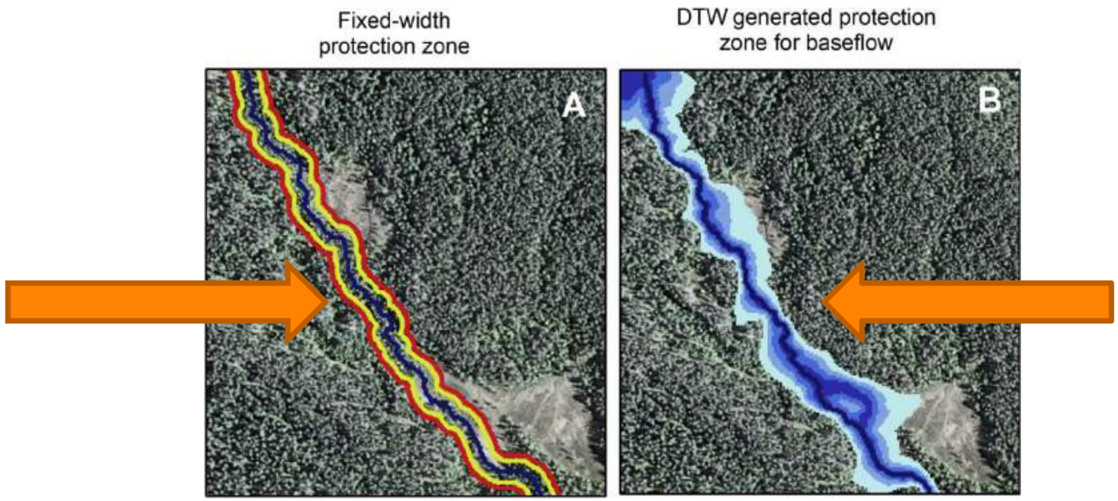
Erosion risk is influenced by soil type, and water flow velocity, which, in turn, is influenced by the area of water shed and channel slope





Use of a moisture index (DTW) to determine the width of buffer zone and GWT hotspots

Fixed-width



DWT generated buffer zone

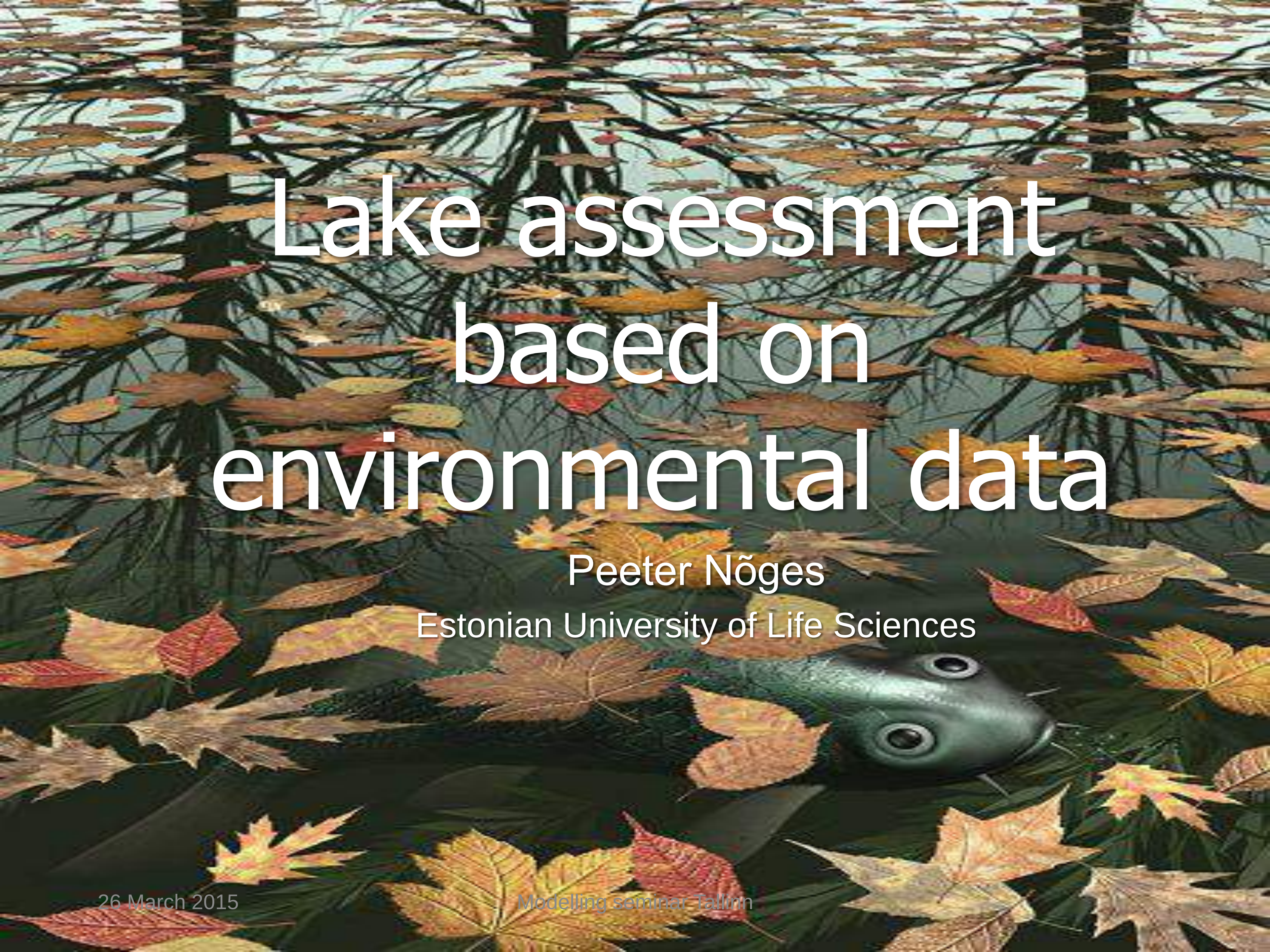
GWT hot spots: Soil carrying capacity against heavy harvesting machinery poor

LUONNONVARAKESKUS

Kiitos!

Thanks!

Luke
LUONNONVARAKESKUS

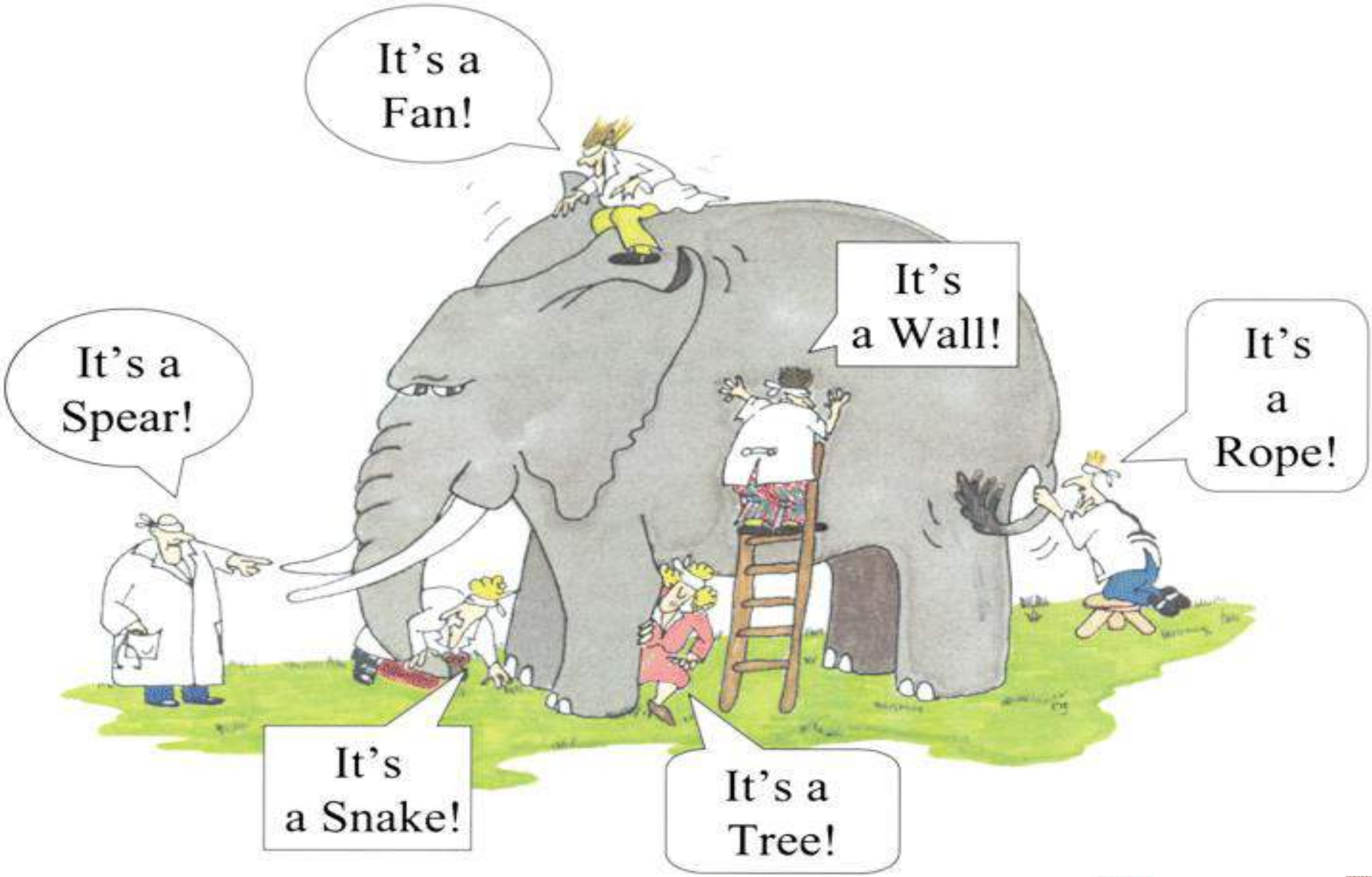


Lake assessment based on environmental data

Peeter Nõges
Estonian University of Life Sciences


Peipsi
Võrtsjärv
1979 - 2003
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
© 2005 Google

Describing the elephant

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Aletschhorn
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BERNINA
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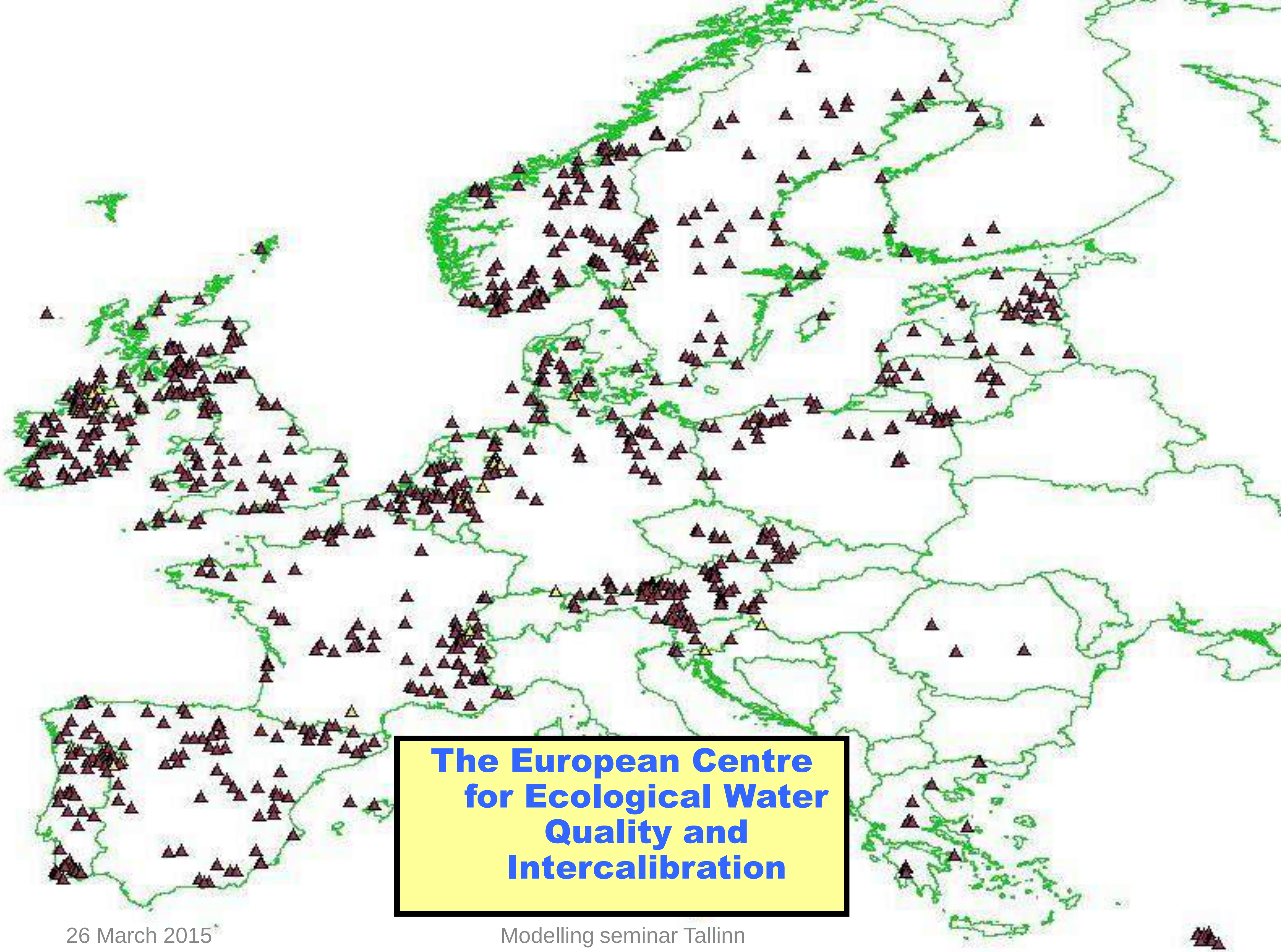
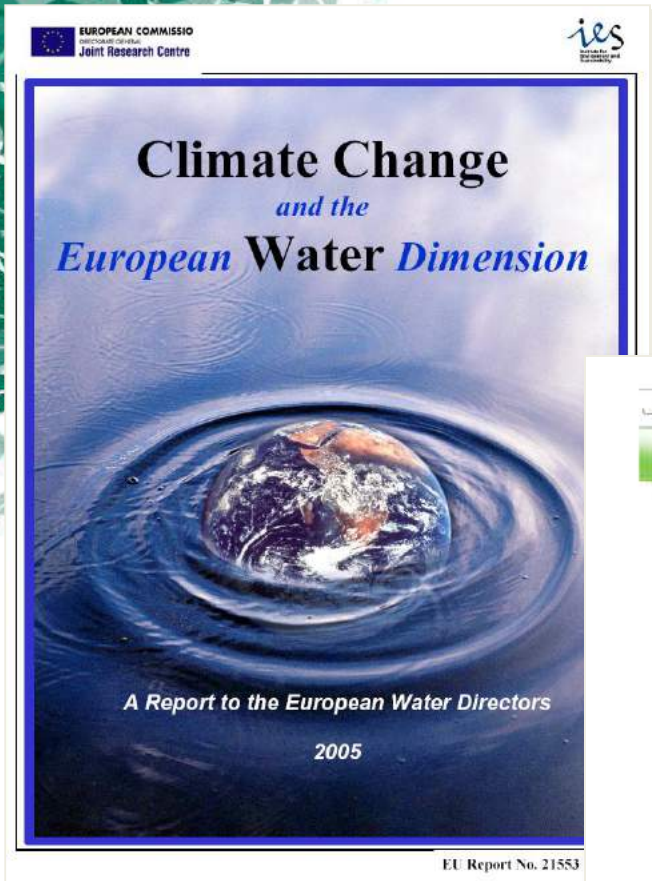
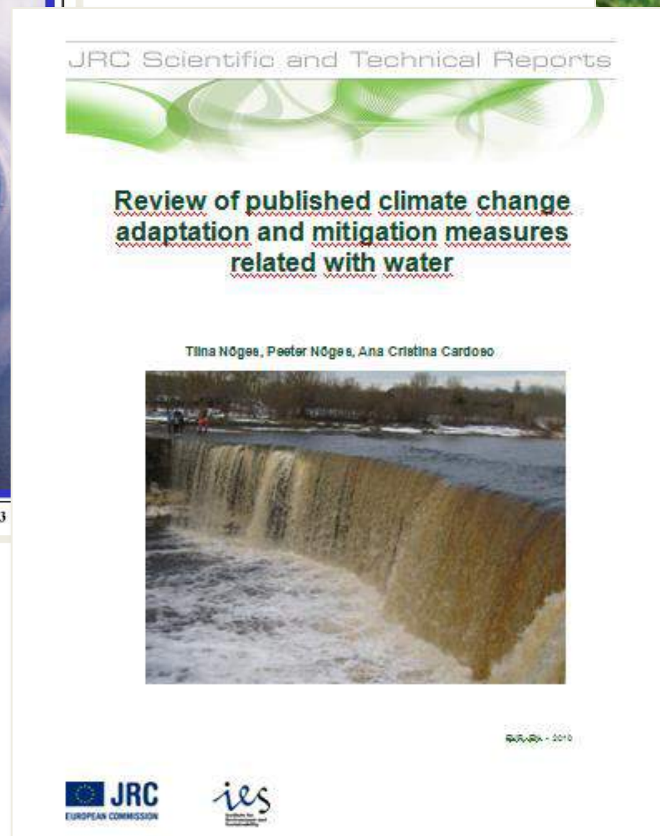
Monte Disgrazia
Adda
ALPES PENNINE
Dom
Weissmies
VAL D'OSSOLA
Pizzo Rotondo
VALTELLINA
Adamello
Pizzo di Coca
VAL SUGANA
VALLI GIUDICARIE
Lago di Lugano
ALPI OROBIE
Sarca
Monte Rosa
VAL CAMONICA
Lago d' Orta
Lago d' Idro
Adige
Sesia
Lago d' Iseo
Dora Baltea
Lago di Garda
Ticino
Lambro
PIANURA LOMBARDA
Mincio
Po
Secchia
Oglio
Taro
VALLE DEL PO



The European Centre for Ecological Water Quality and Intercalibration


EUROPEAN COMMISSIO
Joint Research Centre
Climate Change
and the
European Water Dimension
A Report to the European Water Directors
2005
EU Report No. 21553


JRC Scientific and Technical Reports
Review of published climate change adaptation and mitigation measures related with water
Tiina Nõges, Peeter Nõges, Ana Cristina Cardoso
JRC
EUROPEAN COMMISSION

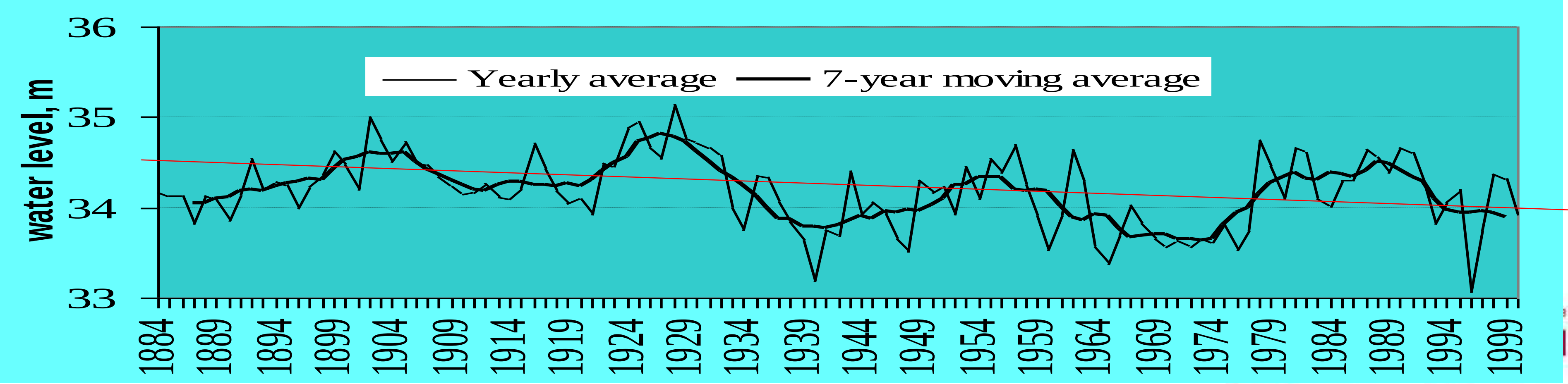

EEA Report | No 4/2008
JRC Reference Report | No JRC47756
Impacts of Europe's changing climate
— 2008 indicator-based assessment
Joint EEA-JRC-WHO report
JRC
EUROPEAN COMMISSION
European Environment Agency

Outline

- Data variability and status assessment
- Uncertainty of environmental data
- Spatial *vs*. year-to-year variability
- Detecting climate change effects

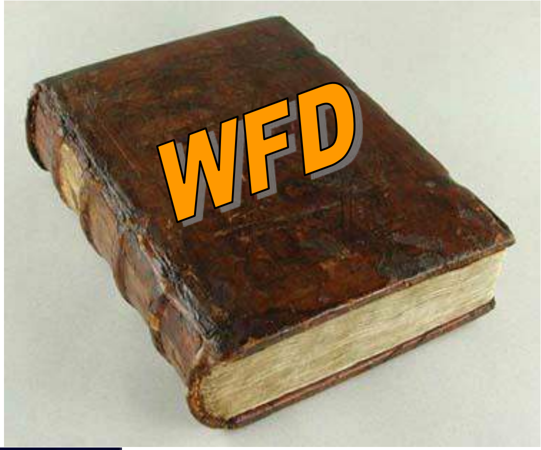
Types of variability

- Regular changes
  - Diurnal changes
  - Seasonal changes
  - Longer periodic changes (NAO)
- Long-term trends, natural or anthropogenic
- Random changes due to meteorology or single events
- System shifts
- Sampling & measurement errors



Challenges

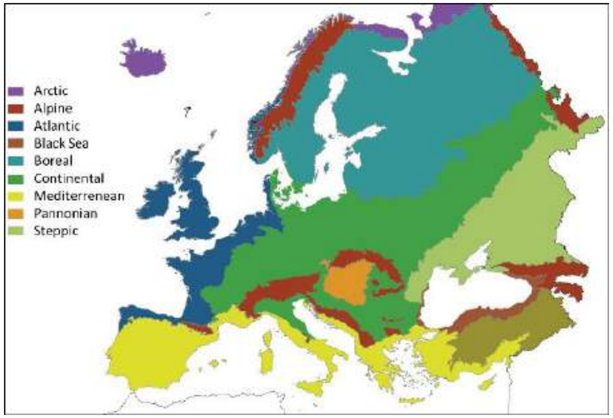
- WFD – Detecting human impact on the background of high natural variability

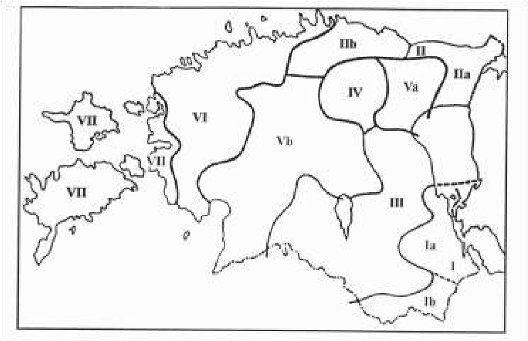


- IPCC – Detecting climate change signal on the background of changing human impact

Managing variability in WFD ecological status assessment

- Regionalization & creating typologies



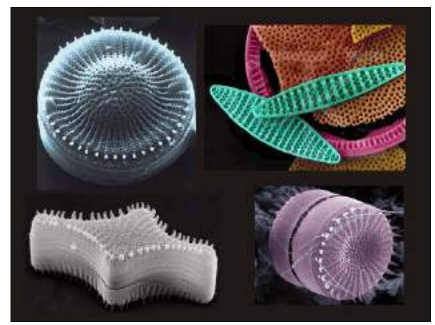


Mäemets, 1976

I Kagu-Eesti vähe- ja huumustoitelised (düstroofsed)
II Kirde-Eesti vähe- ja huumustoitelised
III Kõrg-Eesti rohketoitelised
IV Pandivere kõrgustiku lubjatoitelised
Vb Vahe-Eesti huumustoitelised
VI Madal-Eesti segatoitelised
VII Lääne-Eesti soolatoitelised

Managing variability in WFD ecological status assessment

- Defining type-specific reference conditions
  - Describe the pristine status
  - Include the whole range of natural variability
  - Based on
    - Reference sites
    - Paleo-reconstruction
    - Historical data
    - Modelling
    - Expert opinion

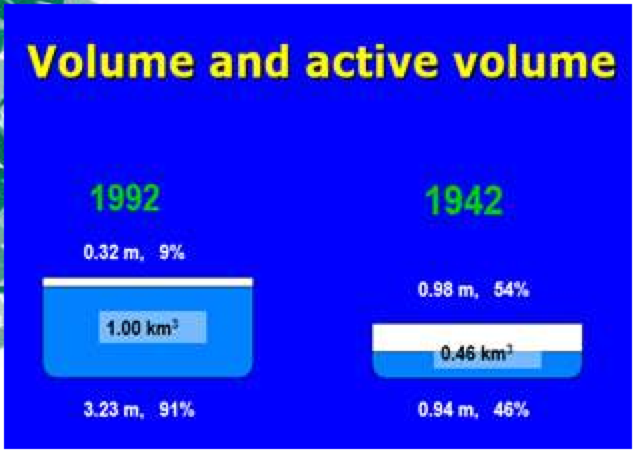


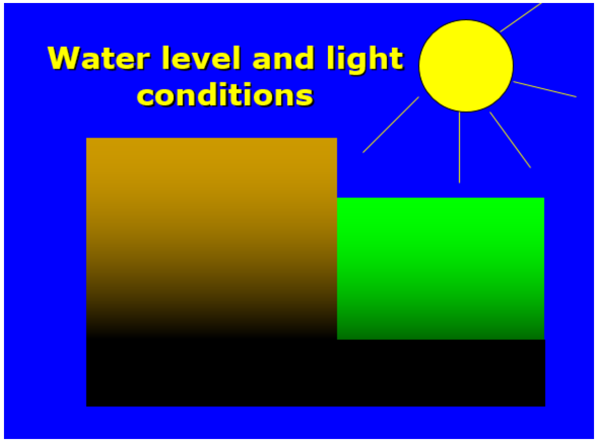

Der See Wirzjerw
in Livland.

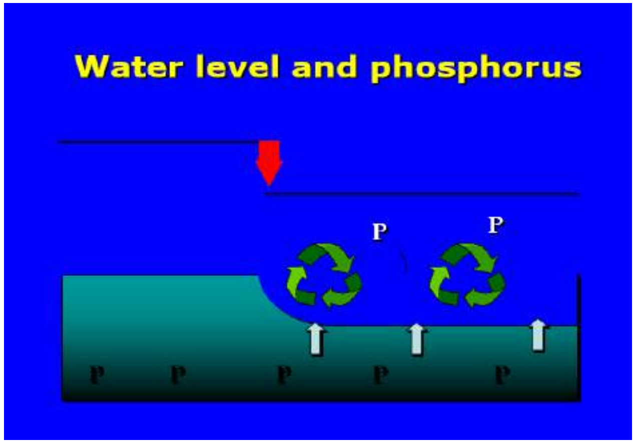
Biologie und Fischerei
von
Max von zur Mühlen und Guido Schneider.

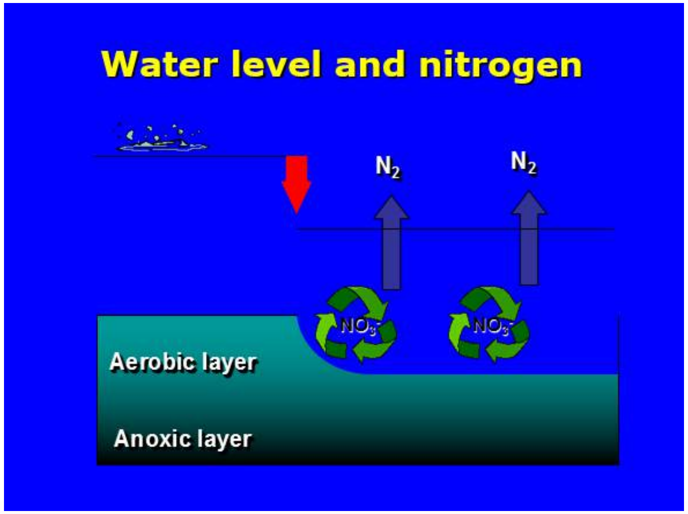
Natural >> anthropogenic

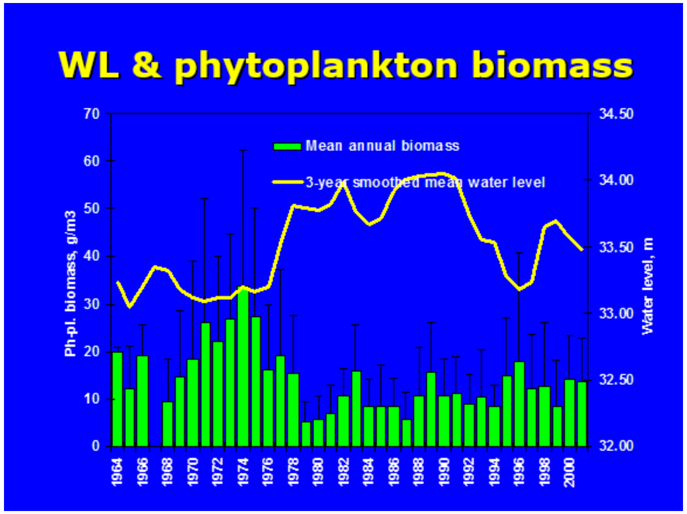
Effects of changing water level



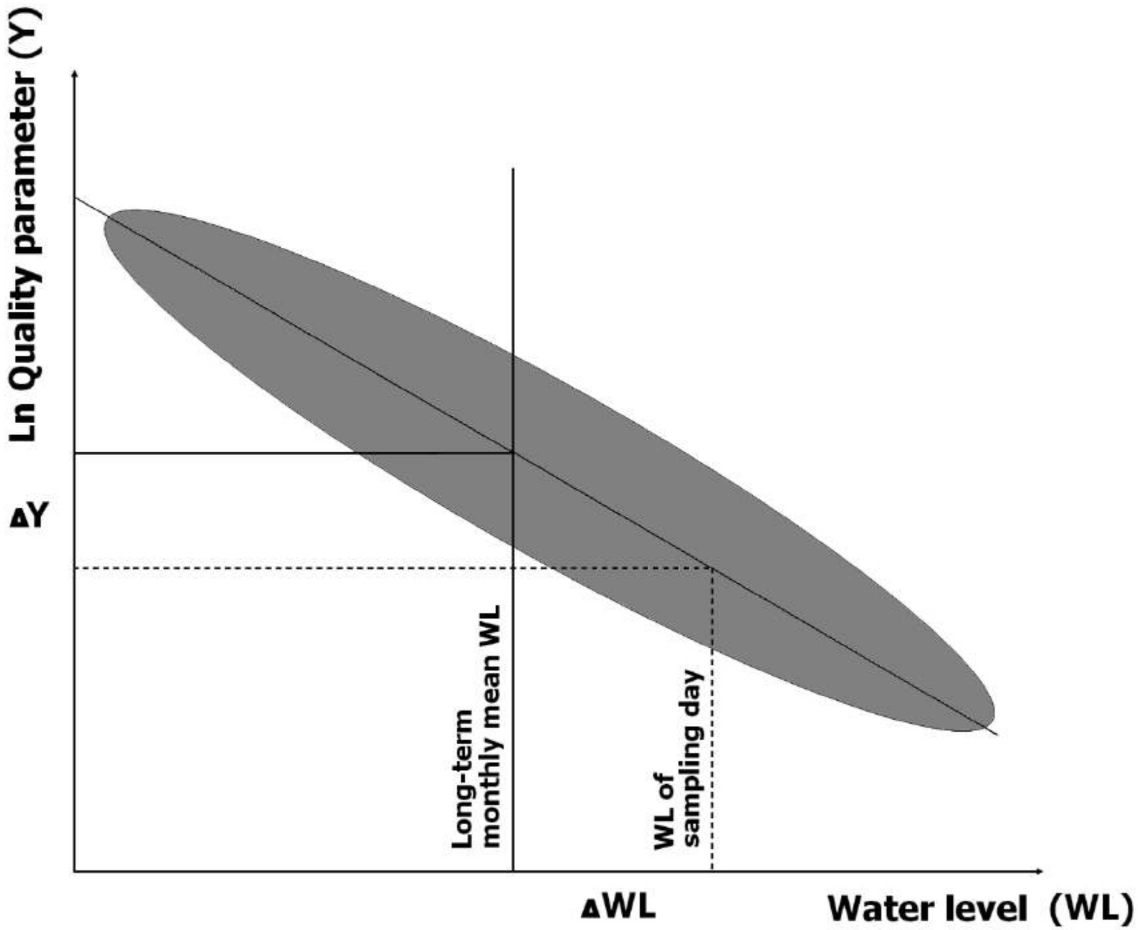




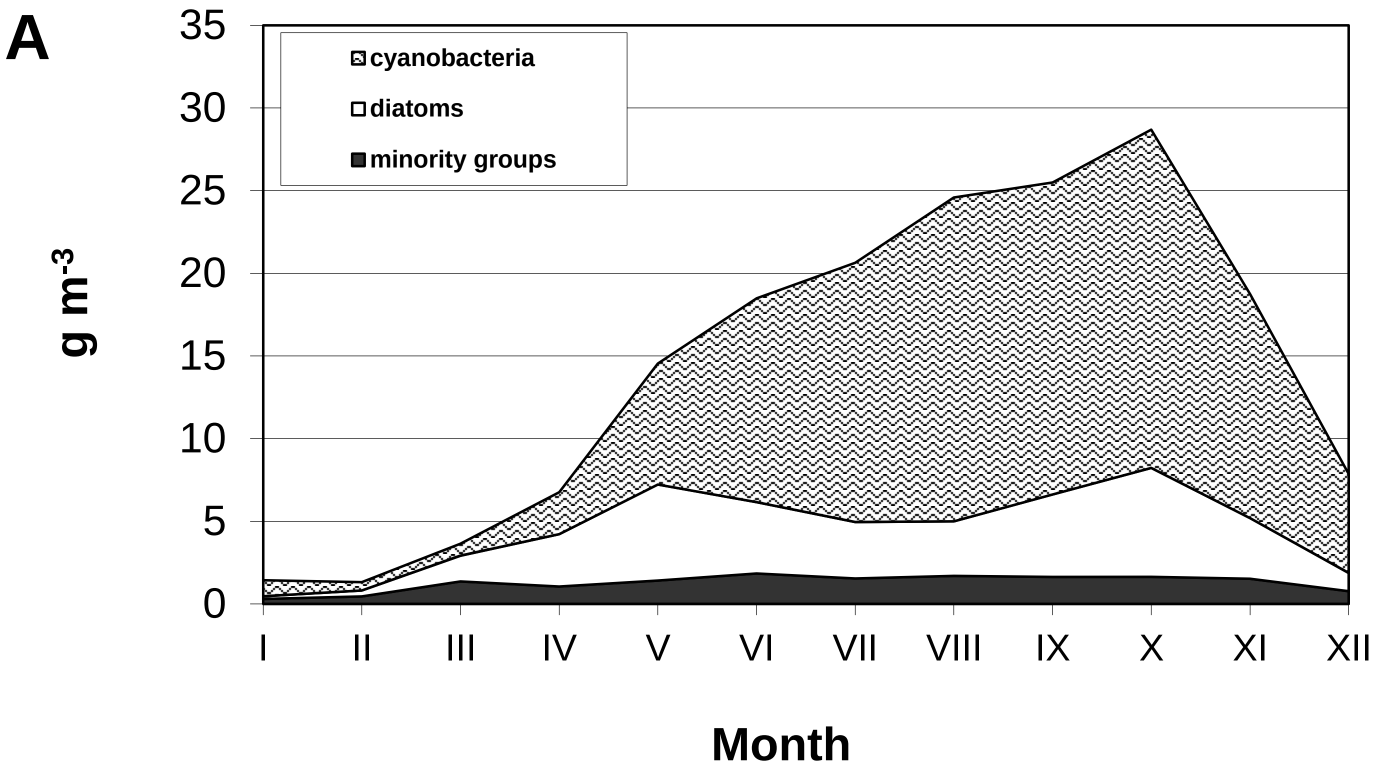




Standardizing for dominant factor



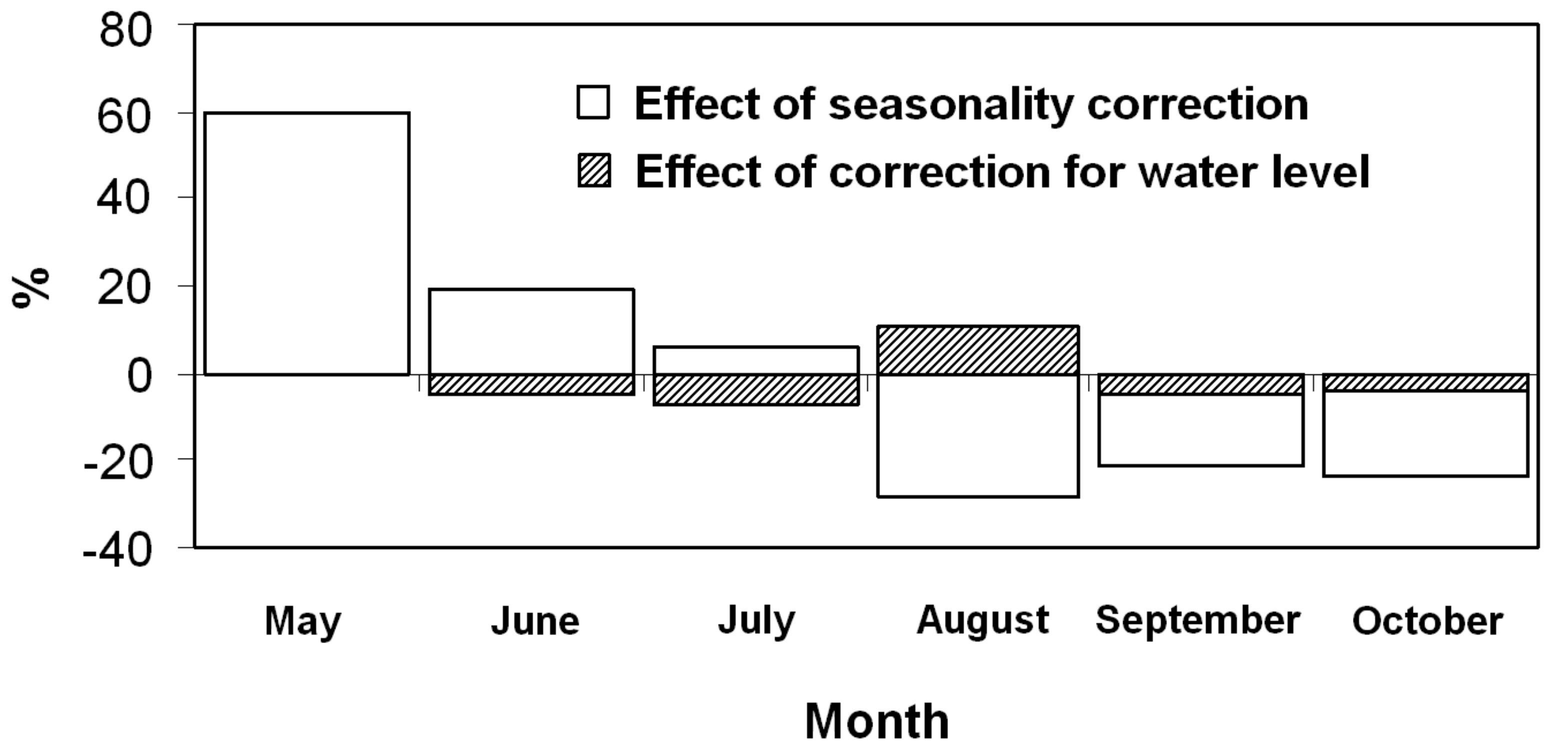
Seasonality



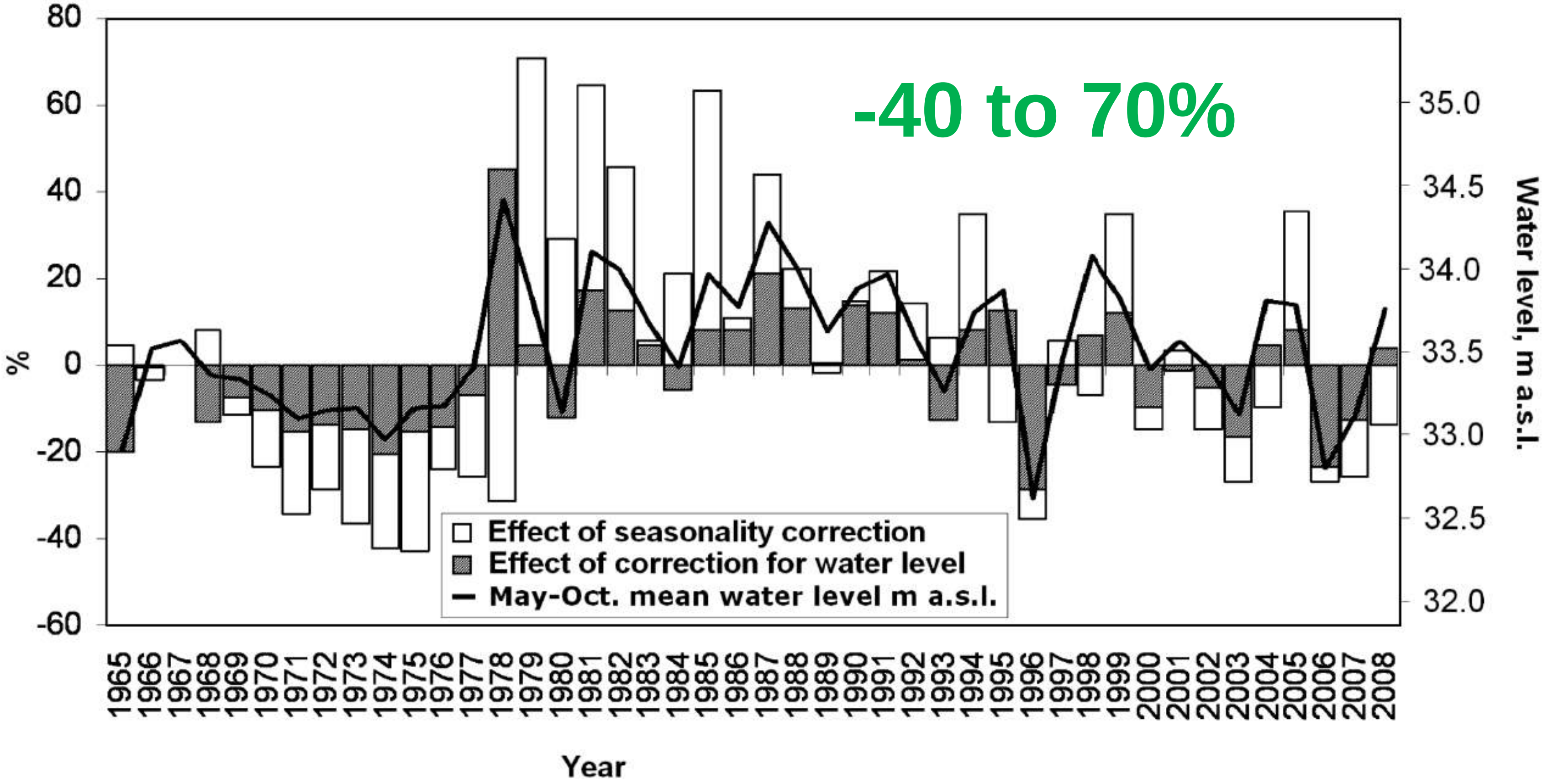
Removing seasonality

- Autoregressive moving average (Box & Jenkins, 1980)
- Seasonal decomposition (Cleveland & Tiao, 1976)
- Seasonal smoothing (Gardner, 1985)
- Regressions to derive seasonal average from single monthly values – works well with data gaps.

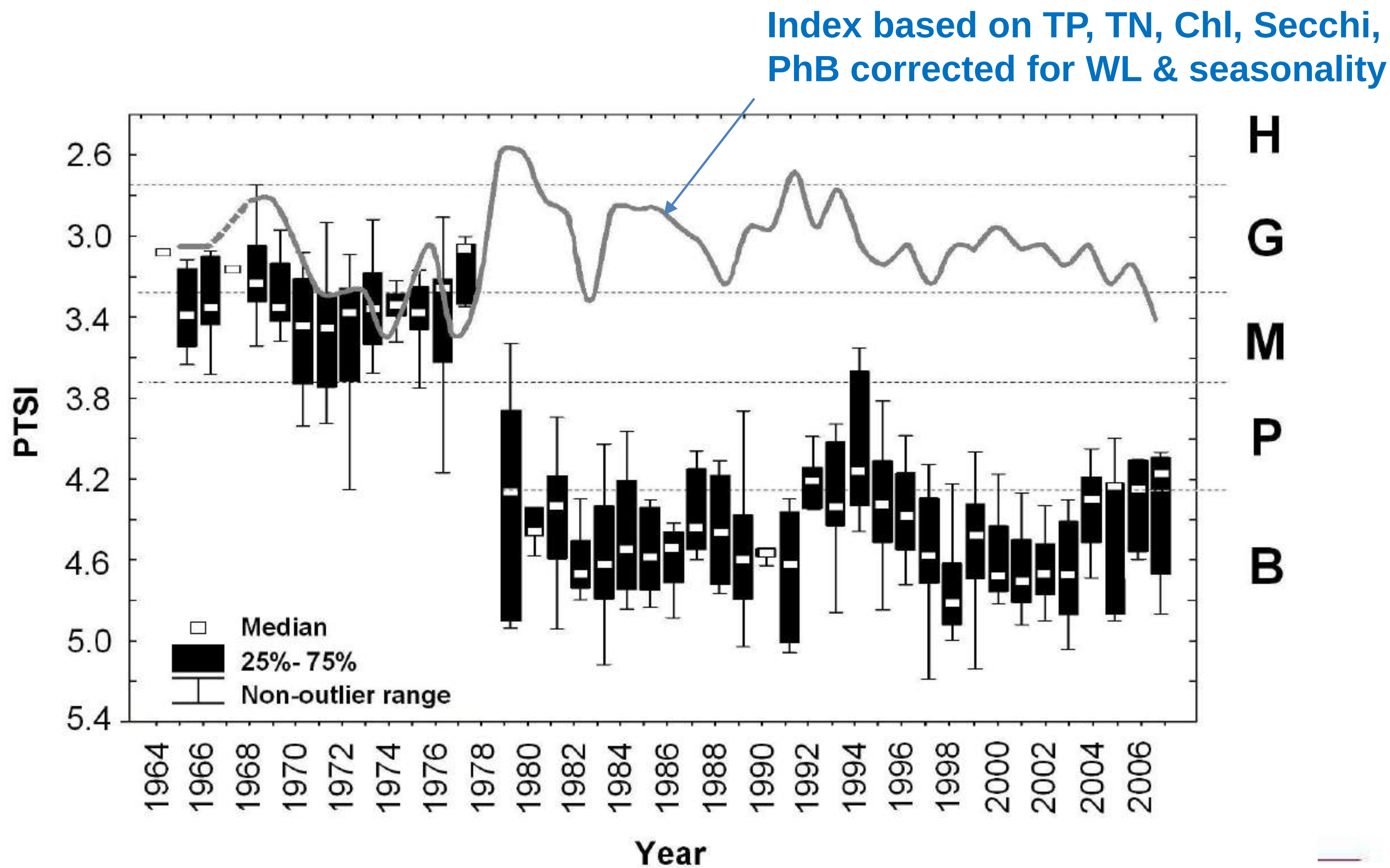
The effect of corrections on monthly phytoplankton biomass



The effect of corrections on annual phytoplankton biomass



Corrected water quality and regime shift in phytoplankton



Quantifying uncertainties

- Do metrics show greater variability among lakes than within lakes or as a result of differences in sample processing?

Ecological Indicators 29 (2013) 34–47

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Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

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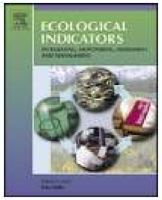
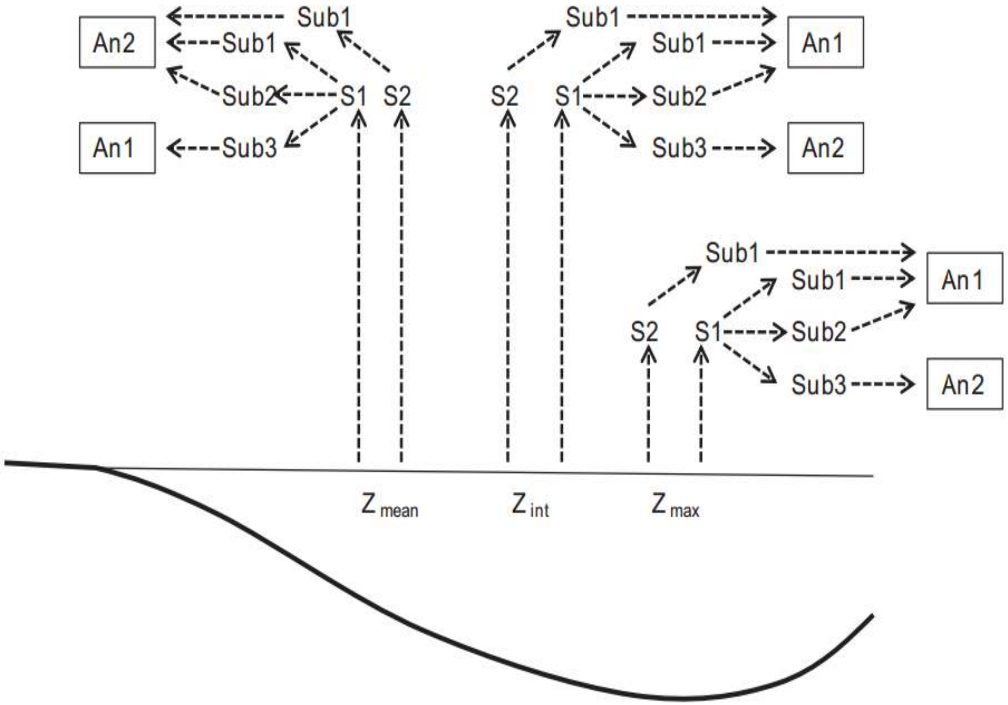


Quantifying uncertainties in biologically-based water quality assessment: A pan-European analysis of lake phytoplankton community metrics

Stephen J. Thackeray[a,*], Peeter Nõges[b], Michael J. Dunbar[c], Bernard J. Dudley[d], Birger Skjelbred[e], Giuseppe Morabito[f], Laurence Carvalho[d], Geoff Phillips[g], Ute Mischke[h], Jordi Catalan[i], Caridad de Hoyos[j], Christophe Laplace[k], Martina Austoni[f], Bachisio M. Padedda[l], Kairi Maileht[b], Agnieszka Pasztaleniec[m], Marko Järvinen[n], Anne Lyche Solheim[e], Ralph T. Clarke[o]

Quantifying uncertainties

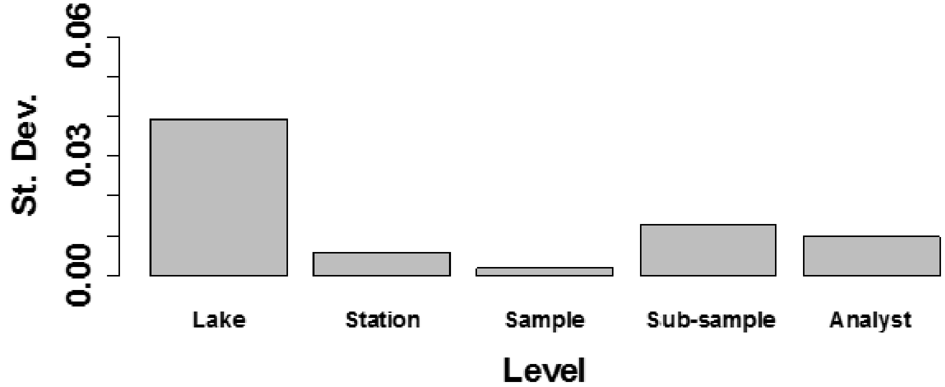
- 7 phytoplankton parameters
- Hierarchical sampling design
  - 32 lakes from 11 countries
  - 3 stations in each
  - 2 water samples
  - 3 subsamples
  - 2 analysts



- Linear mixed effects model
- Nested design

Quantifying uncertainties

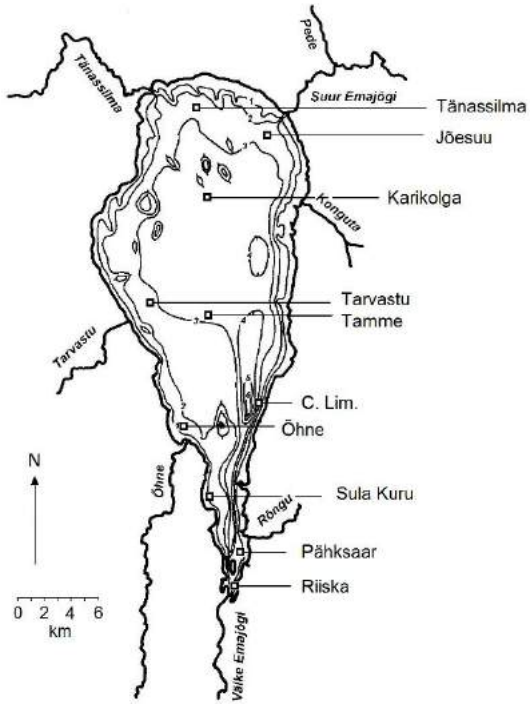
- 65–96% of the variance in metric scores was among lakes, much higher than variability occurring due to sampling/sample processing.
- Variability among stations and samples was minimal (<4%) → single station is representative, sampling ok
- Sub-samples and analysts accounted for much of the within-lake variance → better standardization needed



Typical partitioning of variance for phytoplankton metrics

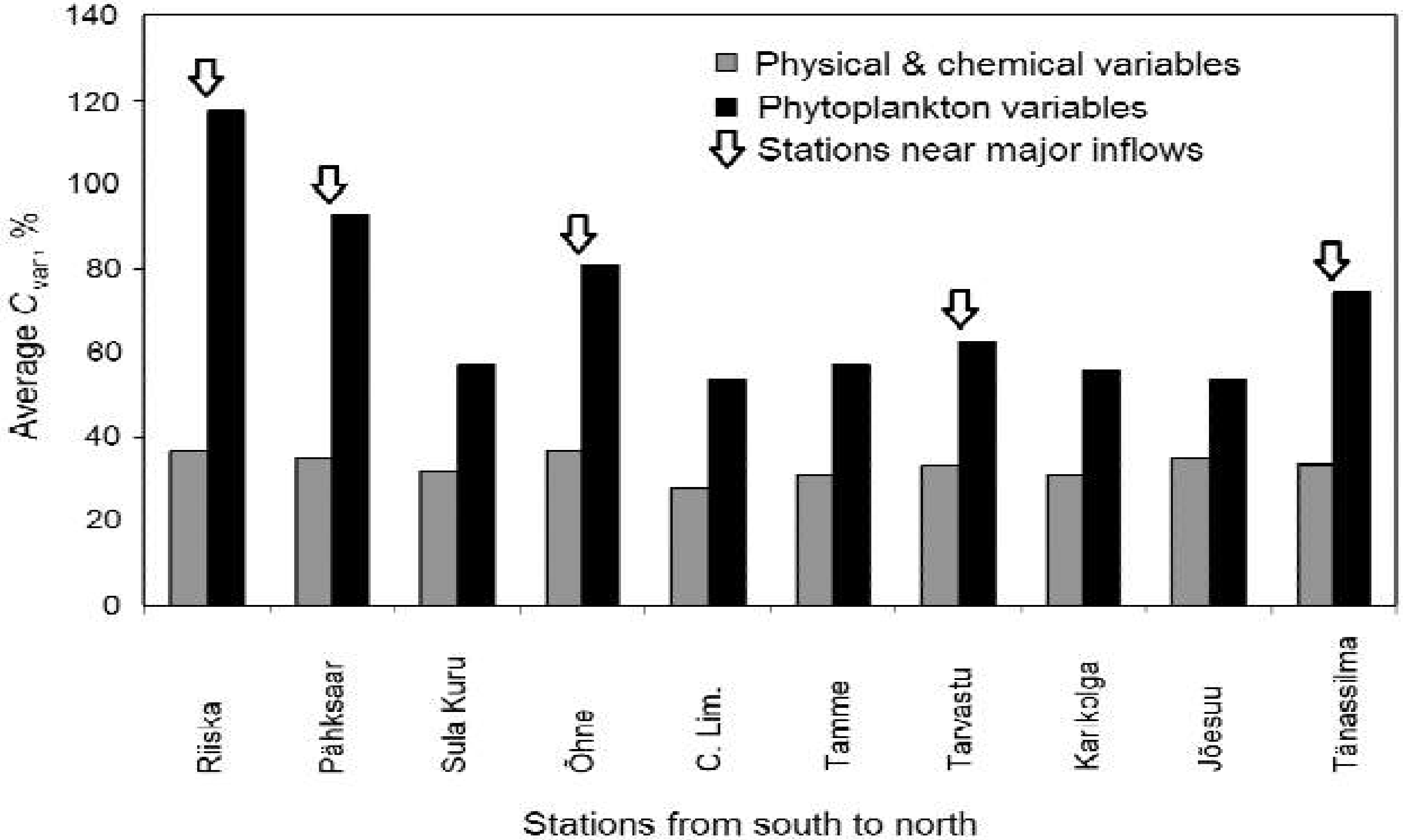
Quantifying uncertainties

- Do metrics show greater spatial or interannual variability within a lake?

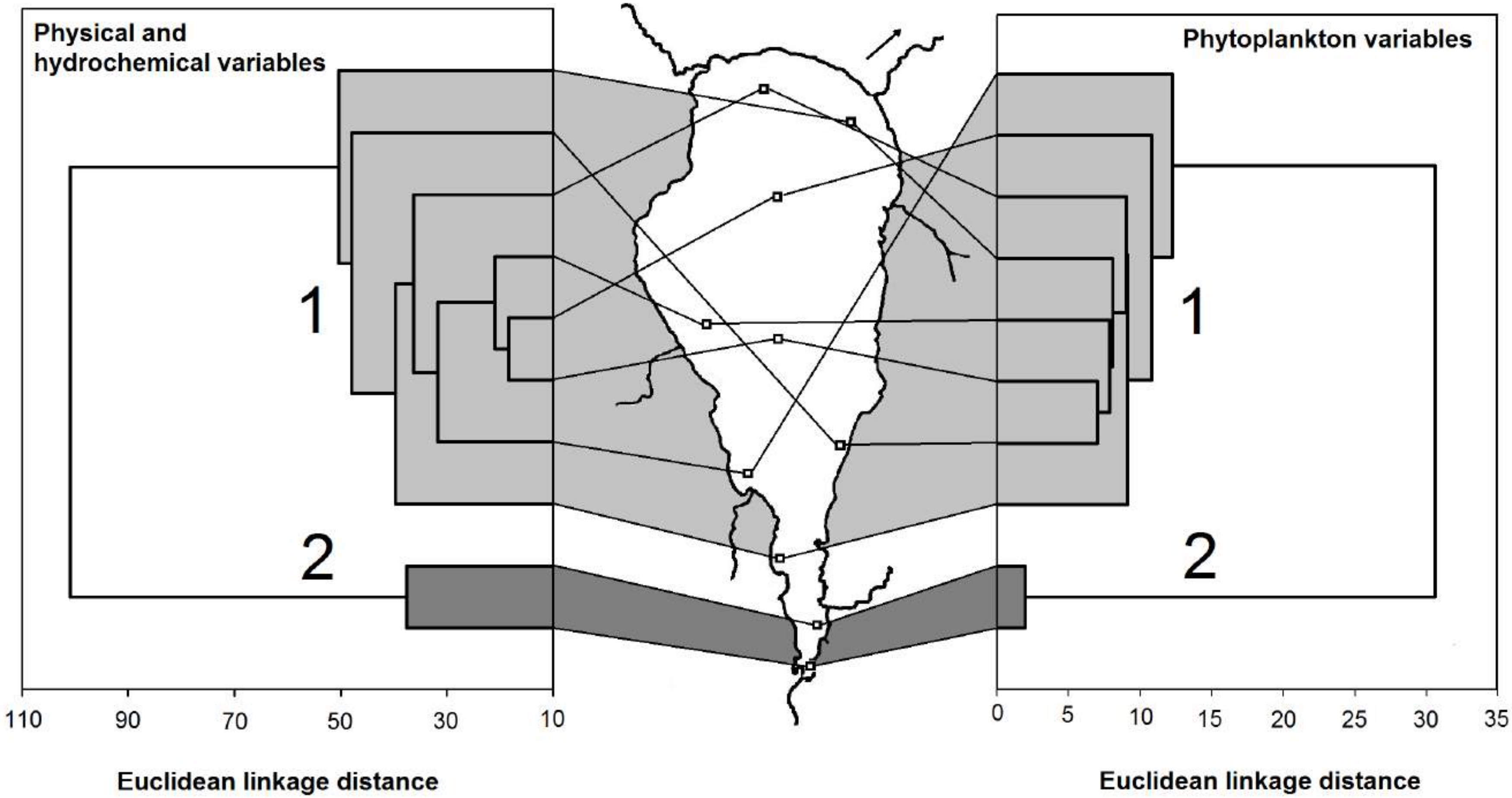


- Data from 10 sampling points during 11 survey expeditions in August 2001- 2011
- 25 physical & chemical variables
- 8 phytoplankton variables

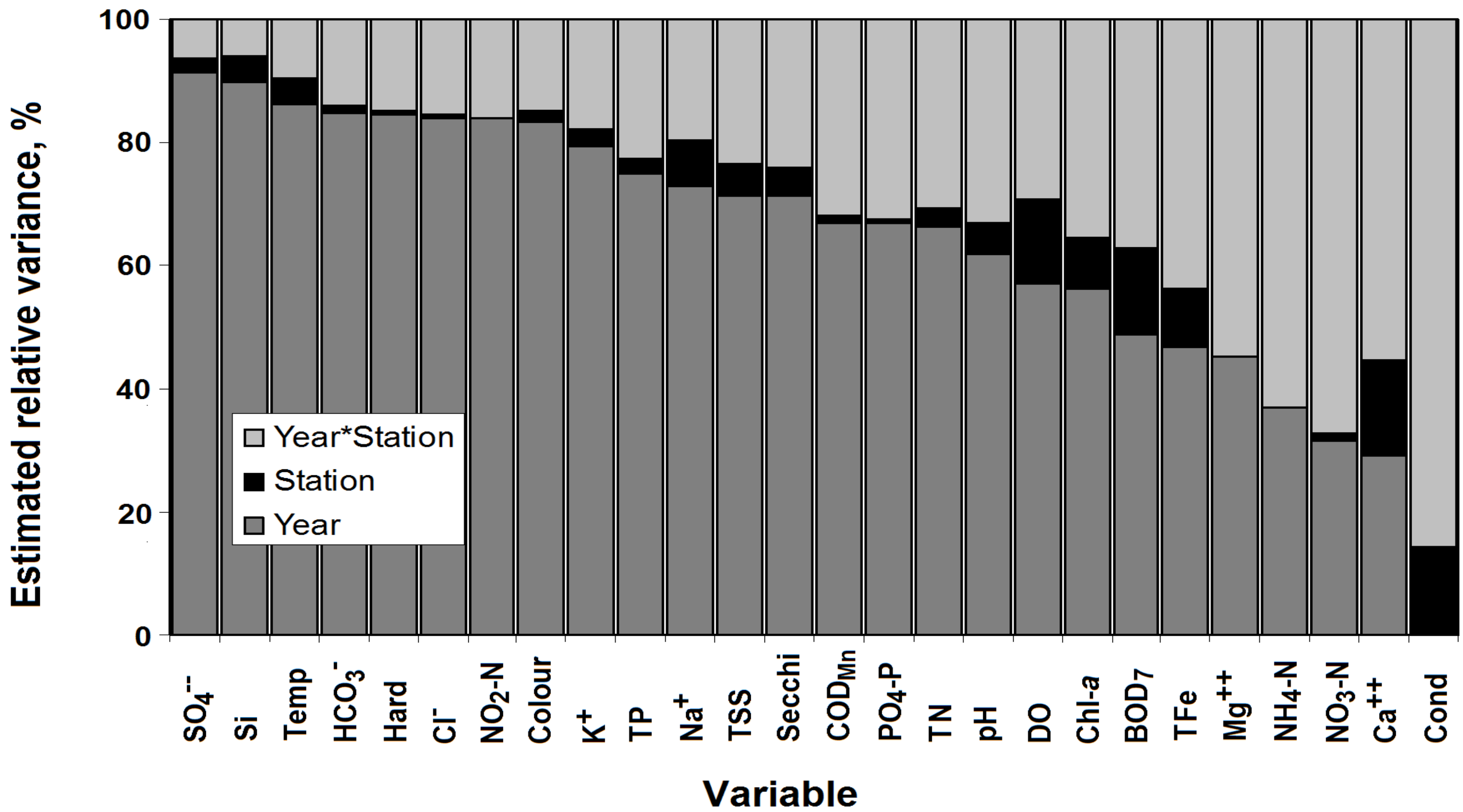
Year-to-year variability



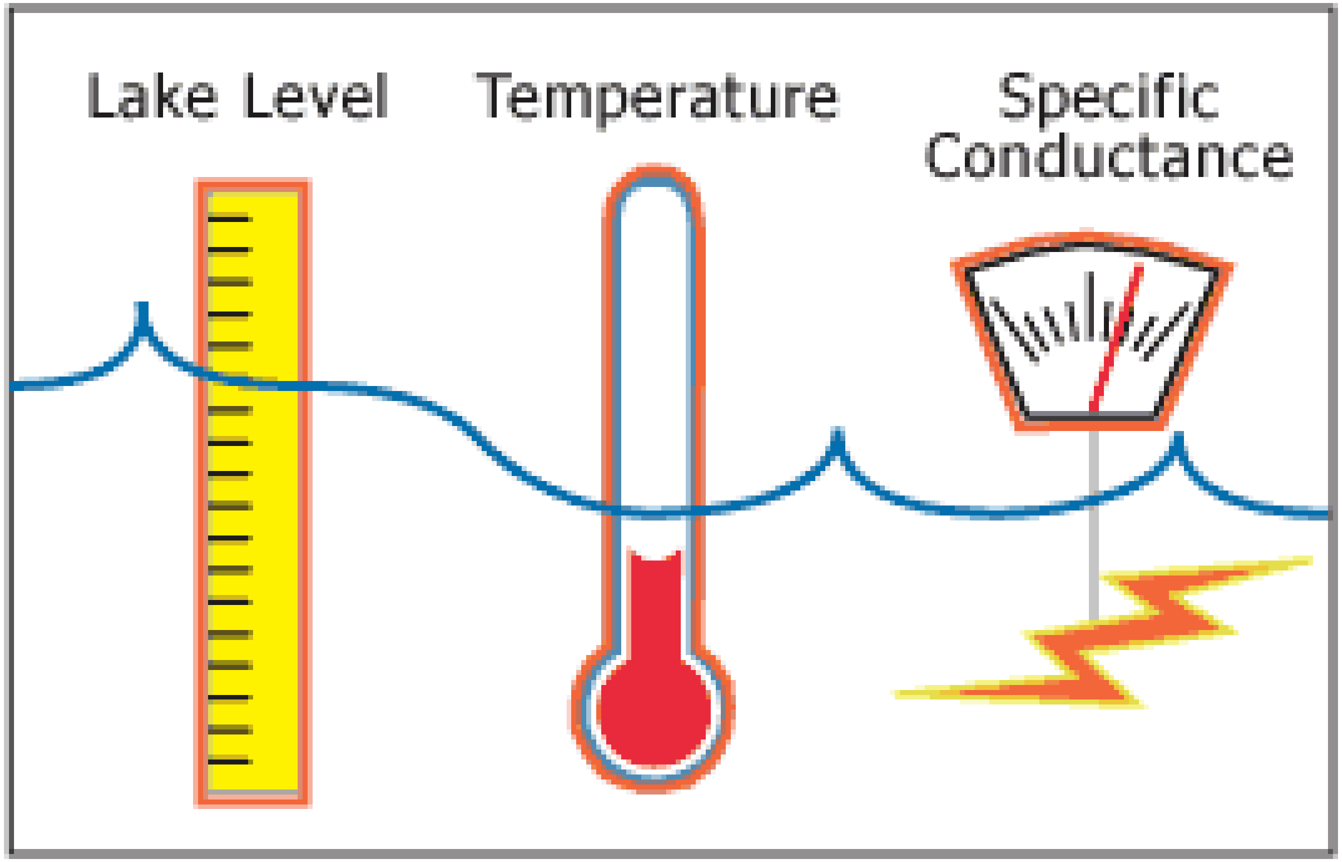
Clusters of stations



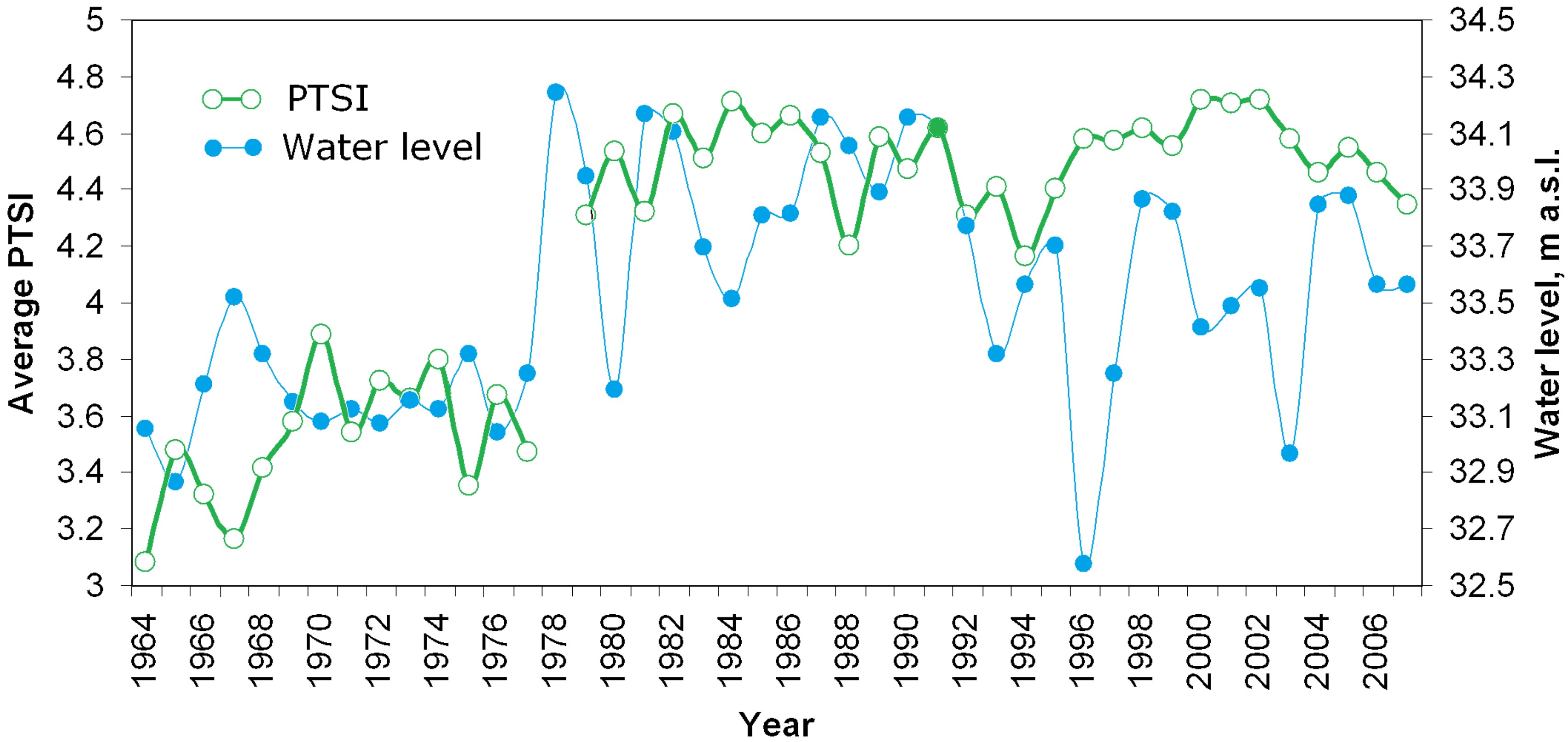
Variability within Võrtsjärv proper



Detecting climate change effects



Analyzing long time series



Nõges et al., 2010

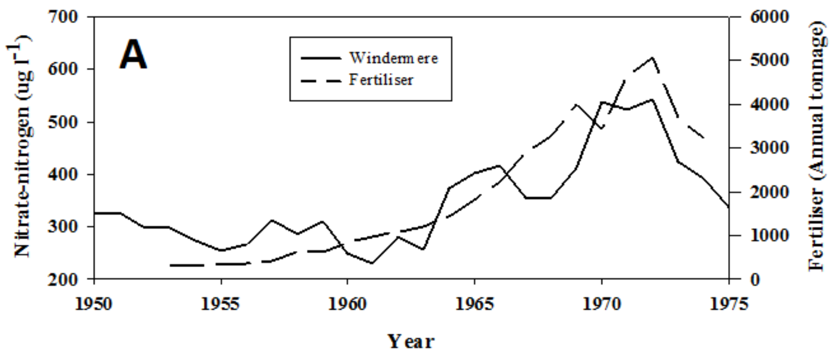
Monitoring of reference sites

- Problems:
  - Strictly do not exist.
  - Studying reference sites does not give information on how impacted sites will respond to climate change.

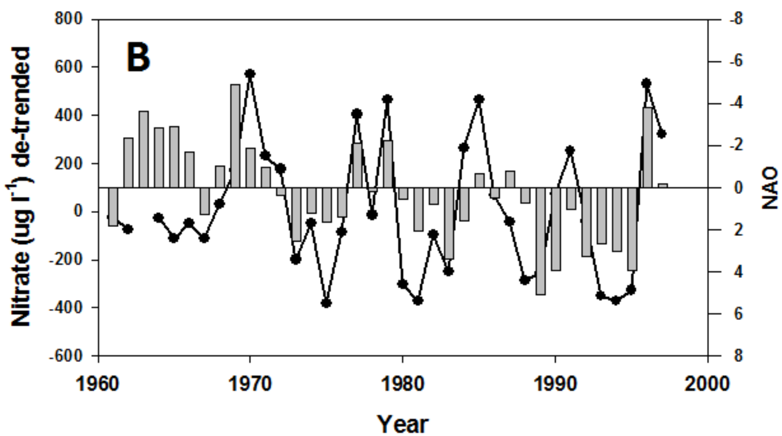
Studying the effect of extreme events

- Gives a hint about possible direction of change
- Shortcoming: The effect of a short-term (one year) impact may be different from that of a long-term change

Residual analysis



Nitrate concentration in Lake Windermere and the use of N-fertilizers in the catchment;



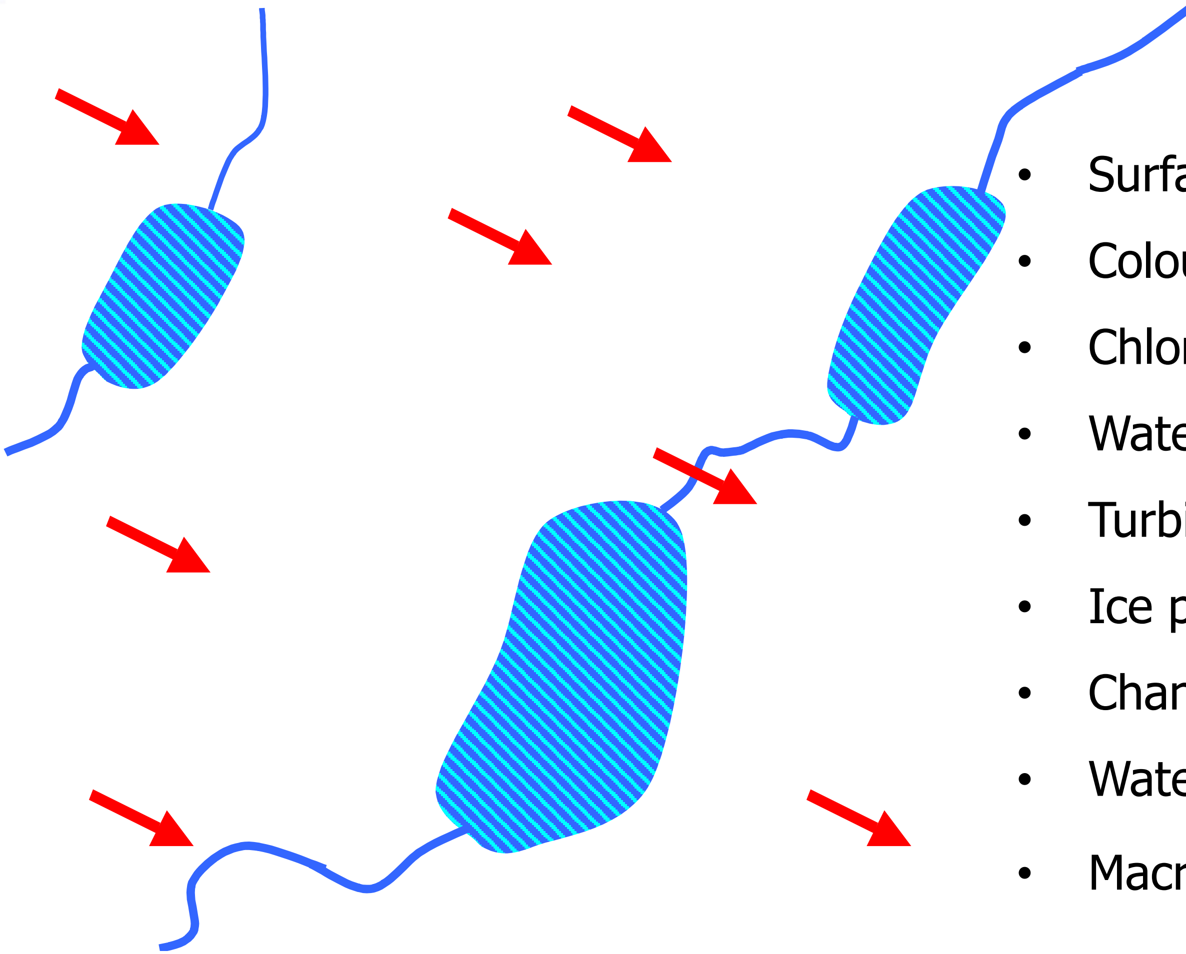
NO3 concentration detrended regarding the use of fertilizers *vs*. The NAO index

George et al., 2004

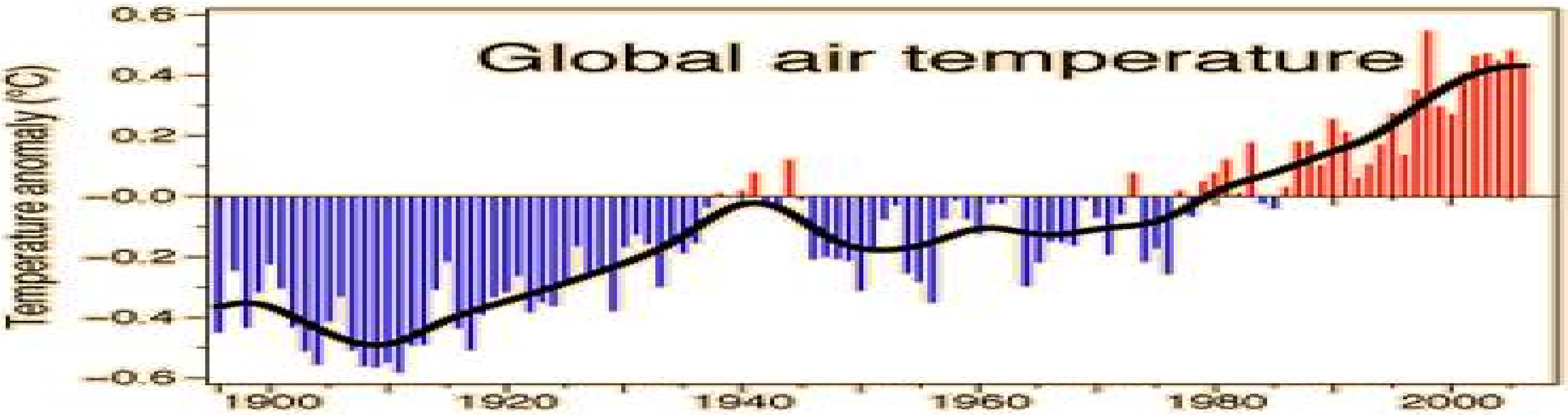
Studies in a climate gradient

REFRESH

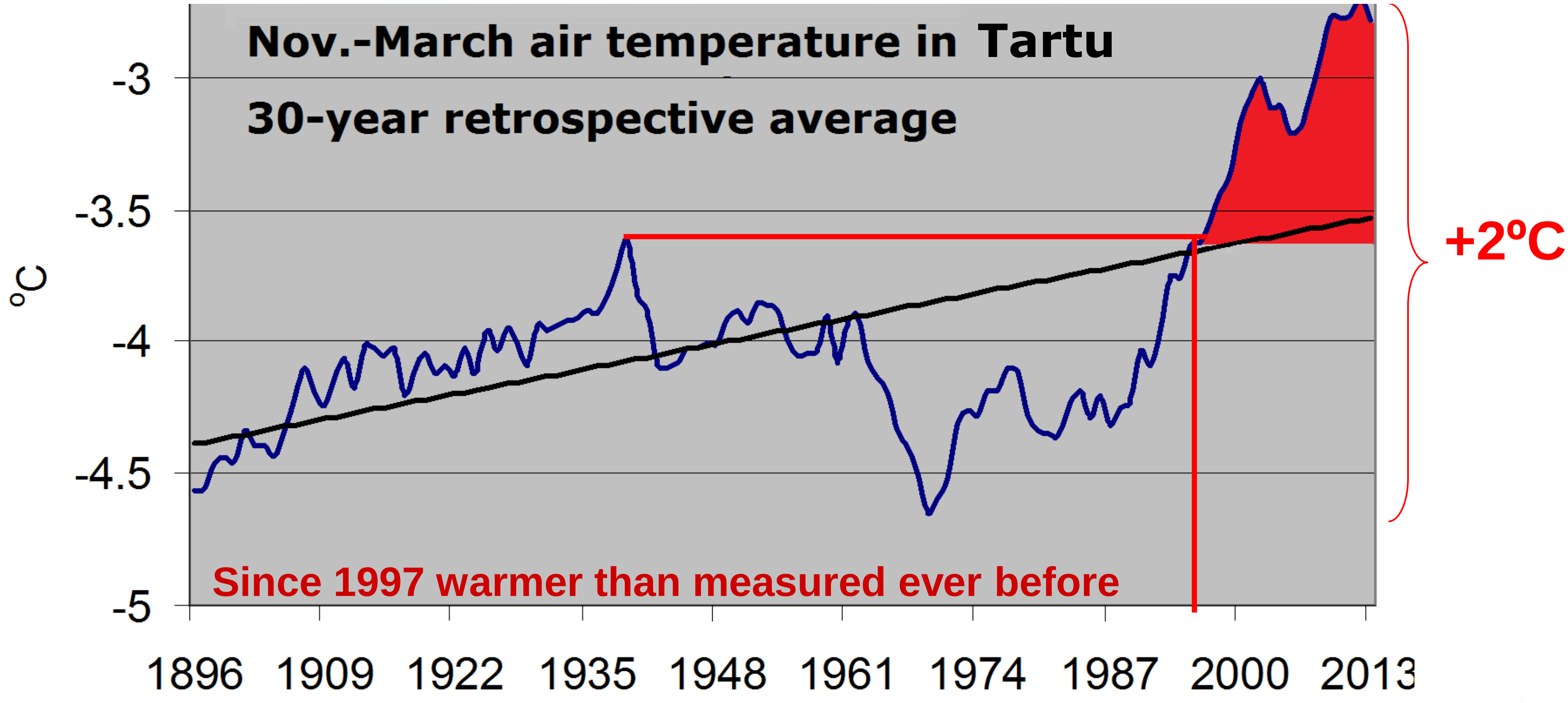
Coherence studies using remote sensing techniques



- Surface water temperature
- Colour
- Chlorophyll & other pigments
- Water blooms
- Turbidity & mixing regime
- Ice phenomena
- Changes in shore line
- Water level
- Macrophyte development

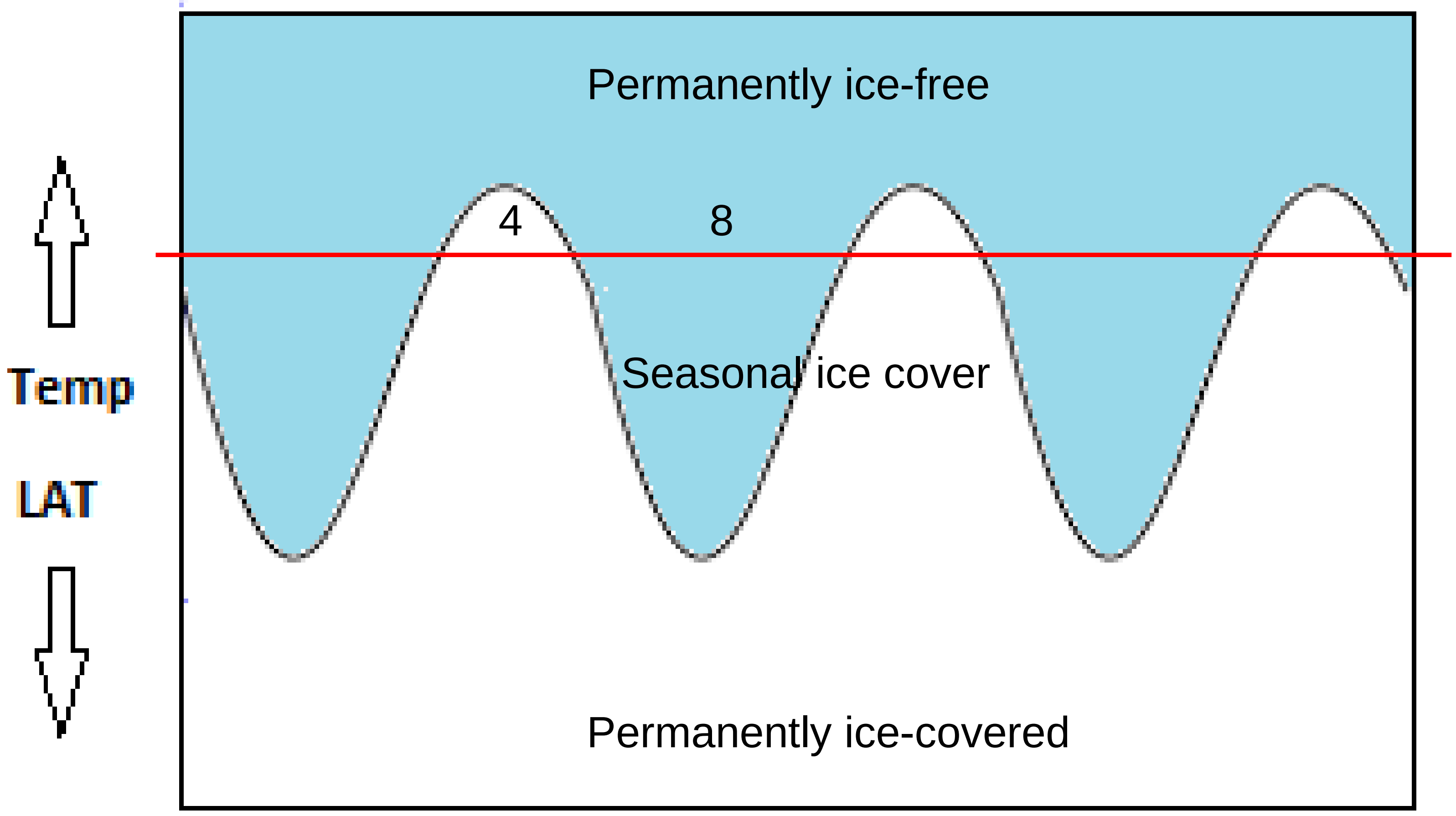


Global air temperature
Temperature anomaly (°C)
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1900
1920
1940
1960
1980
2000

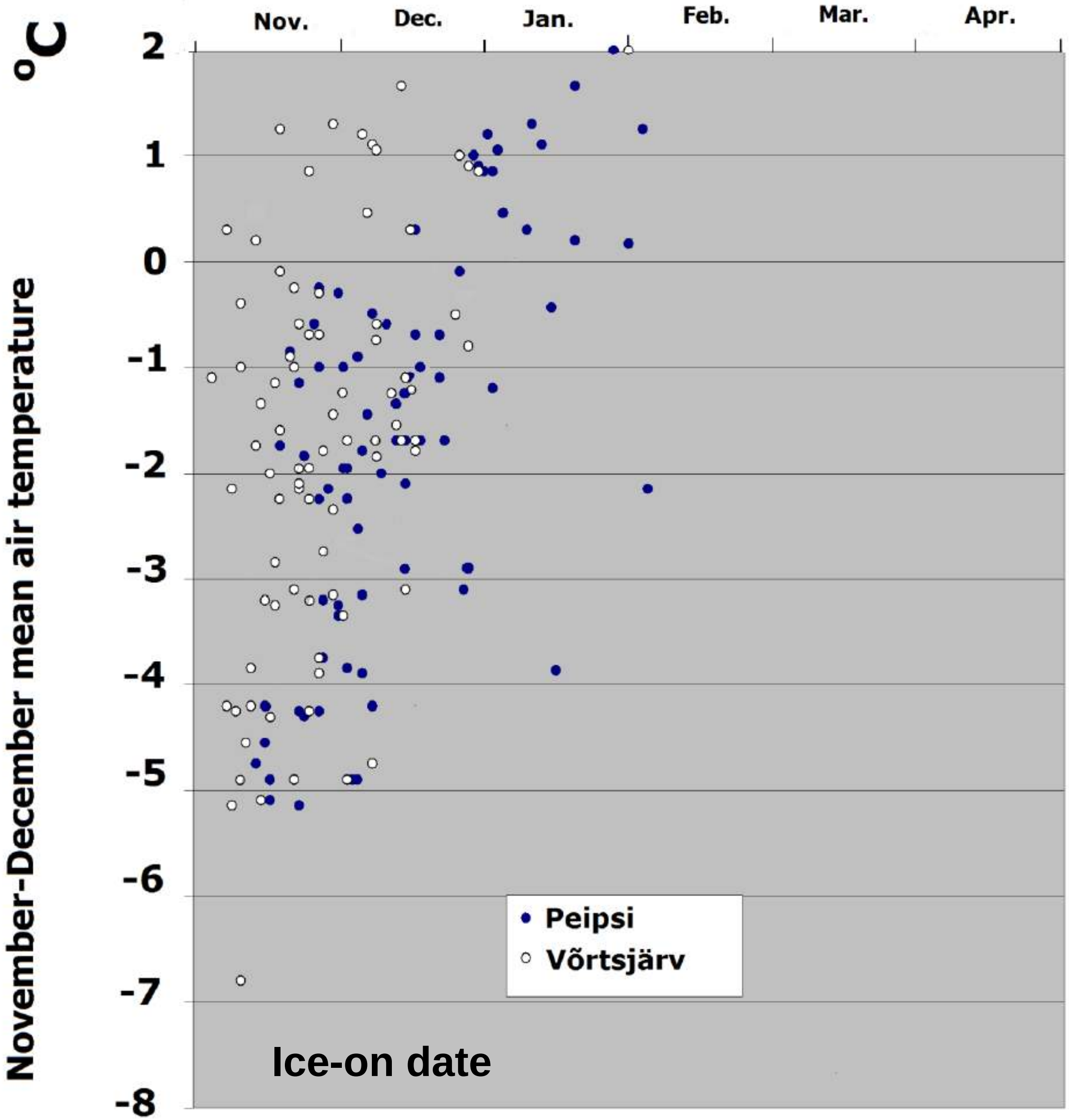


Nov.-March air temperature in Tartu
30-year retrospective average
°C
-3
-3.5
-4
-4.5
-5
+2ºC
Since 1997 warmer than measured ever before
1896
1909
1922
1935
1948
1961
1974
1987
2000
2013

Ice cover predictions

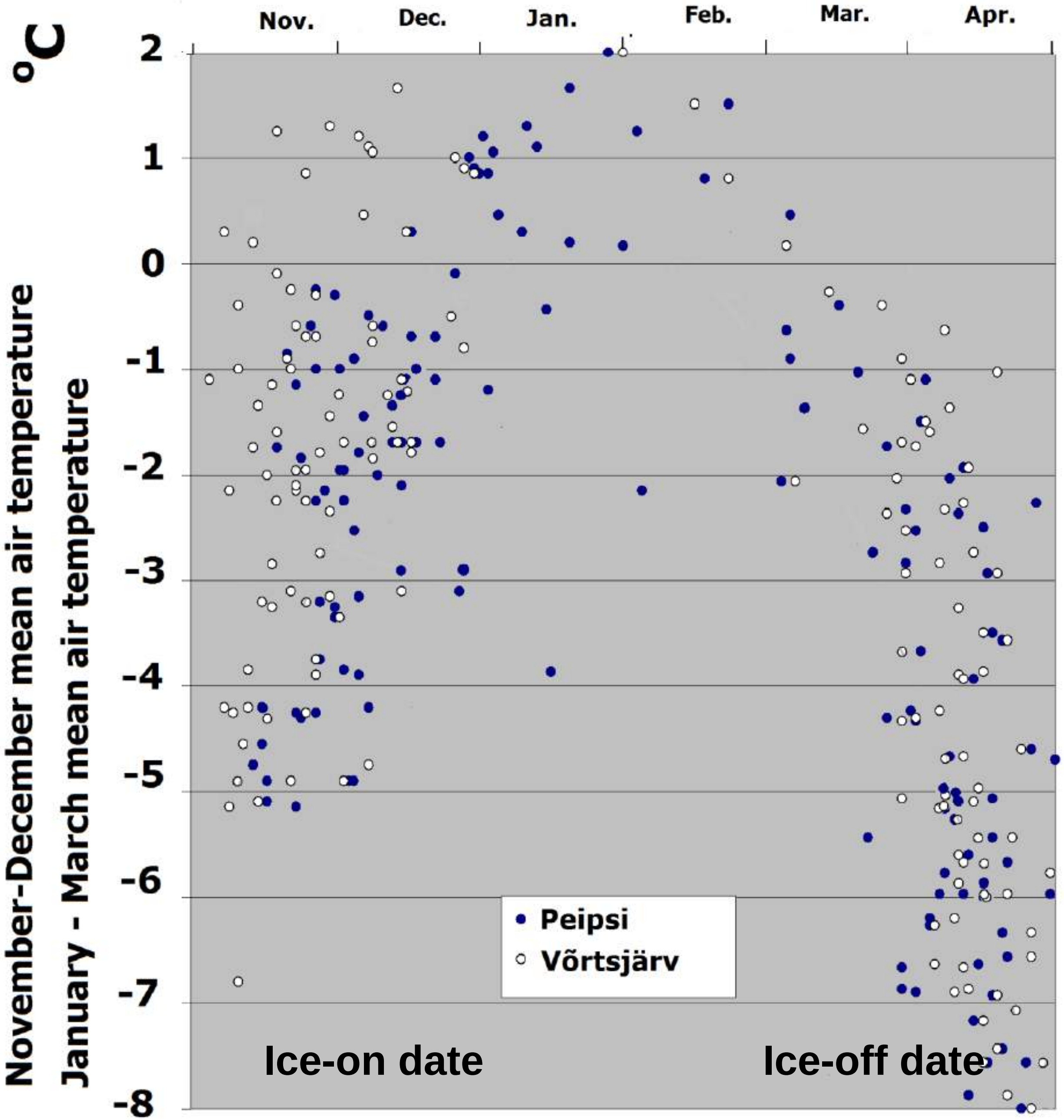


Ice regimes 1924-2011

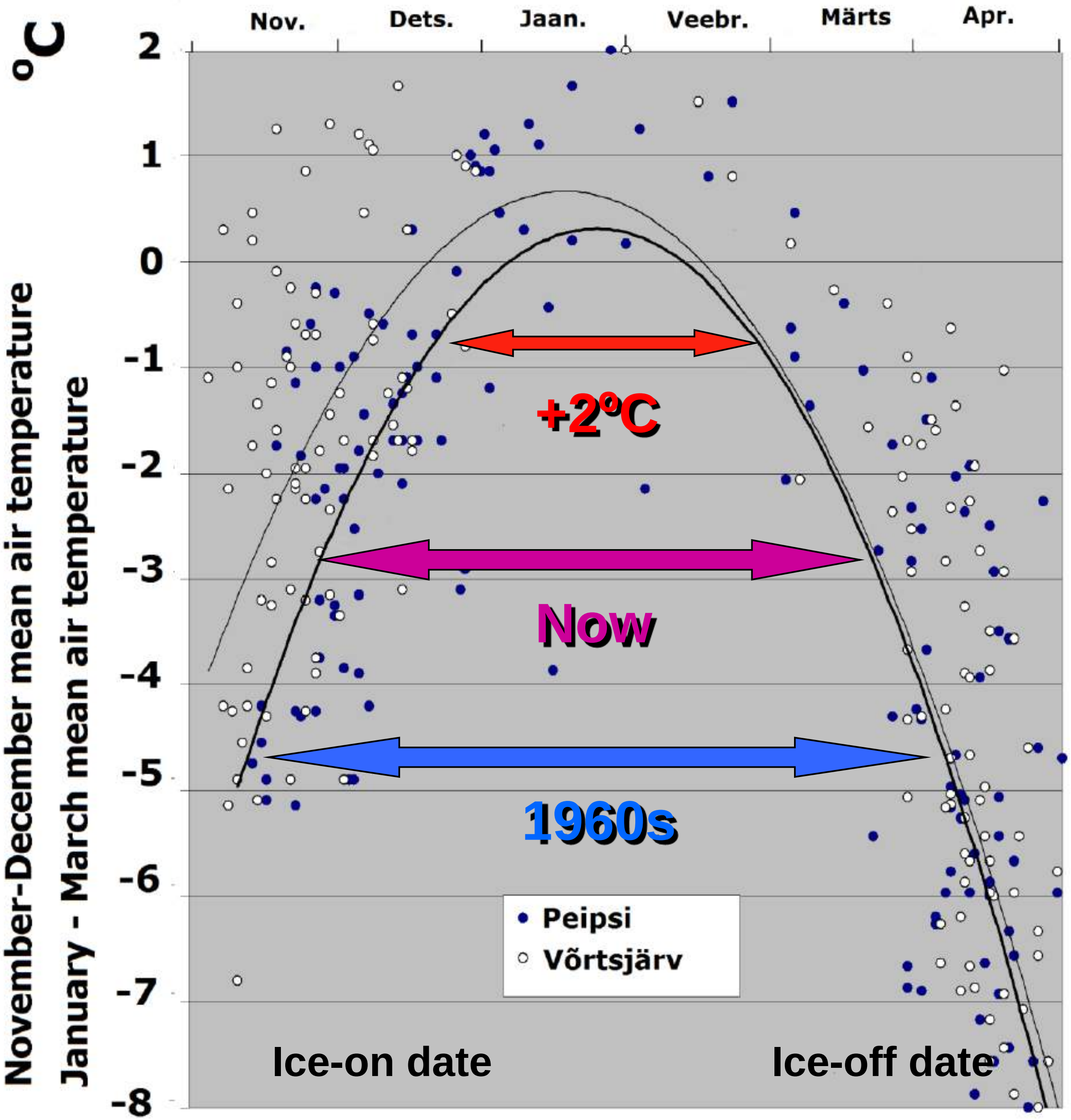


www.emu.ee
Eesti Maaülikool
Estonian University of Life Sciences

Ice regimes 1924-2011



Ice regimes 1924-2011



- Temperature dependence of ice cover is non-linear
- A further winter temperature increase by 2ºC will halve the duration of ice cover on Peipsi
- Ice cover on the larger and deeper lake is more sensitive

www.emu.ee
EMU Eesti Maaülikool
Estonian University of Life Sciences

Is it due to human impact?

http://www.mereblog.com/2010/03/18/jaamurdja-tarmo/
2006

Thank you!

EUSBSR
EU STRATEGY
FOR THE BALTIC
SEA REGION

CENTRAL BALTIC
INTERREG IV A
PROGRAMME
2007–2013

MIMIC

Building common situational awareness for accidental oil spill emergency response

Aps[1], R., Fetissov[1], M., Heinvee[2], M., Jönsson[3], A., Kopti[1], M., Kotta[1], J., Orviku[4], K., K. Tabri[2], Tõnisson[4], H.

[1] University of Tartu, Estonian Marine Institute, Tallinn, Estonia
[2] Tallinn University of Technology, Tallinn, Estonia
[3] Swedish Meteorological and Hydrological Institute, Norrköping, Sweden
[4] Tallinn University, Institute of Ecology, Tallinn, Estonia

KIK
ENVIRONMENTAL INVESTMENT CENTRE

"There are known knowns. These are things we know that we know.

There are known unknowns. That is to say, there are things that we know we don't know.

But there are also unknown unknowns. There are things we don't know we don't know."

Donald Rumsfeld

Stephen Carr, 2014

Terminology

- <u>Situational Awareness</u> (SA) – knowing what has and is occurring within your environment and understanding the implications of these events and the potential outcomes associated with them (*human element - intellectual)*
- <u>Common / Shared Situational Awareness</u> (CSA) - the common (shared) knowledge and understanding held by those involved in a situation that should support unity of purpose and effort, and in turn enable an effective collective response.
- <u>Common Operating Picture</u> (COP) – an overview of a situation that is created by assessing and fusing information from multiple sensors or sources to support timely and effective decision-making (a product of technology)

Stephen Carr, 2014

Smart Response Concept: building a flexible Common Operational Picture (COP) to support Common Situational Awareness (CSA) in crisis management

- **Large crises involve frequent role switching between different actors in a response.**
- **Smart Response solution is to use interactive information overlays to enable different users to fit the COP to their particular CSA needs.**

Coupled Seatrack-Web/SmartResponse-Web system is developed for oil spill response related Common Situation Awareness building through the cyclic process of dynamic situational assessment

- Endsley (2000) differentiates between cognitive processes involved in achieving the situation assessment and the resultant state of knowledge about the situation – situation awareness. Therefore, the situation assessment as an active process of seeking information from the environment is defined separately from situation awareness as the resultant of that process.

Building Common Situation Awareness

- Common Situation Awareness is a state of knowledge that results from Awareness building process and includes
  - Perception – What are the current facts?
  - Comprehension - What is actually going on?
  - Projection - “What is most likely to happen if…
  - Resolution - “What exactly should be done?
- Important - Perception, Comprehension, Projection and Resolution happens in parallel

Salerno, Hinman, Boulware, 2004

The work of coupled Seatrack Web / SmartResponse-Web is based on the imported Web Map Services with the GIS map layers grouped according to the Environmental Sensitivity Index (ESI) framework

- <u>shoreline classification</u> – ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of cleanup (<u>new</u> - original map layer),
- <u>biological resources</u> – including oil-sensitive animals, and habitats, which are used by oil-sensitive species or are themselves sensitive to oil spills (OILRISK map layers),
- <u>human-use resources</u> – specific areas that have added sensitivity and value because of their use, such as beaches, parks and marine protected areas of different level, and historic/cultural sites (<u>new</u> - official map layers)

Cliff shore

1C Exposed bedrock cliffs with talus base

5. Mixed sand and gravel beaches

Sandy shore

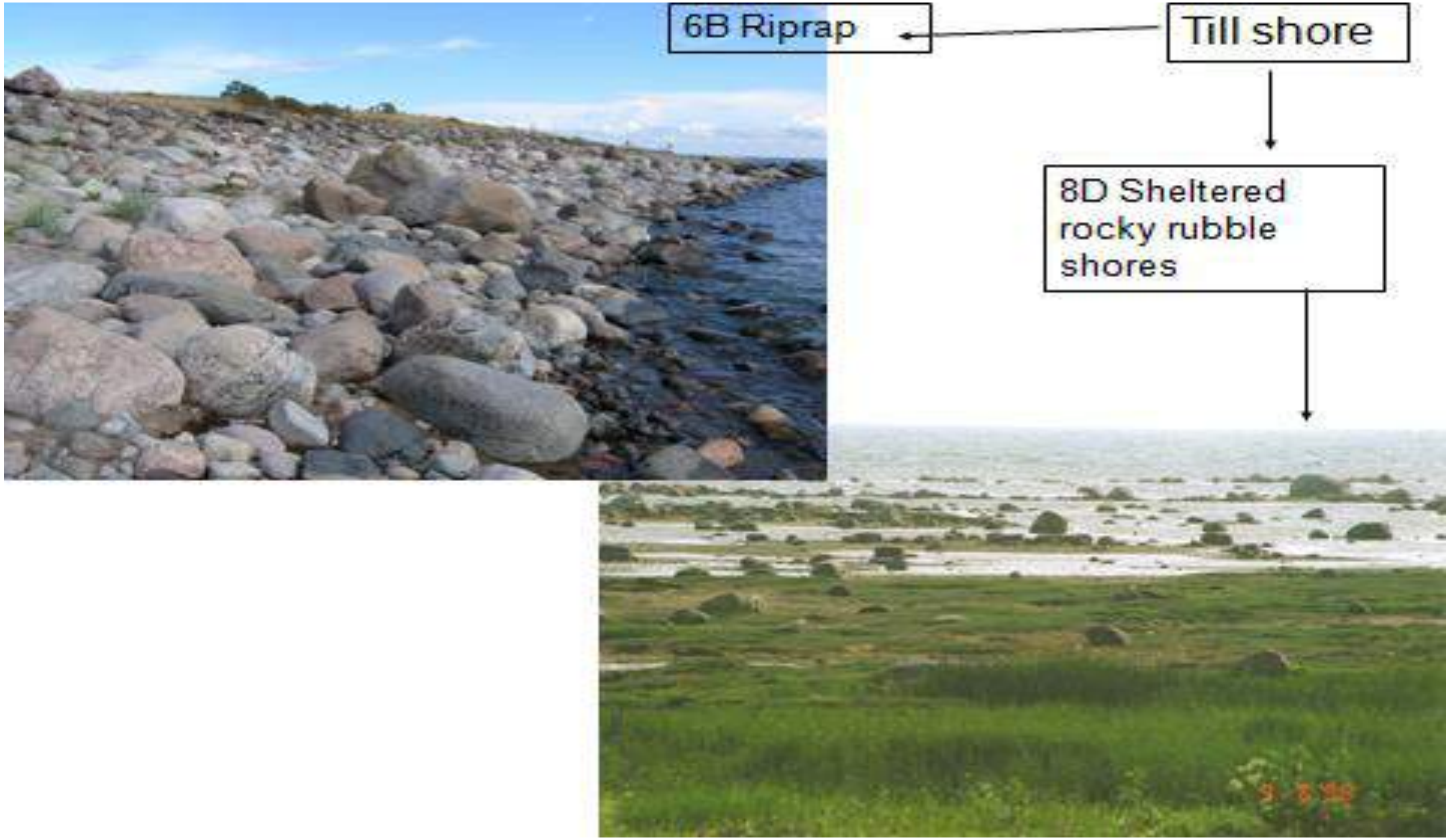
↓

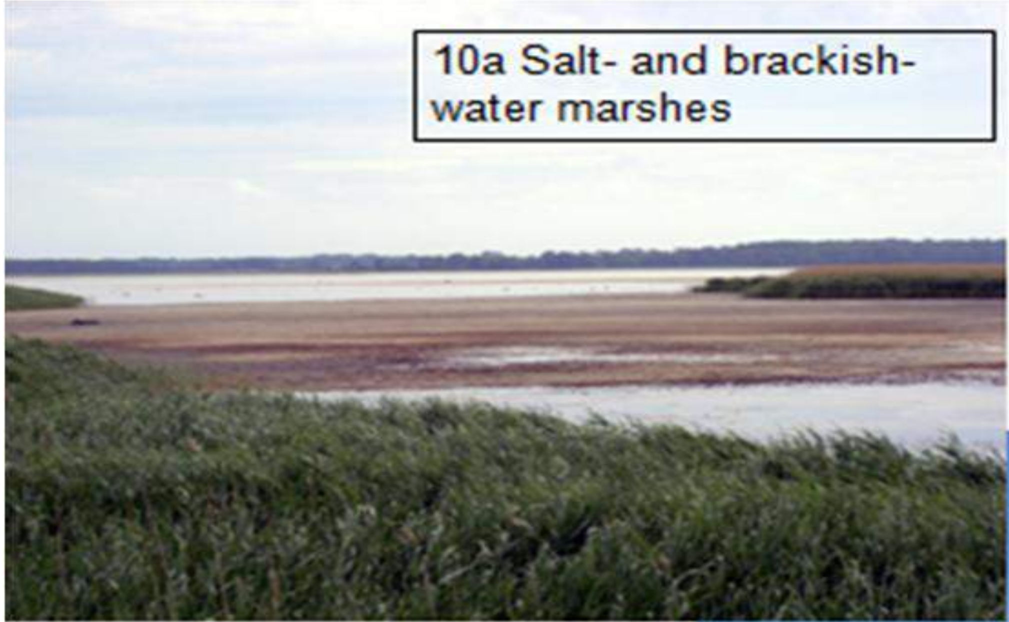
3AFine- to medium-grained sand beaches

Gravel-pebble shore

↓

6a Gravel beaches


6B Riprap
Till shore
8D Sheltered rocky rubble shores



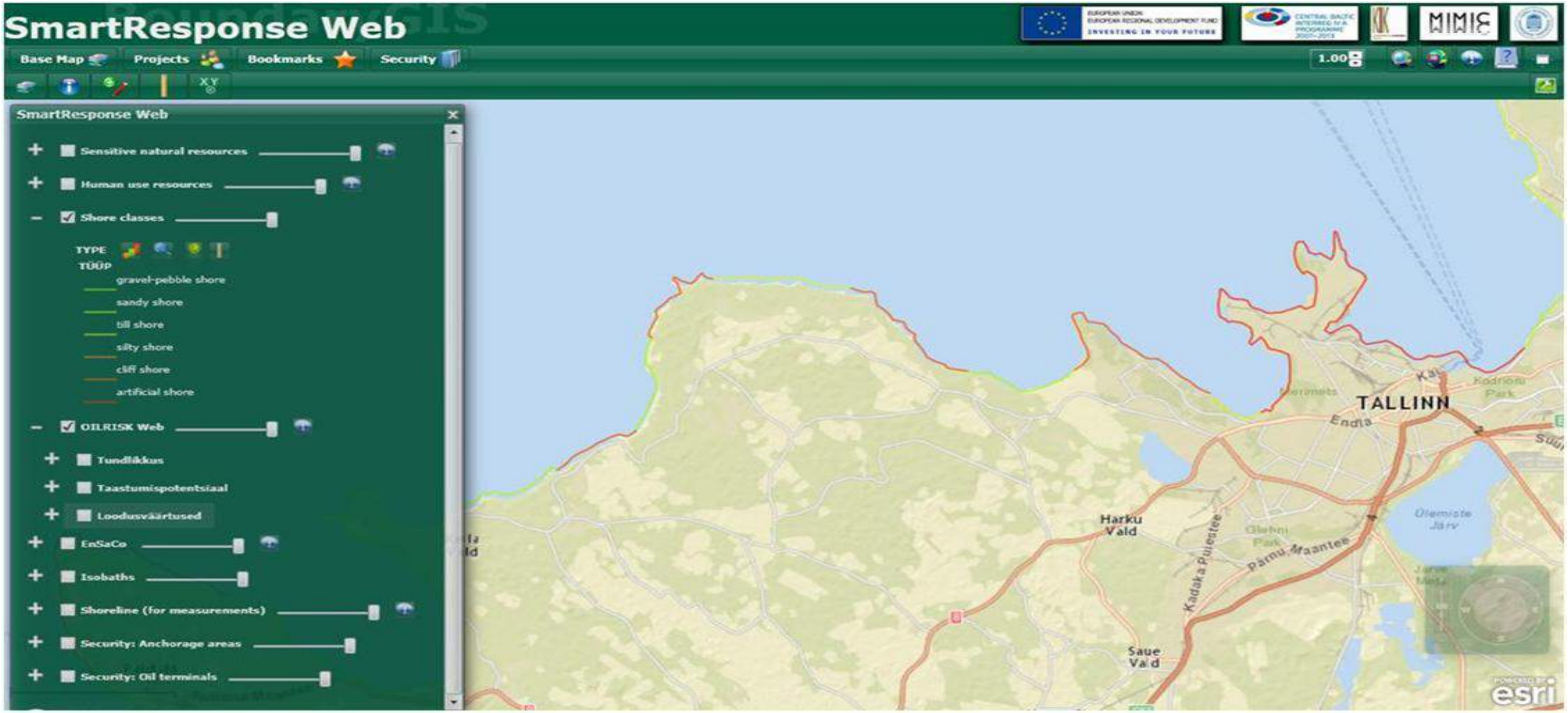
Silty shore

9a Sheltered tidal flats

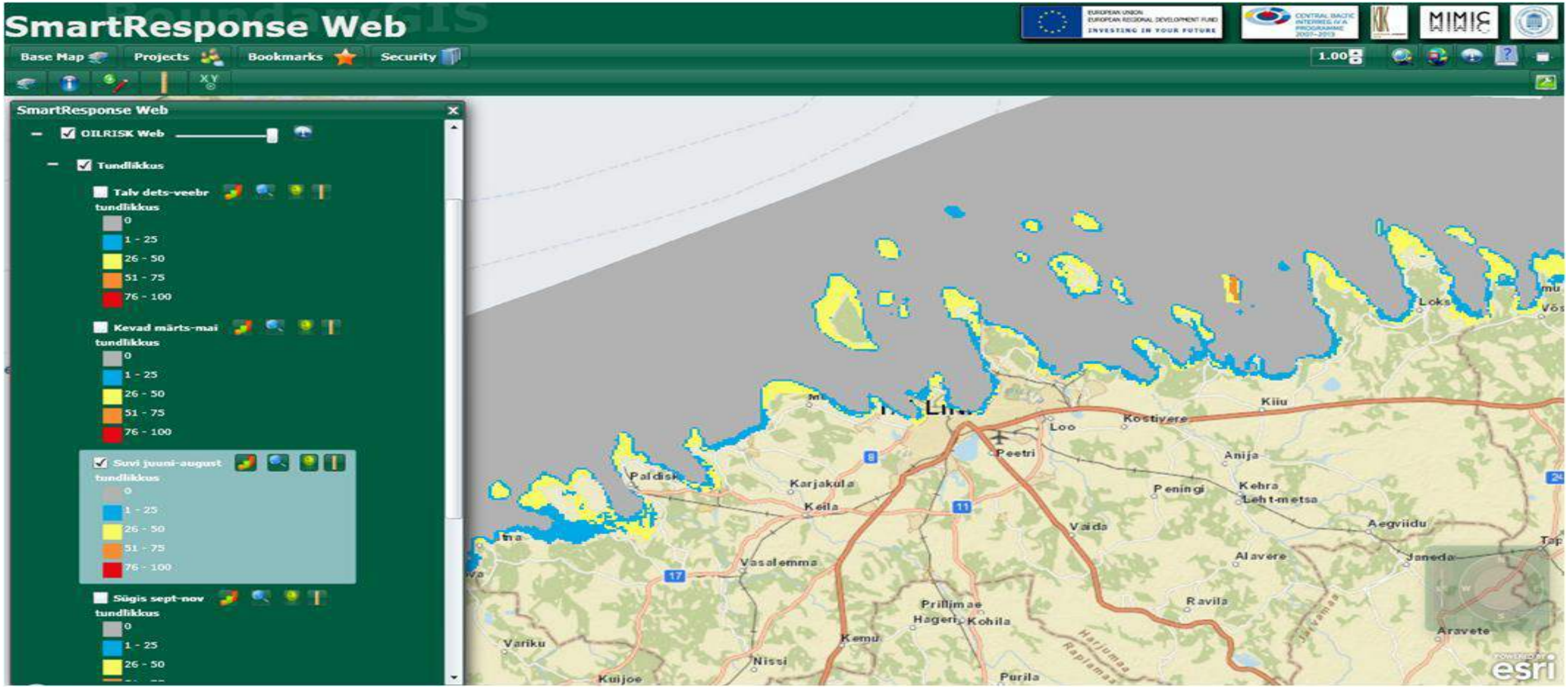
Aps, R., Tõnisson, H, Anfuso, G., Perales, J.A., Orviku, K., Suursaar, Ü. 2014. Incorporating dynamics factor into the Environmental Sensitivity Index (ESI) shoreline classification – Estonian and Spanish example. *In:* Green, A.N. and Cooper, J.A.G. (eds.), *Proceedings 13th International Coastal Symposium* (Durban, South Africa), *Journal of Coastal Research*, Special Issue No. 66, pp. xxx-xxx , ISSN 0749-0208.

- **This paper focuses on amending the Environmental Sensitivity Index (ESI) related shoreline classification to local conditions – dynamically changing categorization of shoreline in terms of its susceptibility to spilled oil caused by extreme meteorological events and taking into consideration a number of natural physical factors**
- **The novelty of this work is in attempt to move from the standard ESI related and locally adapted static shoreline classification towards more dynamic shoreline monitoring based characterization of the sensitive to oil pollution shoreline elements**

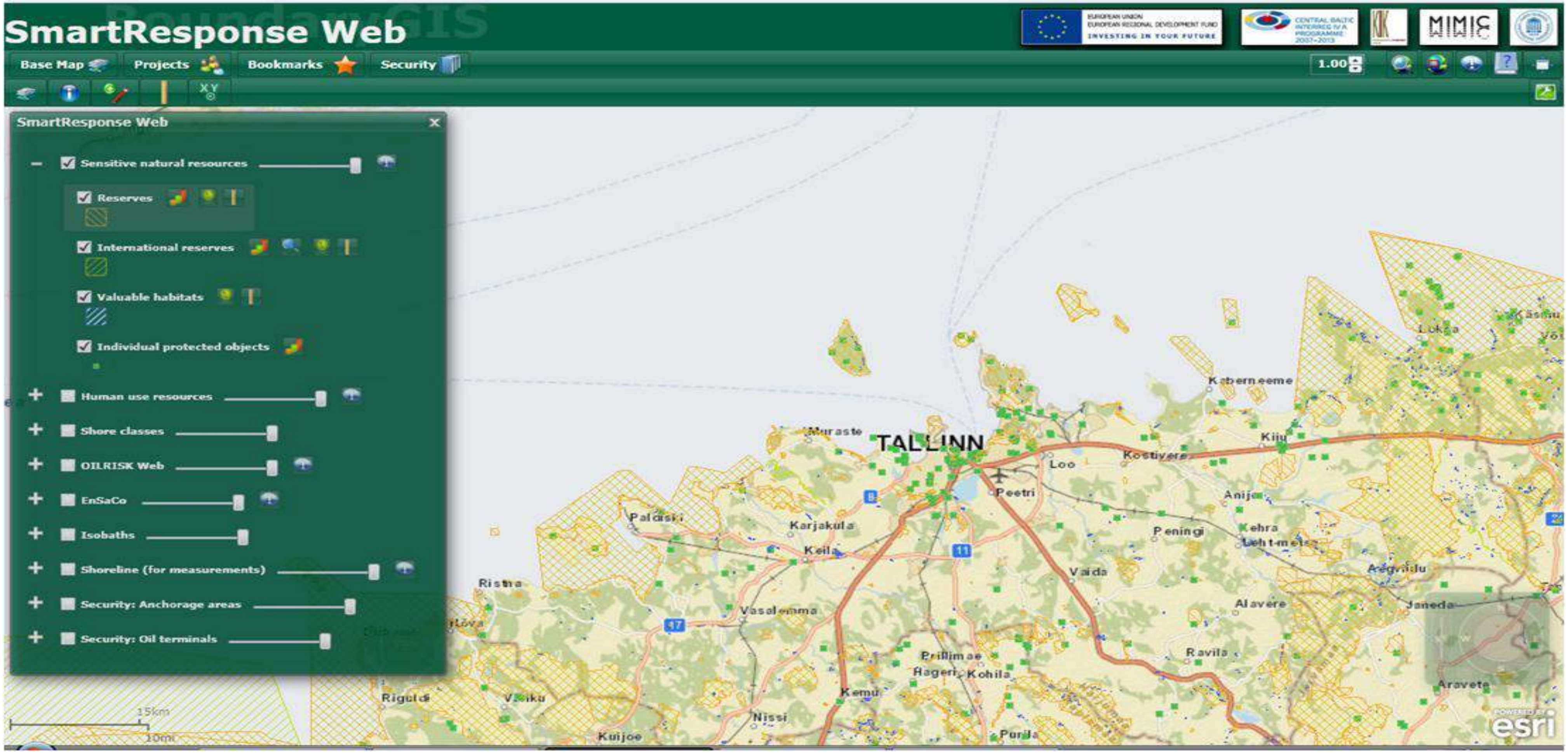
Shoreline classification



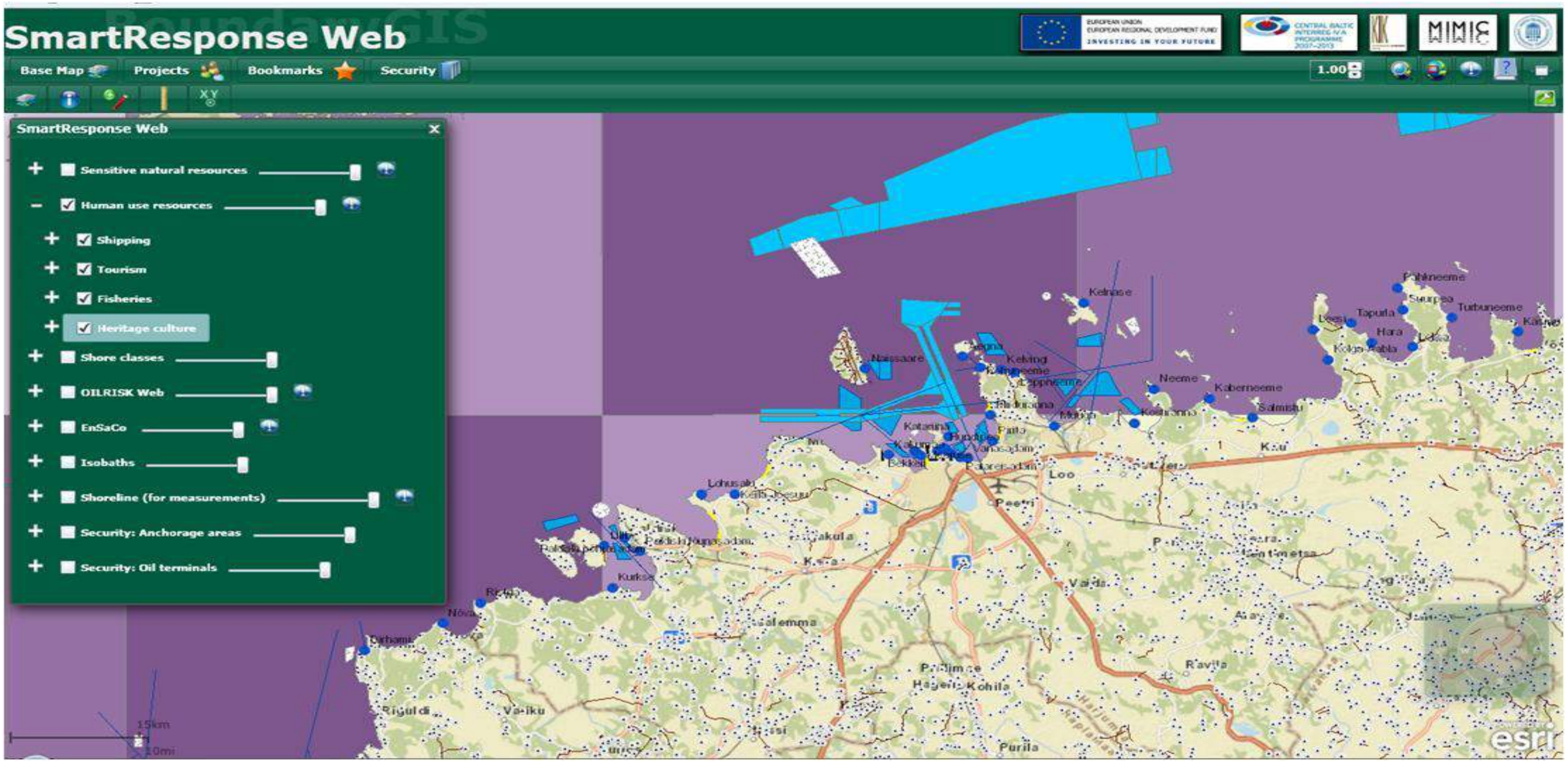
Biological resources



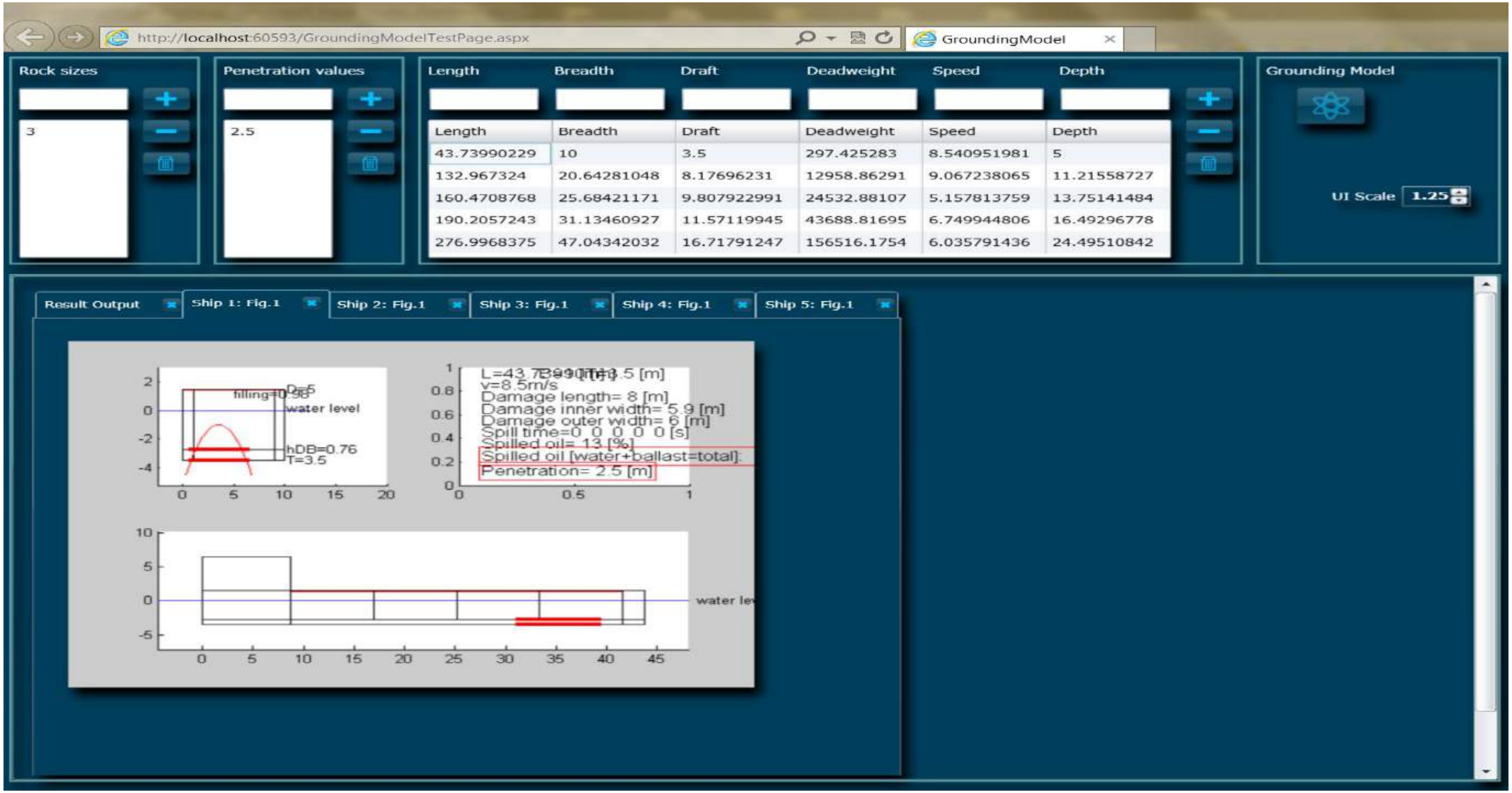
Human use resources



Human use resources

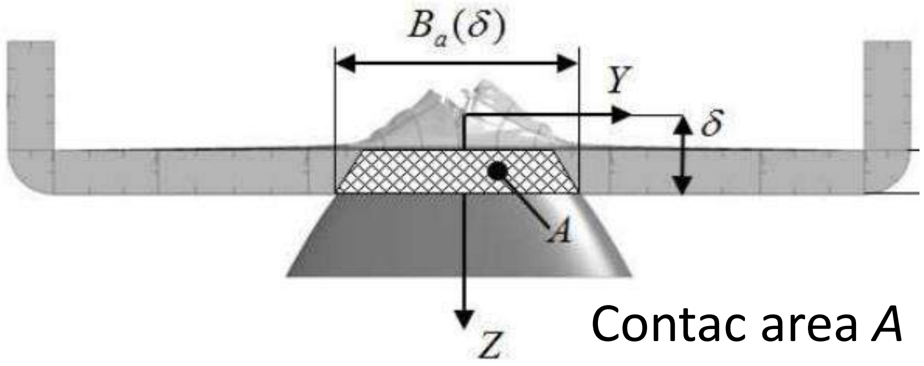


Ship collision / grounding simulation module



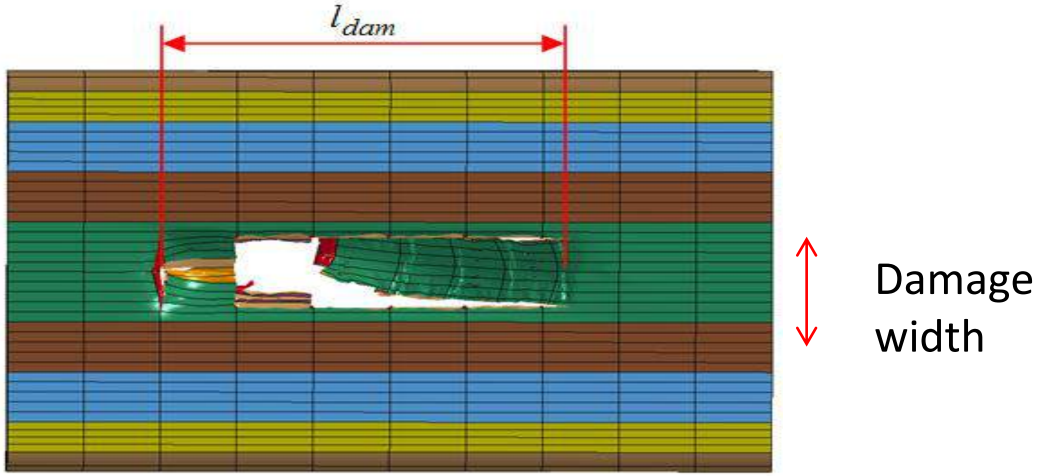
DAMAGE ASSESSMENT MODEL

- The size of the damage opening is evaluated by simplified formulas [Heinvee et al 2015].
- The formulas calculate the length and width of the damage opening, i.e the opening area.
- Limited number of inputs are required: (i) for the ship: velocity, displacement, main dimensions, double-bottom height, structural resistance coefficient; (ii) for the rock: rock size parameter, penetration depth
- The calculation of damage length is based on average horizontal grounding force and energy balance.



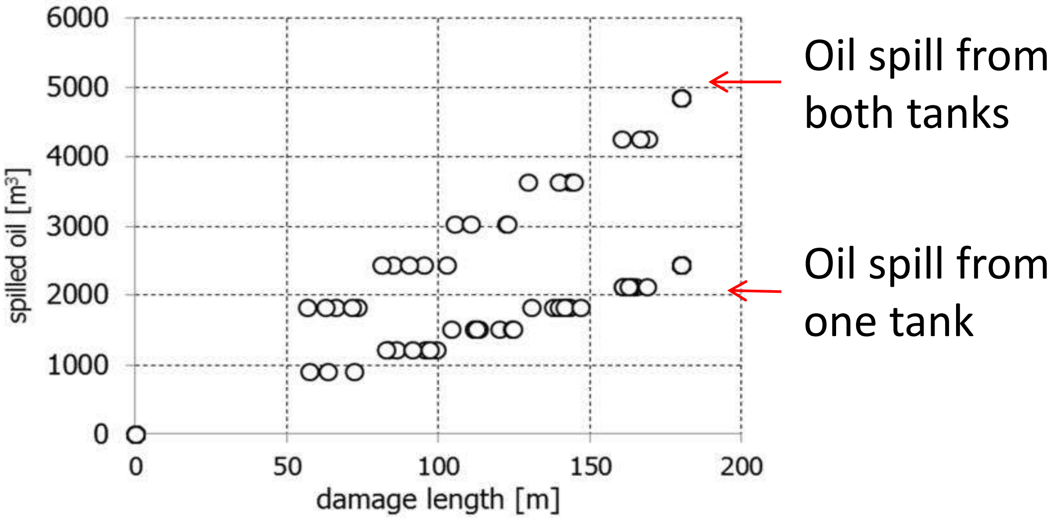
Contac area *A*

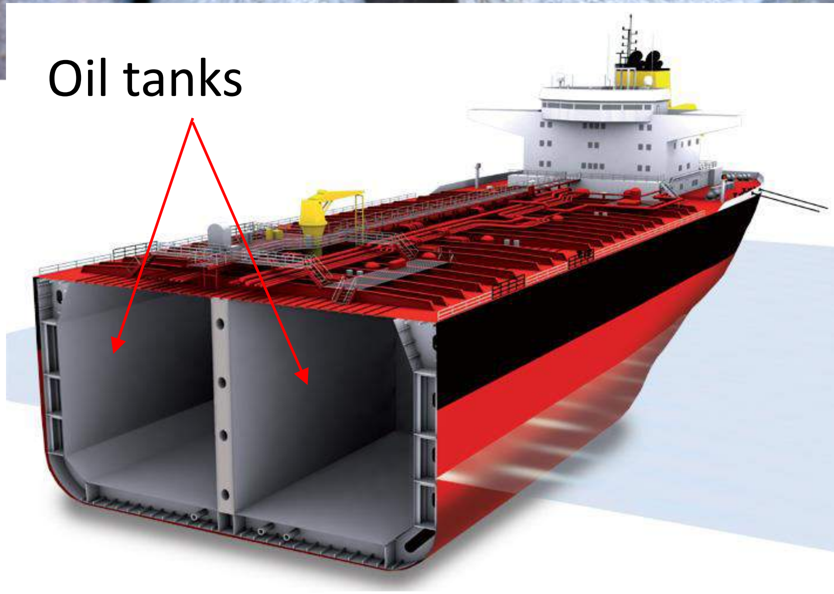
Structural damage length and width:



CASE STUDY: RESULTS (damage size and volume of spilled oil)

All scenarios: Spilled oil as a function of damage length:

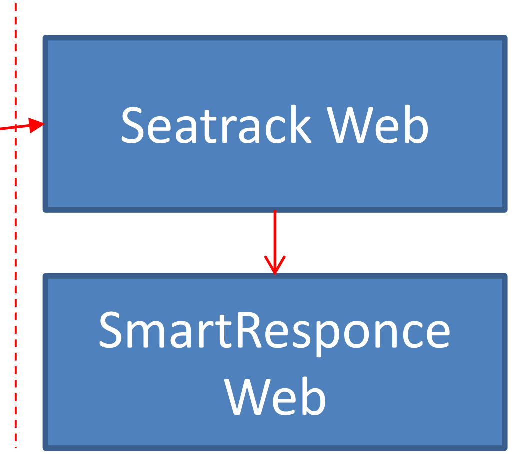




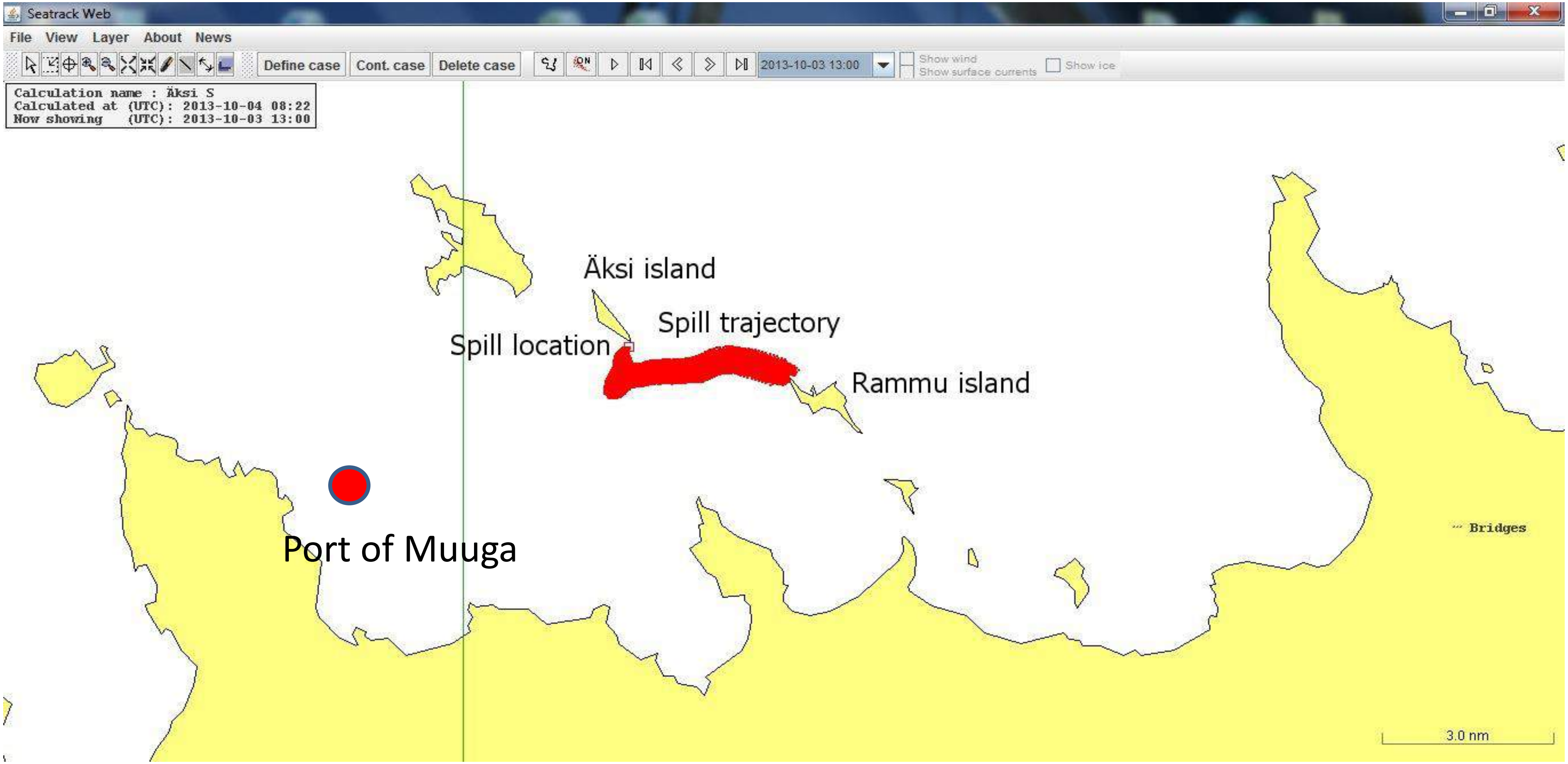
www.marineshight.com

Three scenarios with largest oil spills:

v	*a*	Penetr. *d*	l_{dam}	Oil spill
kn	m	m	m	m^3
14	3	4,0	163	2125
14	6	3,0	166	4249
14	6	4,0	139	3642

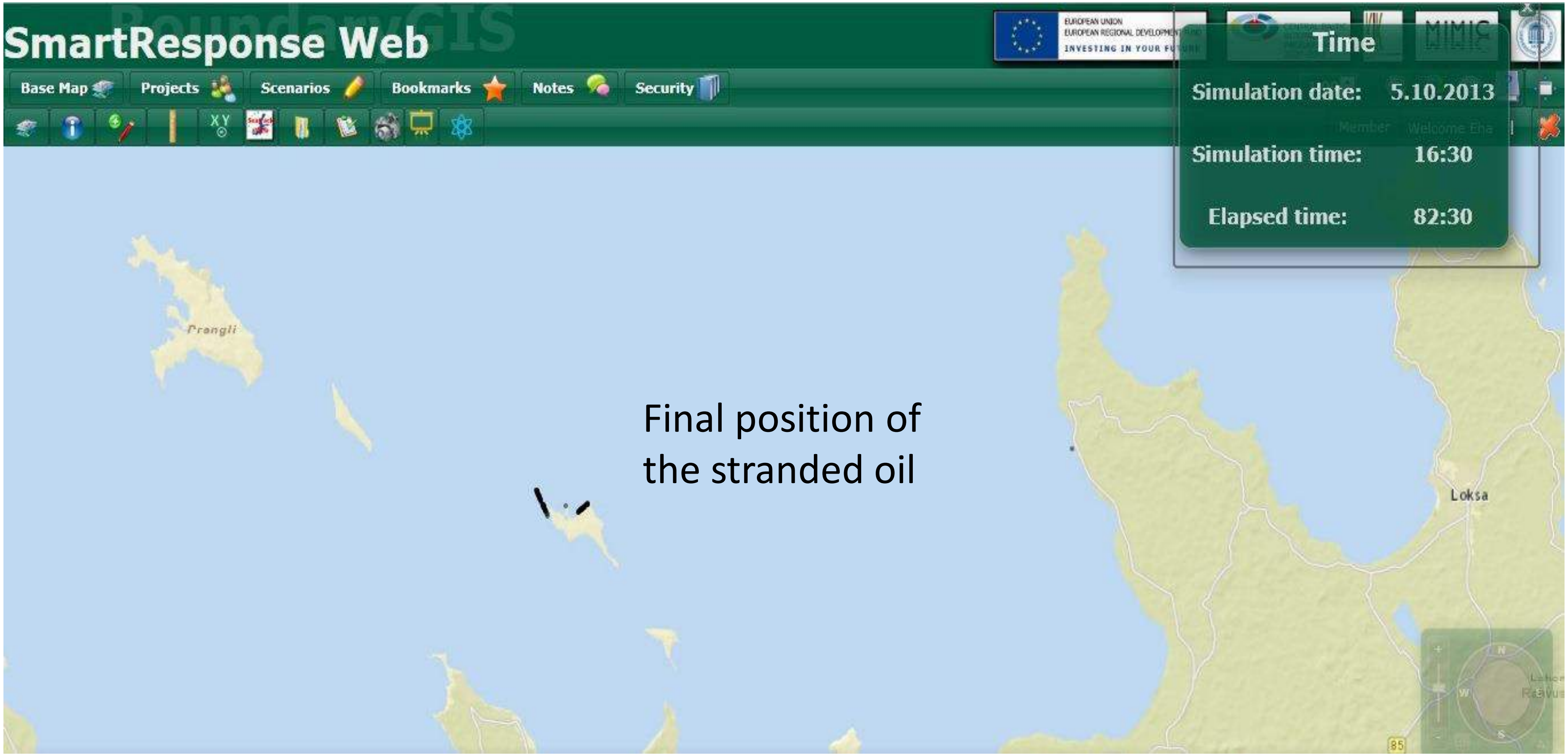


CASE STUDY: oil spill movement (Seatrack Web)



Movement of spilled oil

Movement of spilled oil



Impact to the sea areas and shoreline:

Spill, m³	ESI shore type	Impacted shore length km	Impacted sea area (km²) by environmental sensitivity index intervals 0-25	26-50	51-75	76-100
2125	Silty shore	1.23	0.07	0.16	0	0
3642	Gravel-pebble shore	1.77	0.24	0.03	0	0
4249	Gravel-pebble shore	1.95	0.35	0.08	0	0

Impact to the shoreline areas:

Spill m³	Oil stranding time (hours)	Impacted Natura area (km²)	Impacted Natura and Bird area (km²)
2125	45	0.97	0.49
3642	22.5	0.49	0
4249	25	0.56	0

Oil spill response exercise

Oil spill response exercise

Oil spill response exercise

Acknowledgements

This study is supported by the Estonian Science Foundation grant No.7609, Estonian target financing program SF0180104s08, Estonian Environmental Investment Centre and by Central Baltic INTERREG IVA Programme Project MIMIC ” Minimizing risks of maritime oil transport by holistic safety strategies”

MIMIC

cursor

Elinkeino-, liikenne- ja ympäristökeskus
Centre for Economic Development, Transport and the Environment

KOTKA
CITY BY THE SEA

Kymenlaakson ammattikorkeakoulu
University of Applied Sciences

SMHI

TALLINN UNIVERSITY OF TECHNOLOGY

TARTU ÜLIKOOL · UNIVERSITAS TARTUENSIS · 1632

SYKE

CENTRAL BALTIC
INTERREG IV A
PROGRAMME
2007–2013

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
INVESTING IN YOUR FUTURE

Thank you

Johanna Tengdelius Brunell

Reporting and classification by using the HYPE-model

SMHI

Research and development in every dimension

We conduct research in six main areas:

- Hydrology
- Oceanography
- Air Environment
- Atmospheric Research
- Forecasts and Analysis
- Climate Research

Agenda

The HYPE model

-Hydrological processes and water quality processes

Using HYPE for WFD

-Water web

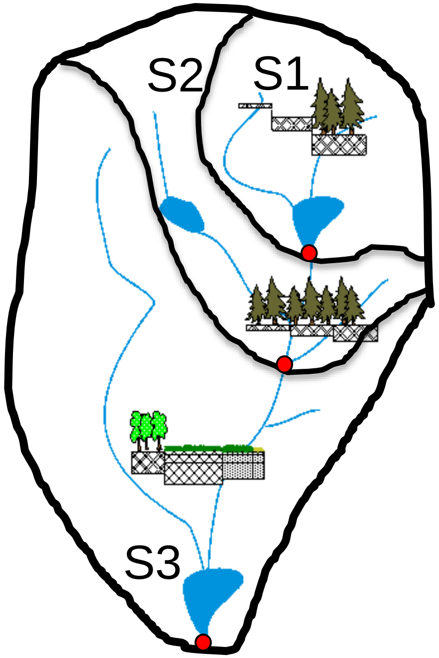
SMED-HYPE and reporting to HELCOM

Model concept - overview

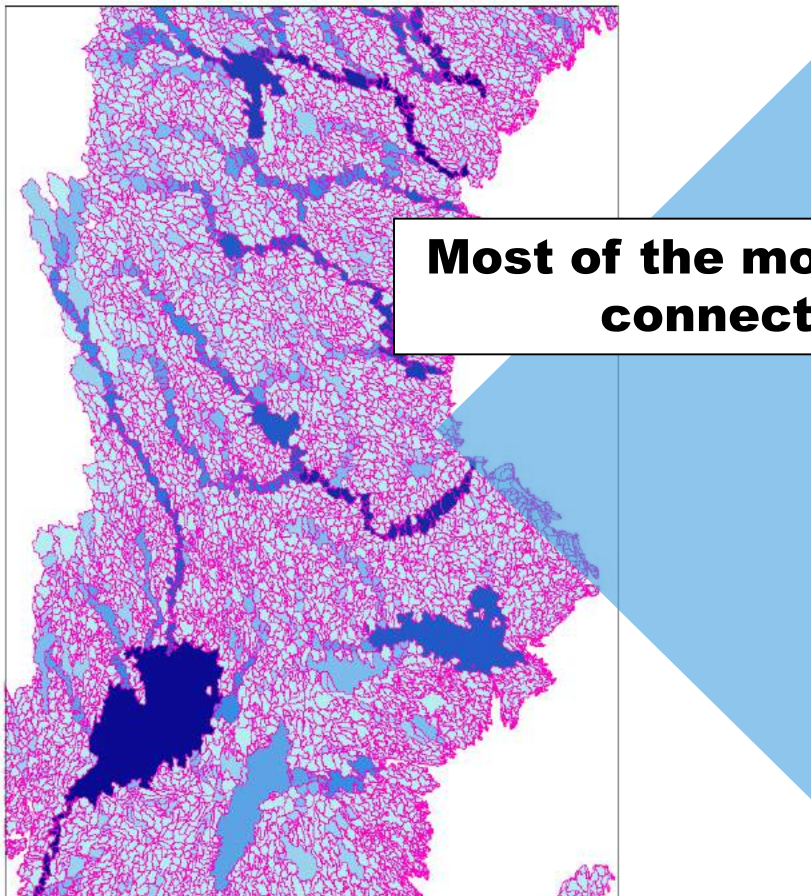
- HYPE: ”**Hy**drological **P**redictions for the **E**nvironment”

- Conceptual rainfall-runoff model with integrated N and P processes
- driven with rainfall and (min/max) temperature data, usually at daily time steps
- N driven with atmospheric deposition
- Scalable application, targeting large model domains
- Model domain divided into sub-catchments (i.e. not grid-based)

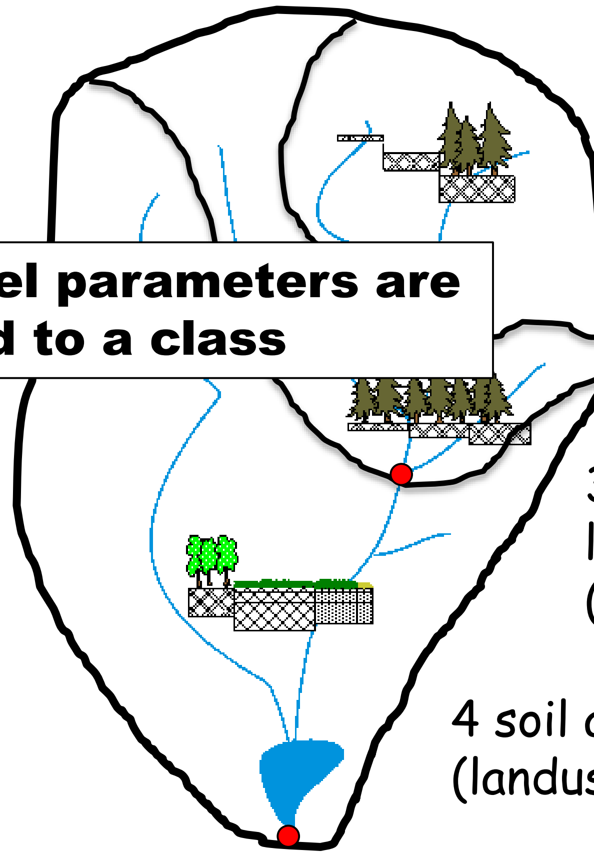
- Soil and landuse classes (SLC)
- ”static” information:
- Land cover
- Lakes and regulation
- Crop dynamics
- Point sources



Model concept – Division of the landscape

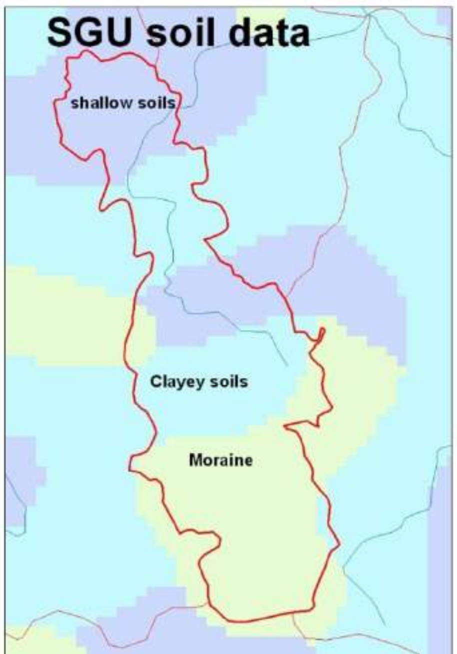


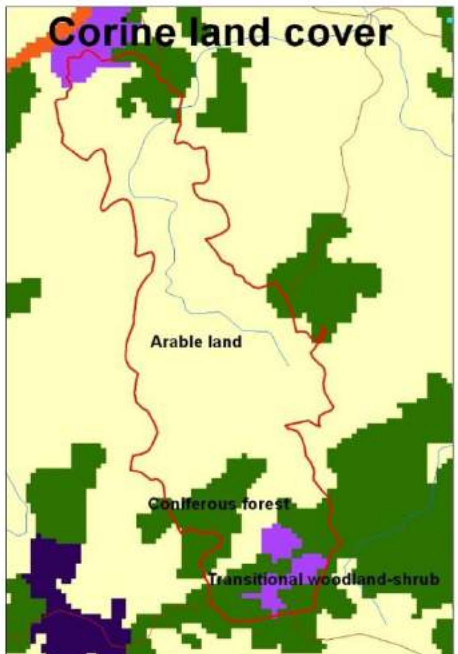
Most of the model parameters are connected to a class

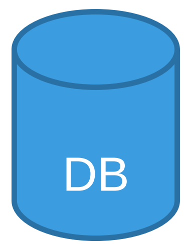


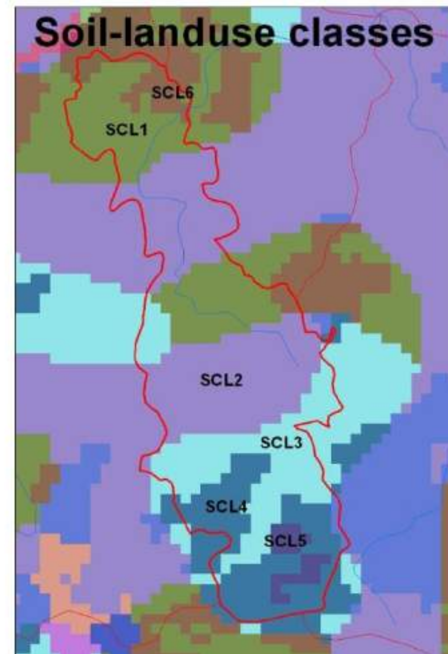
Soil and Land use classes

- Most parameters are dependent on either soil or land use
- No formal restriction on
  - No max limits of number of classes
  - Lakes are special



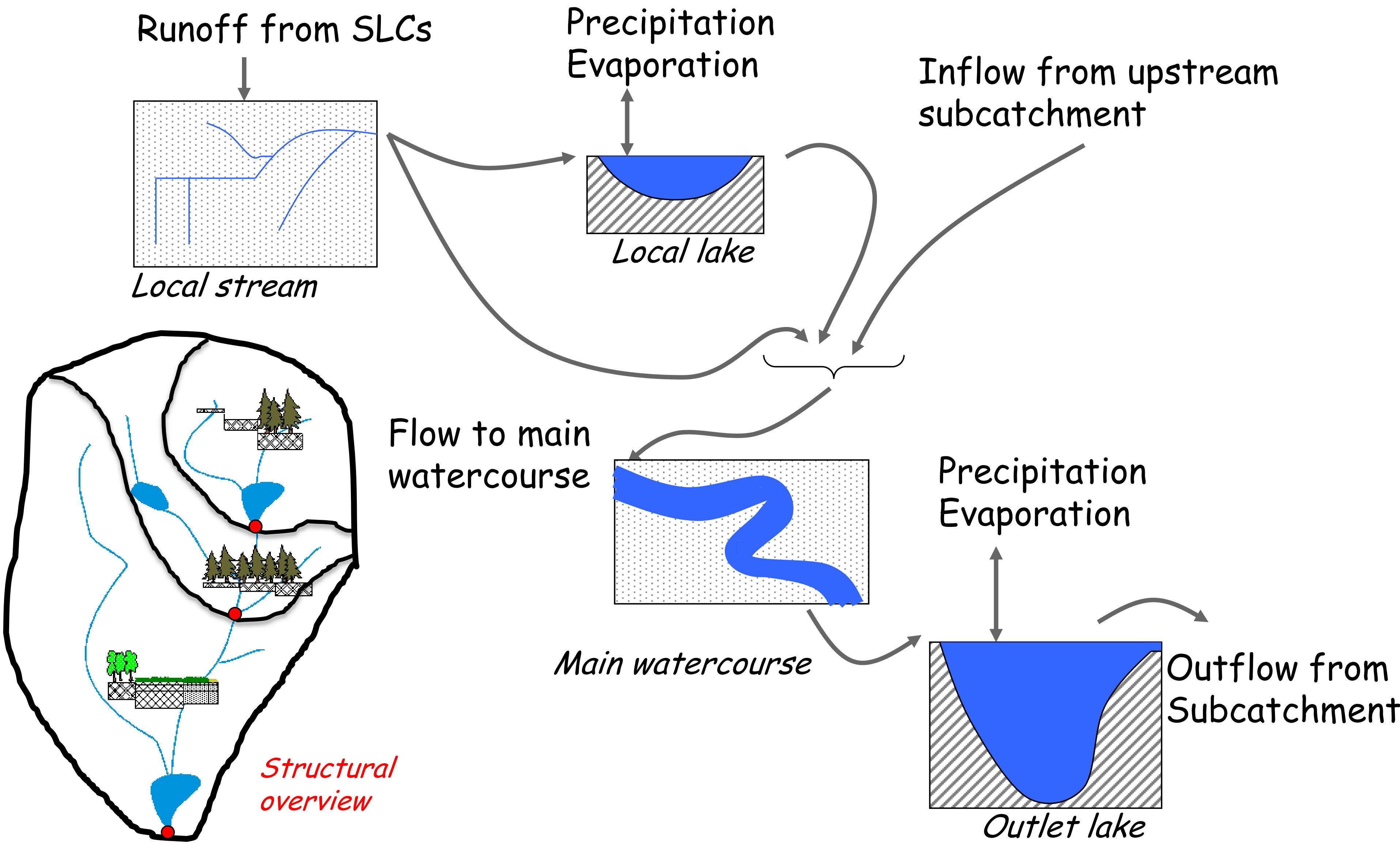




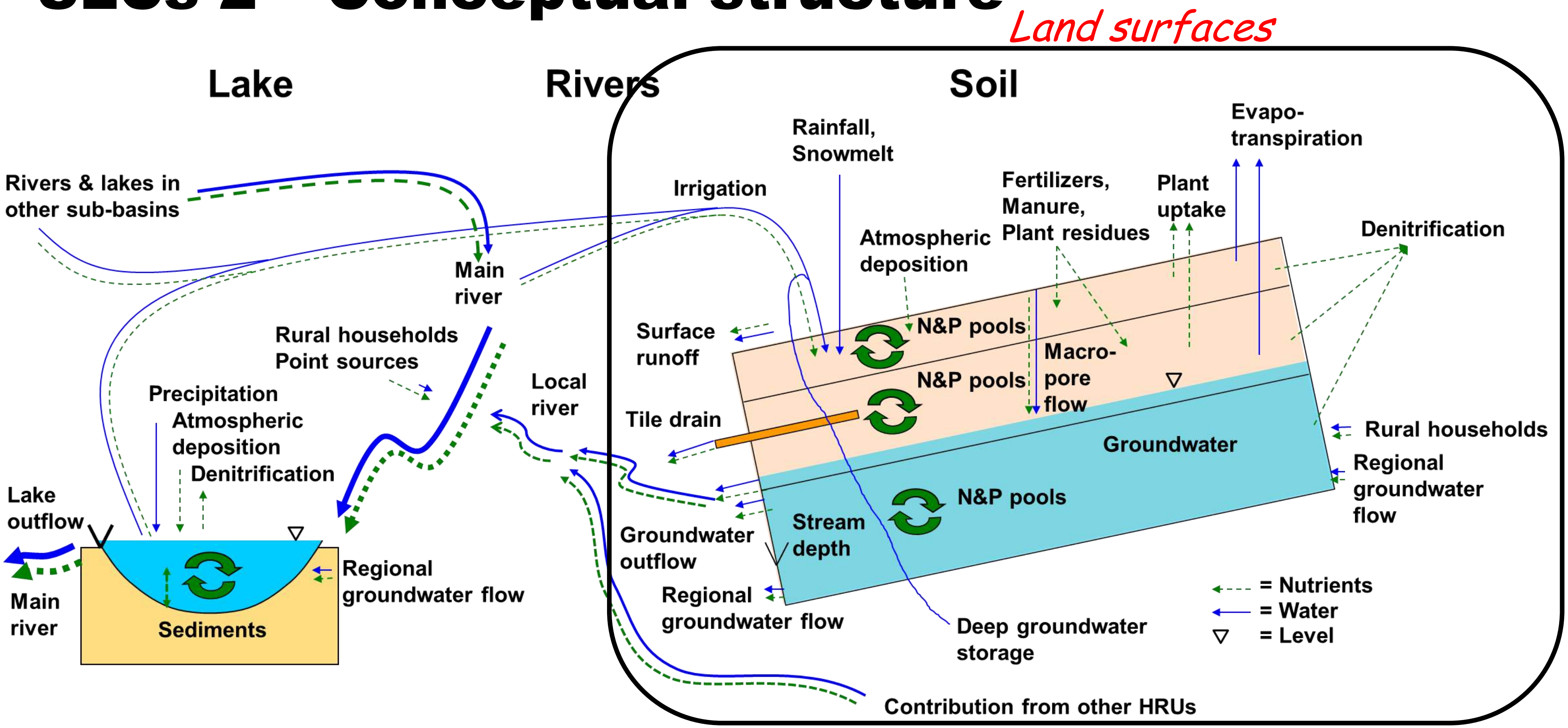


Soil + Landuse + Crops → Soil and Landuse! (simply called SLC)

Rivers, lakes, and routing



SLCs 2 – Conceptual structure



- Up to 3 different layers
- Different flowpaths/runoff
- Groundwater and soil moisture
- Nutrients
  - Sources and sinks
  - Turnover processes

Characteristic/Data type	Info/Name	Provider
Total area (km^2)	8.7 million	-
No. of sub-basins	35408 (mean size 248 km^2)	-
Topography (routing and delineation)	hydroSHEDS (15 arcsec) Hydro1K	Lehner et al. (2008)
Soil characteristics	ESDB, DMSW, SGU	http://eusoils.jrc.ec.europa.eu/esdb_archive/ESDB/Index.htm
Land use characteristics	CORINE, GlobCover	http://www.epa.ie/soilandbiodiversity/soils/land/corine/#.U9JKH2Nv-no
Reservoir and dam	Global Reservoir and Dam database (GRanD)	Bernhard et al. (2011)
Lake and wetland	Global Lake and Wetland Database (GLWD)	Lehner & Döll (2004)
Irrigation	Global Map of Irrigation Areas (GMIA)	Siebert et al. (2005)
Discharge	GRDC, EWA and others (2690 stations)	http://www.bafg.de/GRDC
Precipitation	WFDEI (0.5^o x 0.5^o)	Weedon et al. (2011)
Temperature (mean, min, max)	WFDEI (0.5^o x 0.5^o)	Weedon et al. (2011)
Snow cover area	GlobSnow	Weedon et al. (2011)
Evapotranspiration	MODIS (PET, AET)	-

↓

WHIST

SMHI

SUBID	MAINDOV	BRANCHD	HARO	AROID	AREA	RIVLEN	LAKEDATAID	SLOPE_MEAN	SLOPE_STD	ELEV_MEAN	SLC_1	SLC_2	SLC_3	SLC_4	SLC_5	SLC_6	SLC_7	SLC_8	SLC_9	SLC_10	SLC_11	SLC_12
33763	33792	0	1000	737678-18	34333379	12205	0	4.44875	3.95389	90.8	0	0.0561	0	0	0	0	0.0816	0	0.0379	0.4527	0.0617	0
34697	34680	0	1000	741992-18	98547948	19104	0	1	1	125.9	0	0	0.081	0	0	0	0	0	0	0.8175	0	0
35124	35116	0	1000	744666-18	44286804	11670	0	3.52763	2.8764	173.4	0.0082	0.0793	0	0	0	0	0.2537	0.0116	0.0455	0.4144	0.0048	0.0542
34018	33753	0	1000	738750-18	3.12E+09	126758	0	1	1	146.3	0	0	0.054	0	0	0	0	0	0	0.848	0	0
35805	35754	0	1000	748478-18	62817604	16814	0	2.51244	2.54807	198.4	0	0.273	0.007	0	0	0	0.2722	0	0.011	0.3052	0.0128	0
36021	35827	0	1000	749451-18	50034615	8259	0	3.18308	4.52345	233.5	0.0094	0.4834	0	0	0	0	0.1334	0	0.0511	0.1489	0.0575	0.0027
36137	36003	0	1000	750020-18	54189160	8623	0	2.89359	3.4608	243.2	0	0.3504	0	0	0	0	0.1751	0	0.0551	0.2547	0.0846	0
36233	36109	0	1000	750567-18	56312523	17042	0	3.07397	2.98403	245.9	0	0.329	0	0	0	0	0.1965	0	0.0806	0.3232	0.0452	0
36166	36130	0	1000	750194-18	1.08E+08	13979	0	0	0	237	0	0	0.334	0	0	0	0	0	0	0.6011	0	0
36368	36283	0	1000	751546-17	41888431	11502	0	3.39975	2.81944	278.1	0	0.2412	0	0	0	0	0.1586	0.0237	0.0398	0.393	0.0436	0.0551
36241	36219	0	1000	750637-18	46573325	15517	0	1	1	197.4	0	0	0.1391	0	0	0	0	0	0	0.4866	0	0
36374	36328	0	1000	751573-17	24832617	9091	0	2.02118	1.5452	290.7	0	0.6437	0.002	0	0	0	0.0691	0	0.0931	0.143	0.0038	0
36484	36458	0	1000	752433-18	3330146	1	0	3.29286	3.14589	340.8	0.3294	0	0	0	0	0	0.0052	0	0	0.494	0.0083	0
36039	35988	0	1000	749525-18	4.84E+08	60547	0	1	1	218.9	0	0	0.349	0	0	0	0	0	0	0.5393	0	0
36524	36510	0	1000	752641-17	53157193	12735	0	3.5965	5.17797	374.9	0	0.283	0	0	0	0	0.1476	0	0.0069	0.4547	0.0208	0
36626	36678	0	1000	753264-16	30413365	4478	1	3.68984	3.40828	447.5	0.055	0.1945	0.0178	0	0	0	0.1381	0	0	0.4795	0.003	0
36526	36483	0	1000	752643-17	66023843	18367	0	5.04924	5.09835	354.9	0	0.186	0	0	0.002	0	0.1165	0	0.0443	0.4563	0.0963	0
36667	36728	0	1000	753508-17	34980722	11029	0	3.48353	3.1978	309.2	0	0.221	0	0	0	0	0.0785	0	0.1295	0.4837	0.0638	0
36778	36723	0	1000	754180-18	7319151	597	0	2.84042	2.32123	282.7	0	0.3003	0	0	0	0	0.11	0	0.1453	0.4105	0.0128	0
36660	36640	0	1000	753479-17	91365677	13307	0	2.31375	2.30052	361.7	0	0.5427	0.021	0	0	0	0.1119	0	0.0421	0.2325	0.0029	0
36760	36737	0	1000	754082-18	20431972	9323	0	5.51731	3.86194	340.5	0	0.1039	0	0	0	0	0.0656	0	0.0118	0.5027	0.0764	0
36764	36709	0	1000	754098-17	29440982	10331	0	5.37975	3.67963	368.3	0	0.118	0	0	0	0	0.0667	0	0.1943	0.315	0.0991	0
36774	36761	0	1000	754159-17	19185052	6645	0	3.60562	3.18616	360.1	0	0.2553	0	0	0	0	0.0989	0	0.0339	0.3666	0.012	0.021
36755	36659	0	1000	754015-17	26764469	12364	0	3.17853	2.56836	418.7	0	0.2897	0	0	0	0	0.1518	0	0.0248	0.4889	0.0038	0
36766	36659	0	1000	754111-17	55242640	16511	0	4.32625	4.4134	406.9	0	0.3614	0	0	0.008	0	0.0804	0	0.0096	0.2478	0	0
36784	36723	0	1000	754231-18	42902745	13674	0	4.12171	2.69766	353.1	0	0.1642	0	0	0	0	0.1041	0	0.0629	0.3987	0.0029	0
36802	36773	0	1000	754430-17	39377796	12113	0	3.40813	2.79863	400.1	0	0.168	0	0	0	0	0.1467	0.0088	0.0372	0.4617	0.0665	0.0029
36229	36165	0	1000	750551-18	6.49E+08	60537	0	0	0	272	0	0	0.1838	0	0	0	0	0	0	0.7105	0	0
36833	36627	0	1000	754595-17	46491442	14957	0	5.56049	3.49783	411.3	0	0.1762	0	0	0	0	0.075	0	0.1598	0.2153	0.0136	0
36835	36691	0	1000	754609-18	67070738	14120	0	3.624	3.0008	252.3	0	0.247	0	0	0	0	0.1177	0.0108	0.2296	0.3002	0.0147	0.0147
36957	37026	0	1000	755722-17	45053673	12339	0	4.64354	3.83293	435.3	0	0.3557	0	0	0	0	0.058	0	0.06	0.279	0.011	0
36913	36867	0	1000	755356-17	32623239	6801	0	5.82447	4.03189	478.4	0	0.164	0	0	0.011	0	0.059	0	0.008	0.3489	0	0
36855	36810	0	1000	754841-17	41624791	15962	0	4.16427	3.28616	425.9	0	0.21	0	0	0	0	0.089	0	0.048	0.3069	0.003	0.006
36909	36916	0	1000	755307-18	2.91E+08	29856	0	1	1	283.9	0	0	0.2328	0	0	0	0	0	0	0.6391	0	0
36986	36994	0	1000	755933-17	52226903	12102	0	6.07834	4.37026	421.3	0	0.139	0	0	0.005	0	0.0451	0	0.0285	0.2316	0.0216	0
36827	36773	0	1000	754575-17	74492851	21657	0	4.30144	3.59401	426	0	0.181	0.005	0	0	0	0.091	0	0.0068	0.3404	0.0078	0.0127
36966	37026	0	1000	755759-17	41984876	9981	0	3.30798	2.48051	427.3	0	0.4645	0	0	0	0	0.0749	0	0.012	0.1778	0.001	0
36978	36961	0	1000	755876-17	21993503	9052	0	4.66913	2.93004	548.5	0	0.312	0	0	0	0	0	0	0	0	0	0

```
32  1998-01-30  0.04687 0.02004 72.616  -9999   88.99136   -9999   161.60736  -9999   139.32828  -9999   1.67887 -9999   141.00714  -
33  1998-01-31  0.03391 0.01942 72.46265   -9999   91.86668   -9999   164.32933   -9999   136.1199    -9999   1.71484 -9999   137.83475
34  1998-02-01  0.02466 0.0139  73.25093   -9999   94.09695   -9999   167.34789   -9999   133.85985   -9999   1.78096 -9999   135.64079
35  1998-02-02  0.01807 0.01409 74.70833   -9999   95.8716 -9999   170.57994   -9999   132.25864   -9999   1.86821 -9999   134.12686   -
```

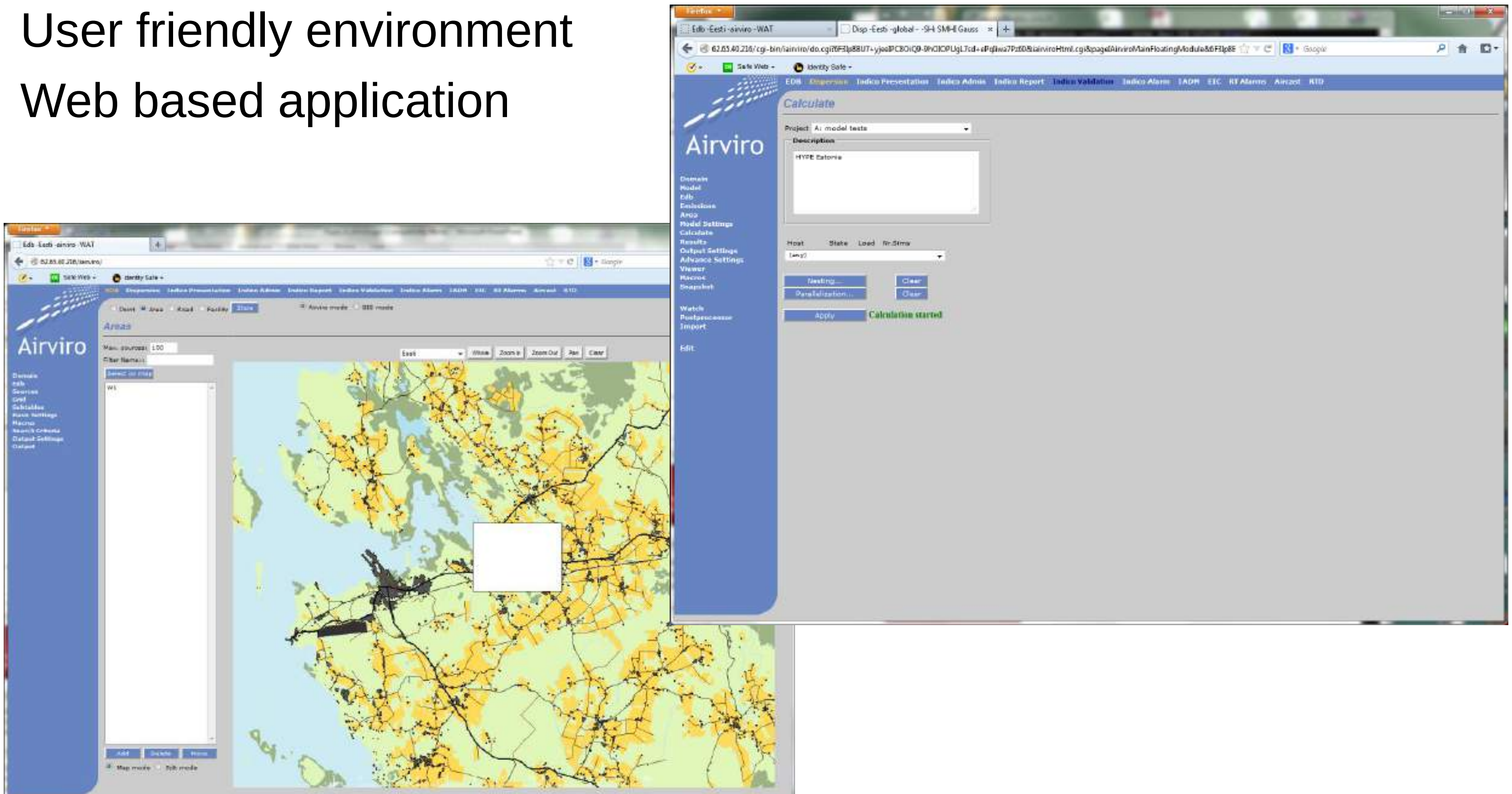
Normal text file | length : 352670 lines : 2925 | Ln : 1 Col : 1 Sel : 0 | Dos\Windows | ANSI | INS

1998 2000 2002 2004 2006 2008

SMHI

Airviro

- Already existing system for air quality management
- User friendly environment
- Web based application



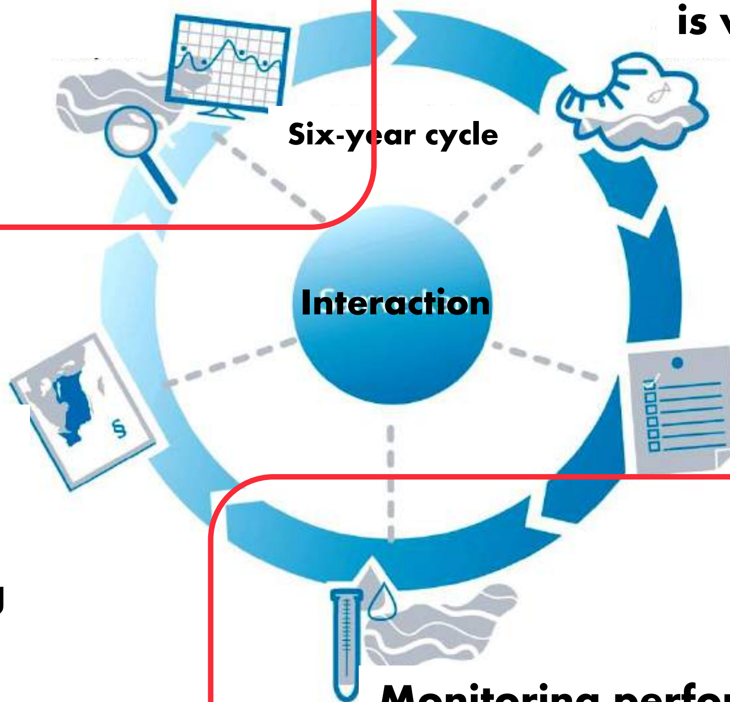
Using S-HYPE for WFD in Sweden

- New administrative organisation:
  the water authority
- No longer administrative boundaries
- Instead natural water boundaries

The water management work cycle

The conditions in the bodies of water are analysed

An action programme is worked out



The quality requirements that will apply to each body of water are established

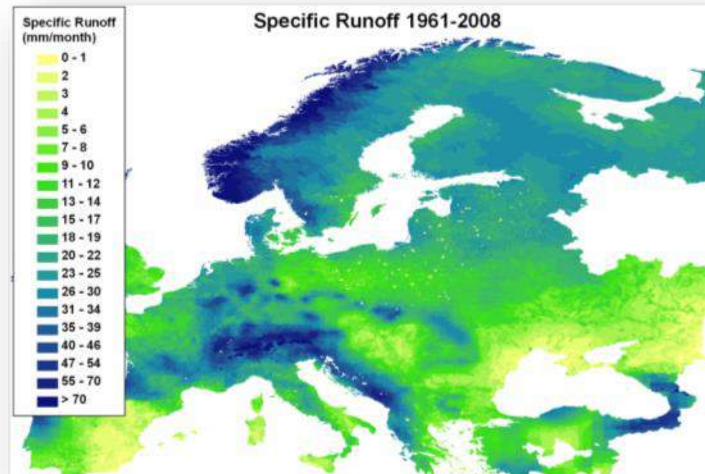
Design management plan and reporting

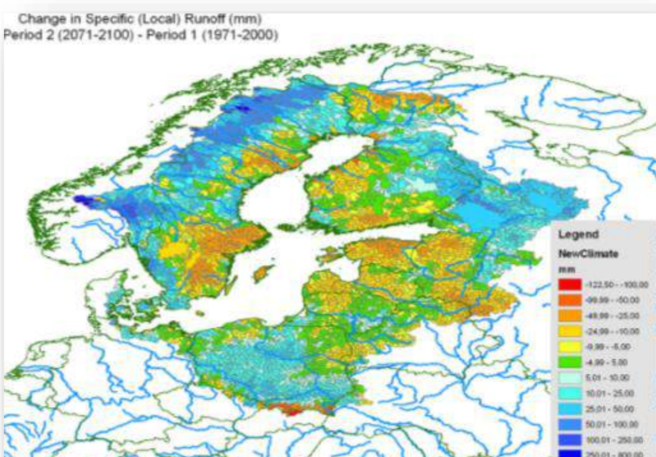
Monitoring performed

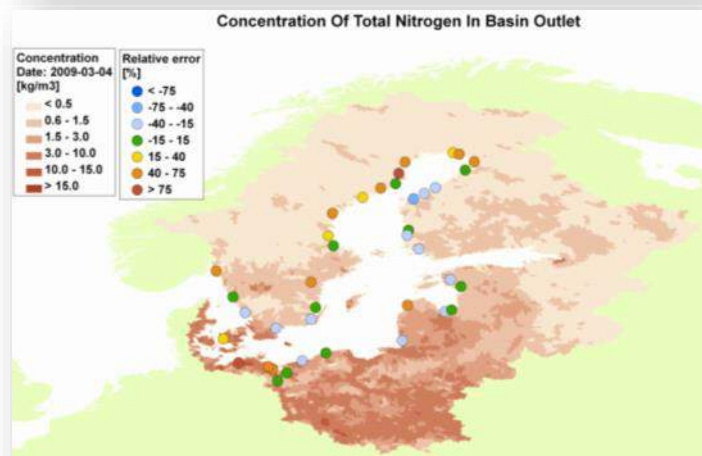
SMHI

How models can support WFD

- Fill gaps in space and time
- Support monitoring programmes
- Calculate source apportionment of emissions
- Run scenarios



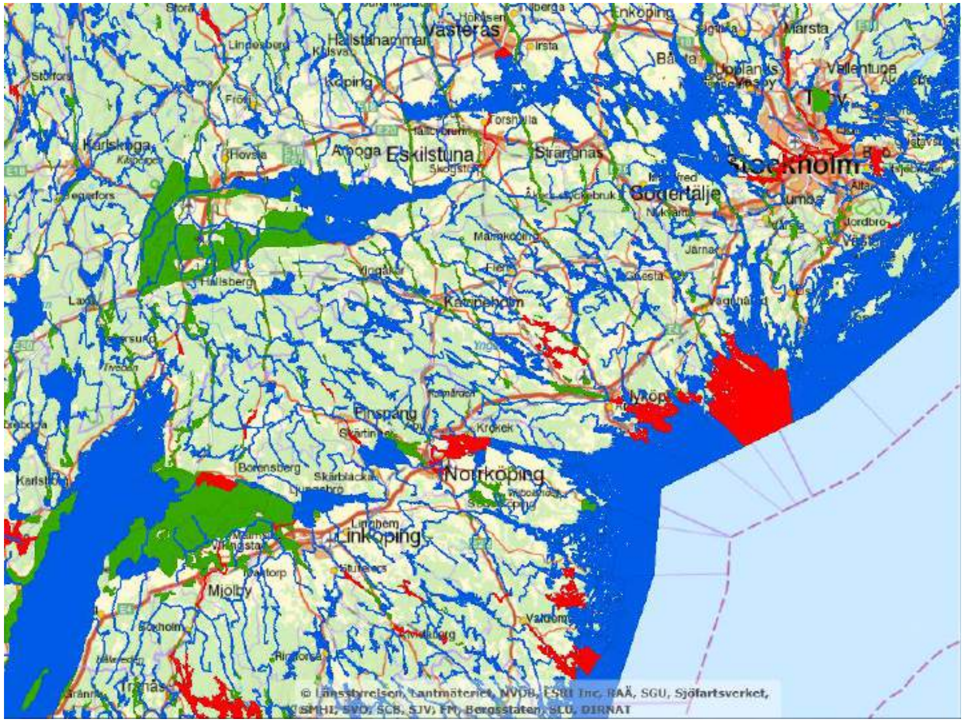




Classification of water bodies

- Water authority is responsible for the classification

- A help to give information about the nitrogen and phosphorus status



Vattenwebb – an online source of data from S-HYPE

http://vattenwebb.smhi.se

PLC6

- Swedish Agency for Marine and Water Management are responsible for reporting to HELCOM, the Helsinki Commission.
- Assignment: Report the load of nitrogen and phosphorus at the Baltic Sea 2013
- Every ~sixth year

The Swedish environmental research institute

Load from rural
and urban surfaces

SMHI

Runoff
Retention

Statistics Sweden

Load from point sources
Other statistic to support all the other models

The Swedish University of Agricultural Sciences

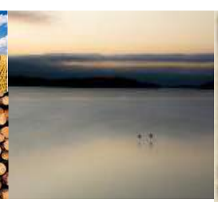
Leakage from agriculture and other land uses

Total load
Source apportionment

PLC6

- Year one (2014), Runoff

- Year two (2015), Retention



Compile

Thank You!

- **HYPE**
  http://hype.sourceforge.net/

- **Airviro**
  http://www.smhi.se/airviro

- **Water web**
  http://vattenweb.smhi.se/

SWAT-i kasutamiskogemus Eestis

Ottar Tamm
Eesti Maaülikool
Veemajanduse doktorant
Toomas Tamm
Veemajanduse osakonna juhataja

Ettekande teemad

SWAT mudel - mis ja miks?

Mudeli sisendid

SWAT Eestis

Probleemid!?

SWAT Maailmas

- Eesmärk – olla esimene ülemaailmselt kasutatav hüdroloogiline mudel
- SWAT'i loojate ambitsioon – katta kogu maakera!
- Üle 4000 teadusartikli, kasutades SWAT mudelit
- Üks enim kasutatavaid füüsikalis-hüdroloogilisi mudeleid!

SWAT

SWAT (Soil and Water Assessment Tool)

„Pinnase ja vee hindamise tööriist“

Füüsikalis-hüdroloogiline mudel, mis on esialgselt mõeldud hindamaks maakasutuse mõju hüdroloogiale ja setete liikumisele

Ruumiskaala – valgla (või suurem)

Ajaskaala – ööpäev (või pikem)

SWAT

Võimalik modelleerida:

- vooluhulk
- sette liikumine
- vee kvaliteet (taimetoitained: lämmastik, fosfor; patogeenid, jm)

Kasutuseesmärgid

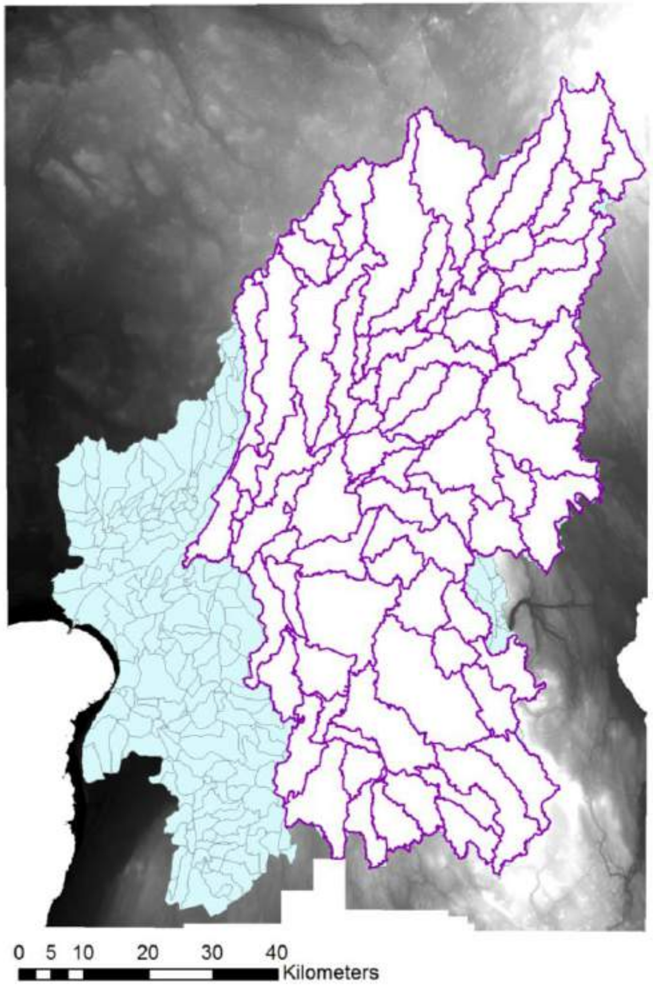
- Kliima ja kliimamuutuste mõju jõgedele (vooluhulgad, vee kvaliteet, jms)
- Modelleerida vooluhulkasid jõe suvalisse punkti ja valglatele, kus puuduvad mõõtmised *(ungauged catchments)*
- Hinnata maakasutuse muutuse mõju hüdroloogiale, veekvaliteedile, jms

SWAT - Sisendit

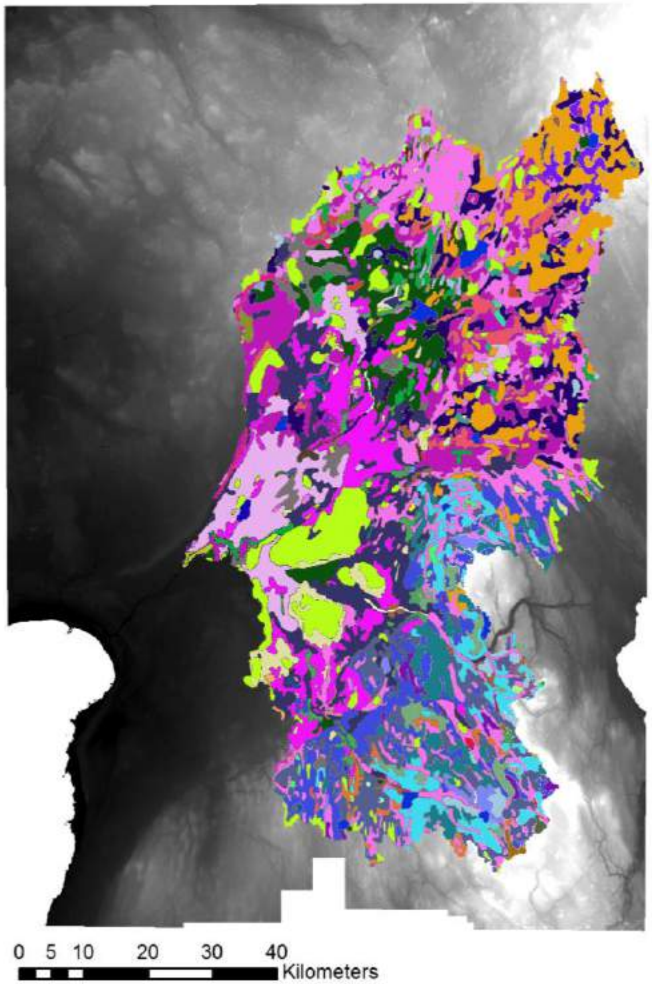
- Sisendid:
  - Kliima – sademed, temperatuur, päikesekiirgus, tuulekiirus, õhuniiskus
  - Kaardikihid: kõrguskaart (DEM), maakasutus, mullakaart
  - Reostus *(point source)*
  - *Taimekasvatus* (pestitsiidid, väetamine, kündmine, jms)

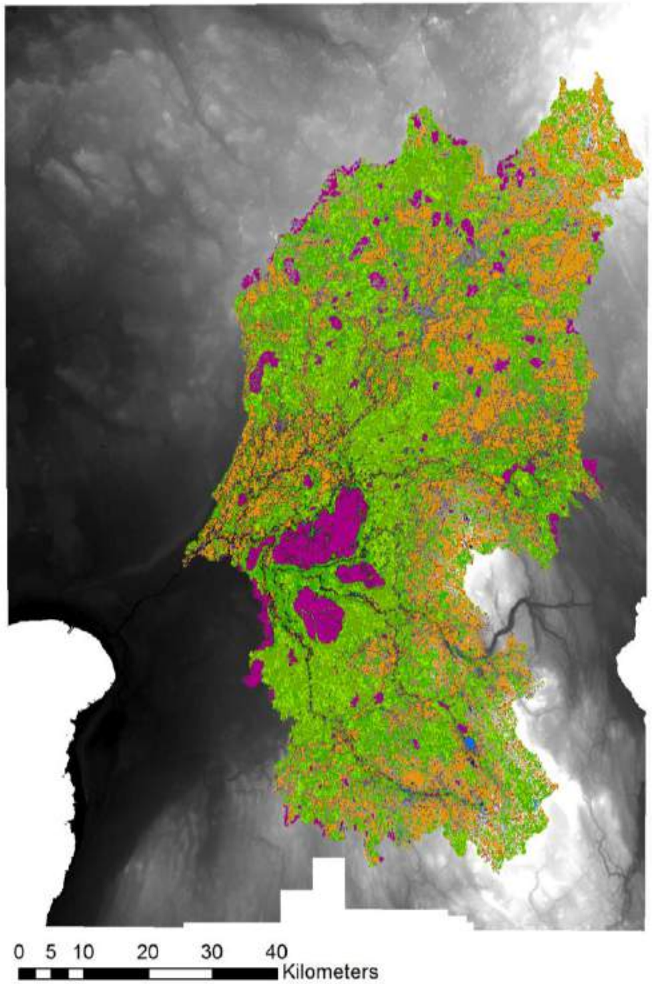
Kõrguskaart (DEM)

- DEM resolutsioon
- Valglate kaardi kasutamine ja/või nende genereerimine *(delineation)*



Mulakaart ja maakasutuse kaart

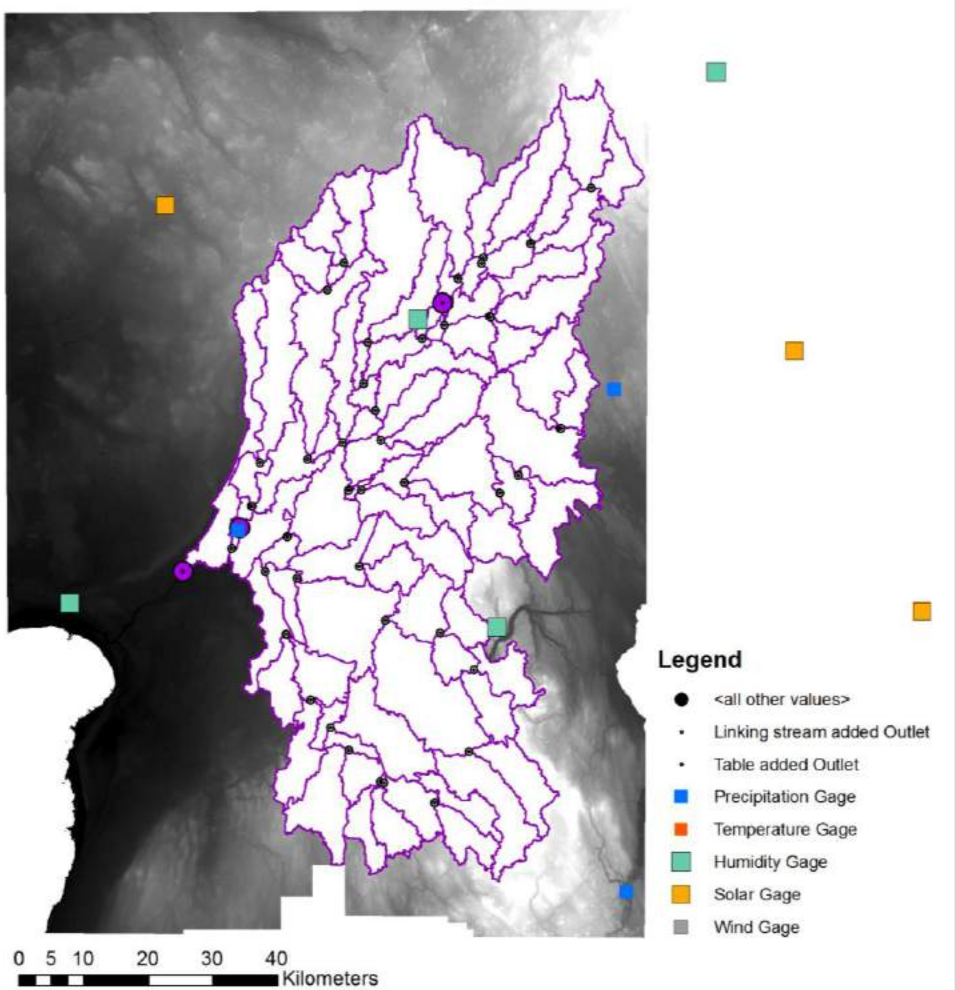




Meteoroloogilised sisendid

Mõõtmisjaamad:

- Türi
- Viljandi
- Pajusi
- Väike-Maarja
- Tahkuse
- Tõrva
- Pärnu
- Kuusiku



Äravoolu arvutus

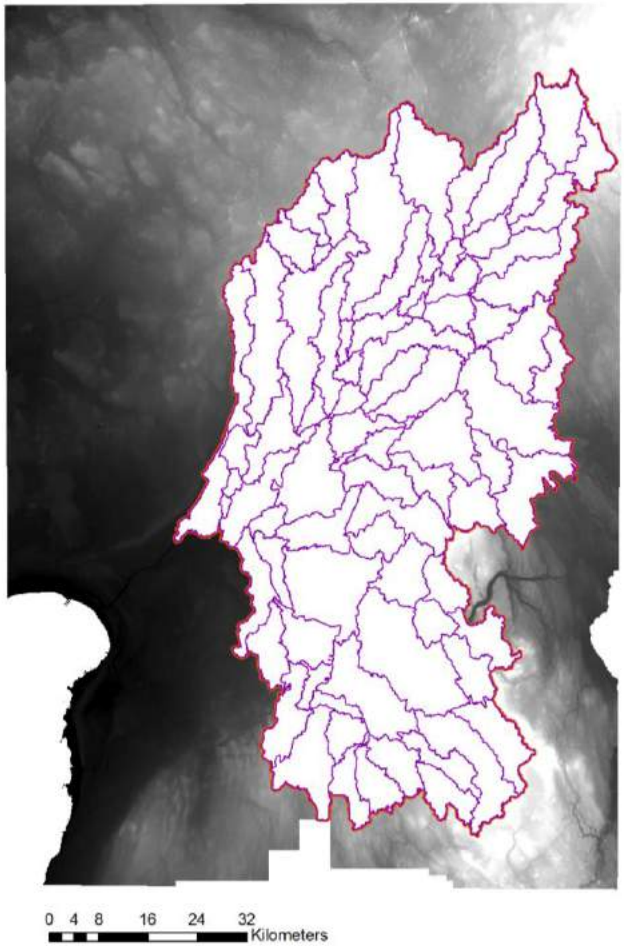
Valgala

↓

Alamvalgalad

↓

HRU (ühetaoline füüsikalis-geograafiline ala)



SWAT Eestis

Kes kasutab?

Eesmärk?

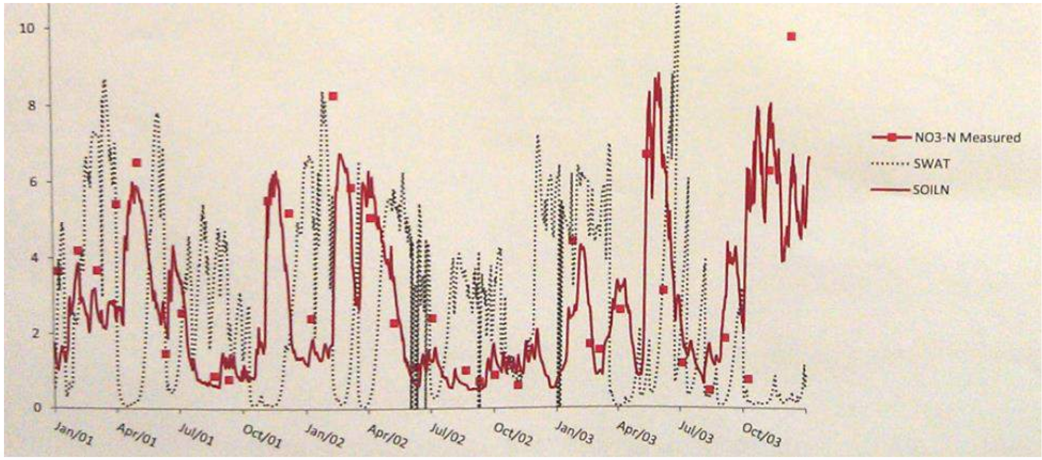
Millised on modelleerimise tulemused?

SWAT Eestis (näited)

Tallinna Tehnikaülikool

Lämmastiku modelleerimine

Leivajõgi, Pärnu



SWAT Eestis

Keskkonnaagentuur (Keskkonnateabekesus)

KTK poolt uuritud jõgedes jäi r^2 väärtus lämmastiku osas kõigis seiratud punktides alla 0.25

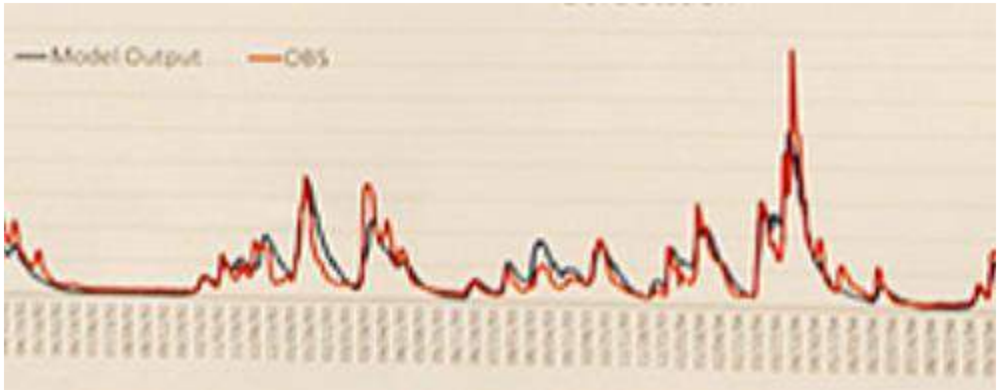
SWAT Eestis

Keskkonnaagentuur (EMHI)

Töötav... vooluhulga mudel:

Pärnu 1992-1995

Emajõgi 2008-2013



Eesmärk kasutada koos ilmaennustusega (HIRLAM või ECMWF)

SWAT Eestis

Eesti Maaülikool – Veemajandus

Eesmärgid:

- jõgede hüdroenergeetilise potentsiaali modelleerimine

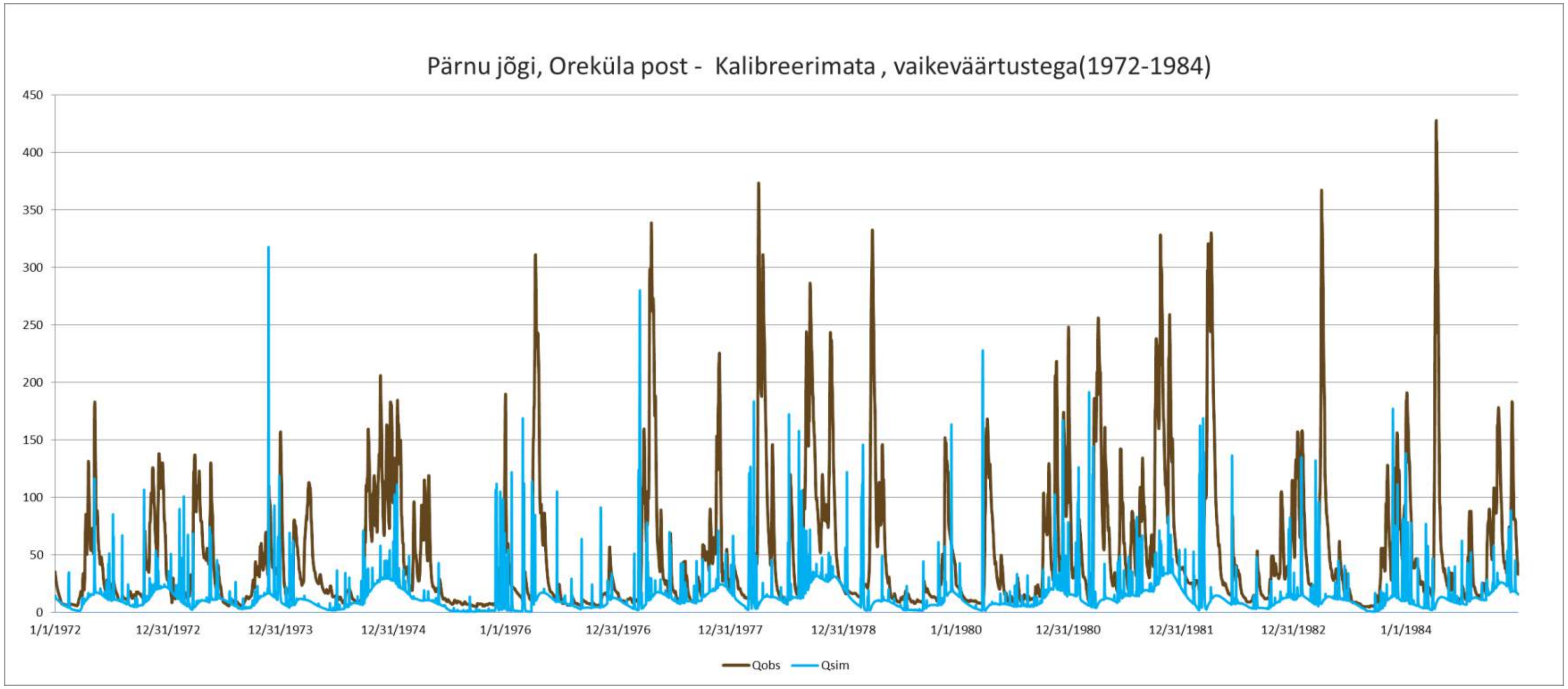
- kliimamuutuste mõju uurimine

SWAT Eestis

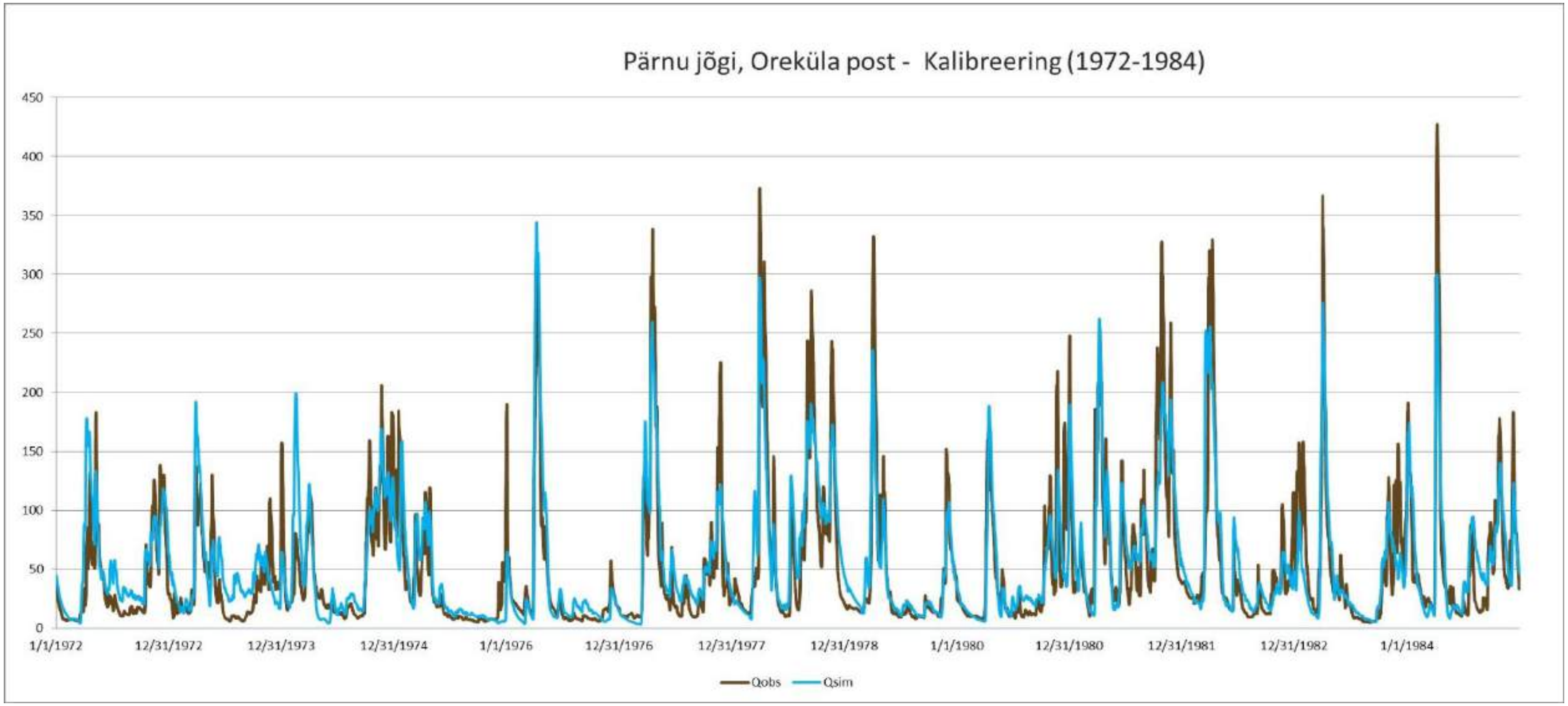
Töötav mudel?

Eesmärgipäraselt kasutatav mudel?

SWAT - Pärnu


Pärnu jõgi, Oreküla post - Kalibreerimata , vaikeväärtustega(1972-1984)
450
400
350
300
250
200
150
100
50
0
1/1/1972
12/31/1972
12/31/1973
12/31/1974
1/1/1976
12/31/1976
12/31/1977
12/31/1978
1/1/1980
12/31/1980
12/31/1981
12/31/1982
1/1/1984
Qobs
Qsim

SWAT - Pärnu



Sarnased tulemused üle Eesti

perioodil 1972-2010

	R2	NS	PBIAS (%)
Kalibreering 1	0.77	0.77	6.37
Kalibreering 2	0.77	0.76	-9.95
Valideering	0.75	0.74	-6.70

Probleemid

Ebamäärasused modelleerimises (uncertainty) :

- sisendandmetes
- mõõtmistulemustes
- mudelis endas (nt lihtsutused!)
- mudeldaja teadmised ja kogemused

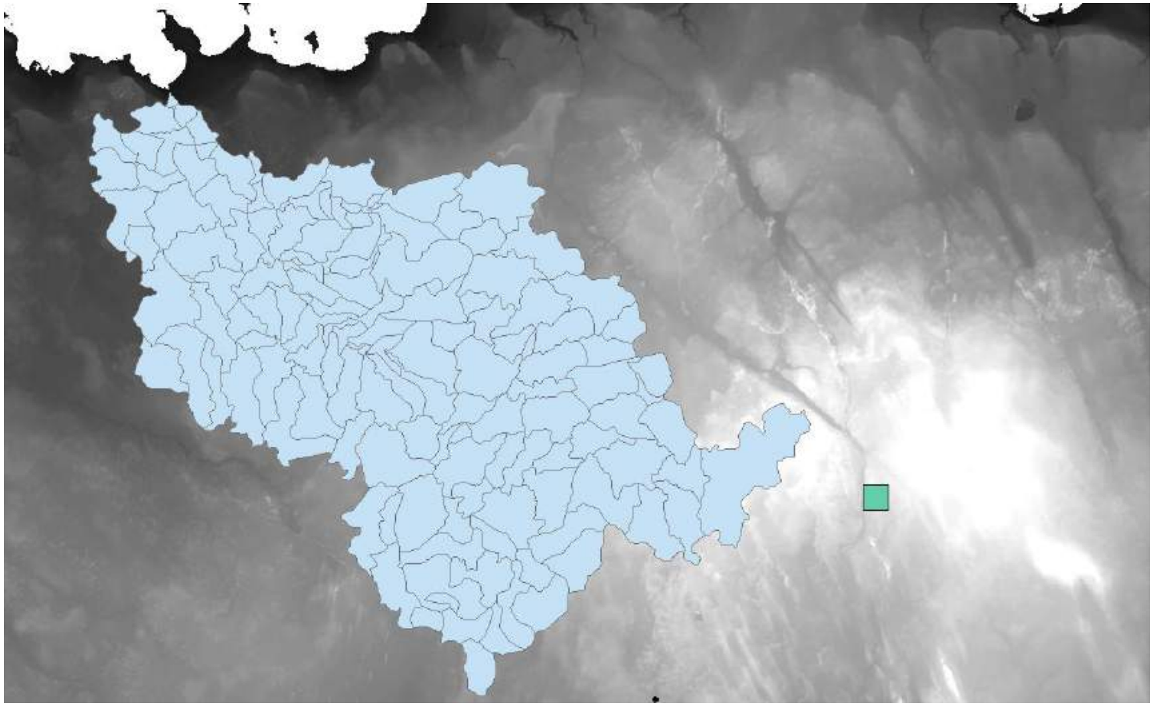
Probleemid

Kliima sisendite täpsus?

- Meteojaamade tihedus ja arv Eestis
- Vaatlusridade pikkus ja mõõdetavate kliimaparameetrite arv
- Automaatjaamadele üleminek, mõõtmisviga

Probleemid

Näiteks sademed…



Probleemid

Mullakaart

- Kui detailine, võib-olla liiga detailne?
- Mullaga seotud hüdrofüüsikalised parameetrid (nt veejuhtivus, veesisaldusomadused *(water retention)*, poorsus, jt)
- Hüdrogruppidesse jaotamine?

Probleemid

Maakasutuskaart

- Ajas muutuv
- Maakasutuse muutuse mõju näiteks mullaomadustele
- Maakasutuse muutus näiteks aurumisele ja transpiratsioonile

Lisaks: *point-source* andmete muutlikkus jms

Probleemid

Maakasutuskaardil vajalikud parameetrid:

CN2 väärtused Eestis?

Taimefüsioloogilsed parameetrid

Kokkuvõte

SWAT vajab paju sisendandmeid

SWAT mudelit tuleb kalibreerida ja valideerida

Tuleb arvestada ebamäärasustega ja andmetest tulenevate usalduspiiridega!

SWAT mudelit saab Eestis kasutada vooluhulkade modelleerimiseks!

Aitäh kuulamast!

Projekt: „Mudelite süsteemi ja töövahendi loomine mere ja maismaa pinnavete integreeritud haldamiseks"

Seminari päevakava

26. märts 2015 Tallinn Meriton Grand Conference & Spa Hotel Konverentsikeskus Peterson I saal

Aeg	Ettekandja	Teema
9.00 – 9.30	Registreerimine, tervituskohv	
9.30 – 9.40	**Rene Reisner** Keskkonnaministeerium, veeosakonna juhataja	Tervitussõnad
9.40 – 10.00	**Erik Teinemaa** Eesti Keskkonnauuringute Keskus OÜ, projektijuht	Projekti tutvustus
10.00 – 10.40	Akad. **Tarmo Soomere** Eesti TA president	Mere ja ranniku mudelite ning andmestike võimalusi ja kitsaskohti
10.40 – 11.20	**Tiit Kutser**, PhD Tartu Ülikool	Kaugseire ranniku- ja sisevete seisundi hindamisel
11.20 – 11.40	Kohvipaus	
11.40 – 12.20	**Robert Aps**, PhD TÜ Mereinstituut	Building common situational awareness for accidental oil spill emergency response
12.20 – 13.00	**Peeter Nõges**, PhD Eesti Maaülikool	Järvede seisundi hindamine keskkonnaandmete alusel

13.00 – 14.00	Lõuna	
14.00 – 14.40	**Mika Nieminen**, PhD Natural Resources Institute Finland	Calculation tools for N and P exports from forests/peatlands to waters in Finland
14.40 – 15.20	**Per Stalnacke**, PhD Norwegian Institute for Agricultural and Environmental Research	Nutrient fluxes from source to the sea
15.20 – 15.40	Kohvipaus	
15.40 – 16.20	**Johanna Tengdelius Brunell** MSc, Swedish Meteorological and Hydrological Institute	Reporting and classification by using the HYPE-model
16.20 – 17.00	Prof. **Toomas Tamm** Eesti Maaülikool **Ottar Tamm,** doktorant Eesti Maaülikool	SWAT-i kasutamiskogemus Eestis

Mere ja ranniku mudelite ja andmestike võimalusi ja kitsaskohti

Tarmo Soomere

Eesti Teaduste Akadeemia

TTÜ Küberneetika Instituut
Lainetuse dünaamika labor
Mittelineaarsete Protsesside Analüüsi Keskus

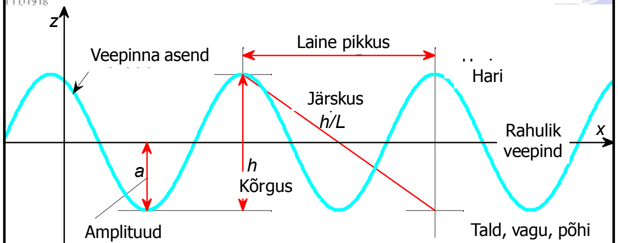
Esimene osa

Lained:
Üks meie maailma tugisambaid

Mass, energia, impulss liiguvad ühel moel kahest

- Liigub aine (mass, energia, impulss)
- Liigub laine (energia)
  - energia levimine mingis keskkonnas nõnda, et keskkond ise liigub minimaalselt
- veepinna mistahes häiritus hakkab levima pinnalaine(te)na

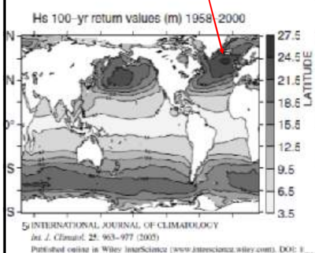
Lainetel on mõned omadused

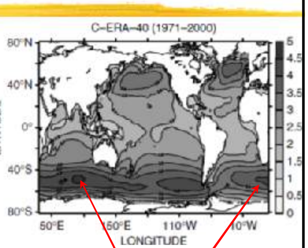


- Periood: ajavahemik kahe järjestikuse laineharja vahel
- Levikusuund
- Oluline lainekõrgus: 1/3 kõrgeimate lainete keskmine kõrgus

Ekstreemsed tingimused ja muidu kõrged lained: erinevates kohtades

Kõrgeimad lained üksikus tormis: Atlandi põhjaosas





Keskmine lainekõrgus: suurim möirgavatel 40ndatel

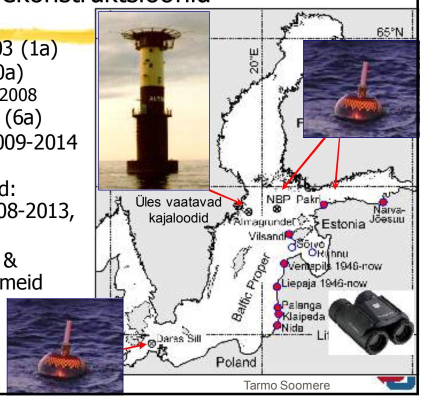
INTERNATIONAL JOURNAL OF CLIMATOLOGY
Int. J. Climatol. 25: 963–977 (2005)

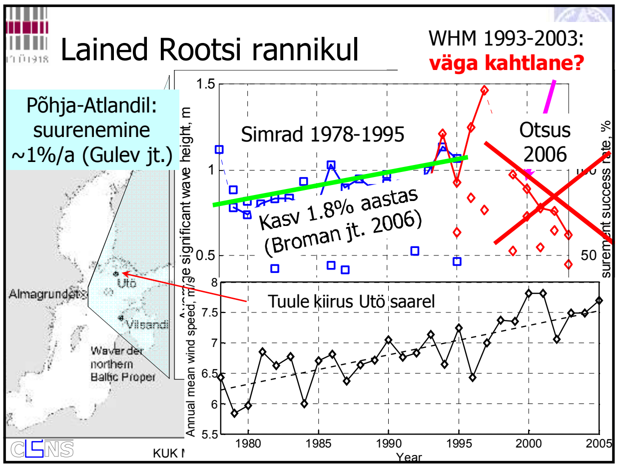
CLIMATOLOGY, VARIABILITY AND EXTREMA OF OCEAN WAVES: THE WEB-BASED KNMI/ERA-40 WAVE ATLAS

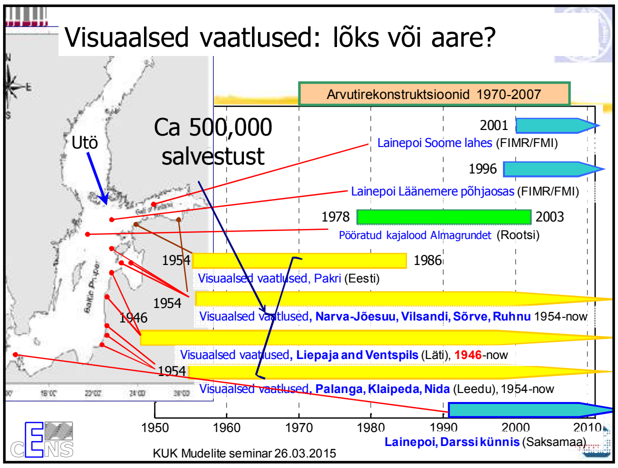
ANDREAS STERL and SOFIA CAIRES

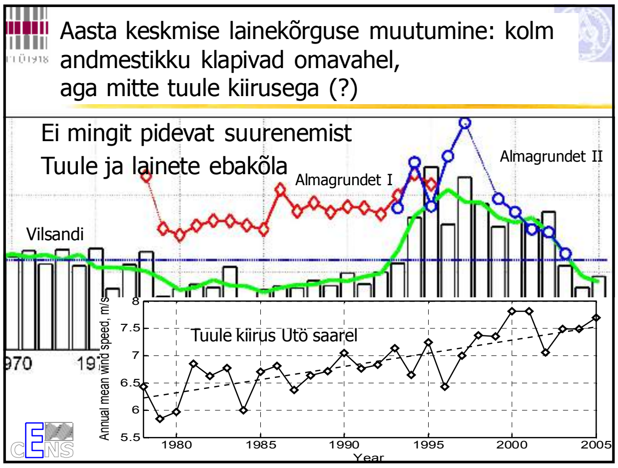
Mida teame Läänemere lainetest: mõõtmised, vaatlused, rekonstruktsioonid

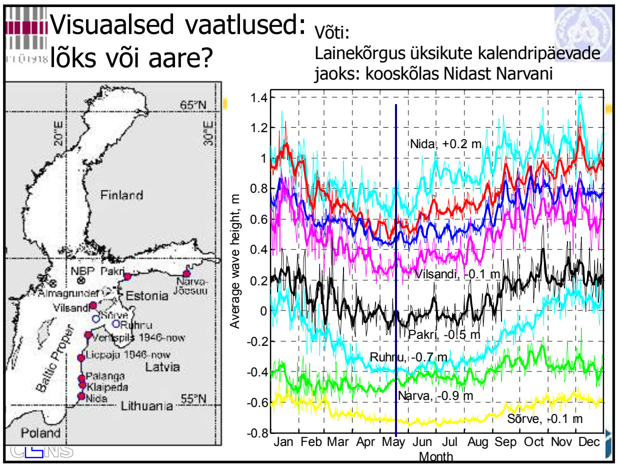
Rekonstruktsioonid
- Jönsson et al. 2003 (1a)
- Augustin 2005 (40a)
  - Schmager et al. 2008
- Tuomi et al. 2011 (6a)
- Räämet [et al.] 2009-2014 (38 a)
- SMB-tüüpi mudelid: Suursaar [et al.] 2008-2013, ~40a
- Hulk laineatlaseid & publitseeritamata andmeid (e.g. Alari 2013)

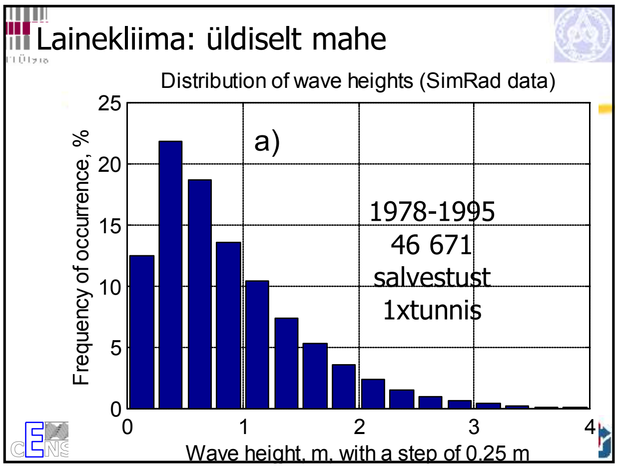


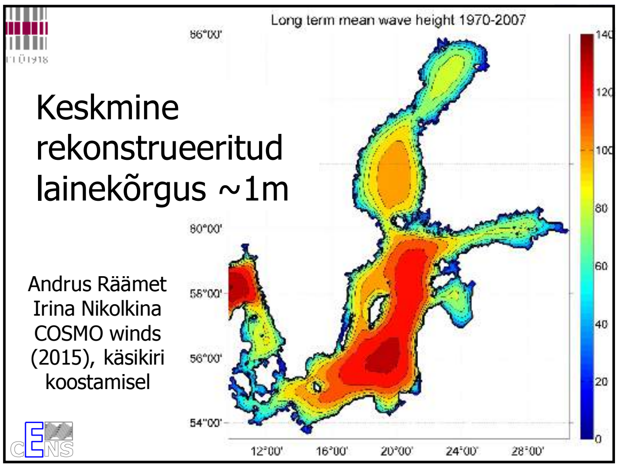

Lained Rootsi rannikul
WHM 1993-2003:
väga kahtlane?
Põhja-Atlandil: suurenemine ~1%/a (Gulev jt.)
Simrad 1978-1995
Otsus 2006
Kasv 1.8% aastas (Broman jt. 2006)
Tuule kiirus Utö saarel
Almagrundet
Utö
Vilsandi
Wave der northern Baltic Proper
Annual mean significant wave height, m
Annual mean wind speed, m/s
Year
KUK


Visuaalsed vaatlused: lõks või aare?
Arvutirekonstruktsioonid 1970-2007
Ca 500,000 salvestust
Utö
2001
Lainepoi Soome lahes (FIMR/FMI)
1996
Lainepoi Läänemere põhjaosas (FIMR/FMI)
1978
2003
Pööratud kajalood Almagrundet (Rootsi)
1954
1986
Visuaalsed vaatlused, Pakri (Eesti)
1954
Visuaalsed vaatlused, Narva-Jõesuu, Vilsandi, Sõrve, Ruhnu 1954-now
1946
Visuaalsed vaatlused, Liepaja and Ventspils (Läti), 1946-now
1954
Visuaalsed vaatlused, Palanga, Klaipeda, Nida (Leedu), 1954-now
1950 1960 1970 1980 1990 2000 2010
Lainepoi, Darssi künnis (Saksamaa)
KUK Mudelite seminar 26.03.2015


Aasta keskmise lainekõrguse muutumine: kolm andmestikku klapivad omavahel, aga mitte tuule kiirusega (?)
Ei mingit pidevat suurenemist
Tuule ja lainete ebakõla
Almagrundet I
Almagrundet II
Vilsandi
Tuule kiirus Utö saarel
Annual mean wind speed, m/s
Year


Visuaalsed vaatlused: lõks või aare?
Võti:
Lainekõrgus üksikute kalendripäevade jaoks: kooskõlas Nidast Narvani
Finland
Estonia
Latvia
Lithuania
Poland
Baltic Proper
Nida, +0.2 m
Vilsandi, -0.1 m
Pakri, -0.5 m
Ruhnu, -0.7 m
Narva, -0.9 m
Sõrve, -0.1 m
Average wave height, m
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

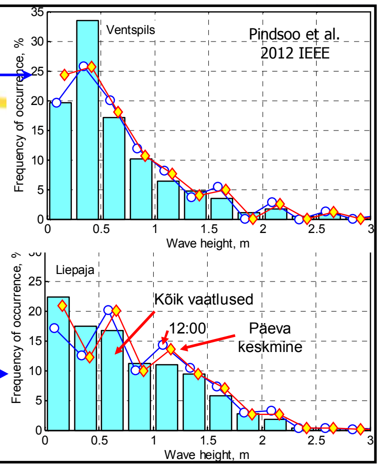

Lainekliima: üldiselt mahe
Distribution of wave heights (SimRad data)
a)
1978-1995
46 671 salvestust
1xtunnis
Frequency of occurrence, %
Wave height, m, with a step of 0.25 m


Long term mean wave height 1970-2007
Keskmine rekonstrueeritud lainekõrgus ~1m
Andrus Räämet
Irina Nikolkina
COSMO winds (2015), käsikiri koostamisel

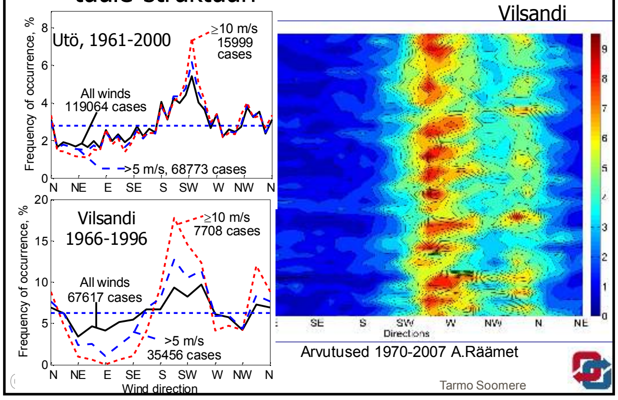
Tüüpiline avamerele

A feature, not a bug:
Sama kliima ilmneb erinevalt eri kohtades

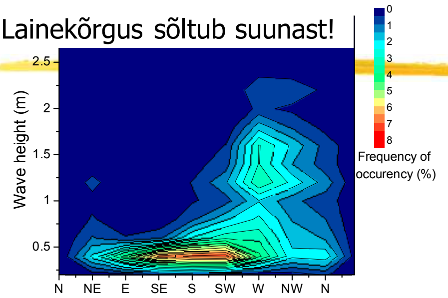
Tüüpiline varjatud ranna-aladele



Lainelevi suund: peegeldab kahetipulist tuule struktuuri



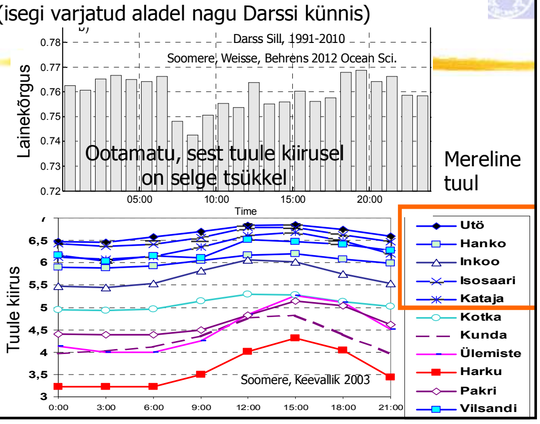
Lainekõrgus sõltub suunast!



Lainekõrguste ja saabumissuundade ühisjaotus (visuaalsed vaatlused, 1993–2008 Kelpšaite et al. 2011 BER)

Ööpäevane tsükkel puudub

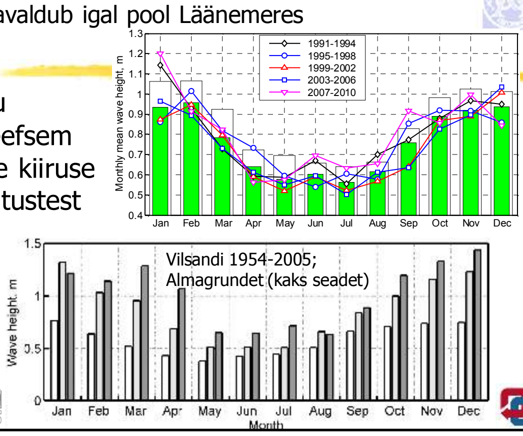
(isegi varjatud aladel nagu Darssi künnis)



Mereline tuul

Sesoonne muutlikus: avaldub igal pool Läänemeres

Palju reljeefsem tuule kiiruse muutustest



Ekstreemne lainetus Läänemeres 1978-2012:

mõõdukas, sest sobivad tingimused kõrgete lainete tekkimiseks esinevad harva

- Jaanuar 1984: Hs=7.82 m (Almagrundet)
- (väga tugev torm jaanuaris 1993, ei salvestatud)
- Detsember 1999: kaks korda Hs>7m kahe nädala jooksul (avamere lainepoi);
- Üldine usk 2004: Hs saab olla maksimaalselt ~8-8.5 m
- 23 detsember 2004: Hs=8.2 m (Tuomi et al. 2011)
  2005 jaanuaris: rekonstrueeritud 9,5-9,7 m (Soomere jt., 2008; Tuomi jt., 2011)
- 09 jaanuar 2005: Hs=7.2 m

Ruumiline muster: tugevalt anisotroopne

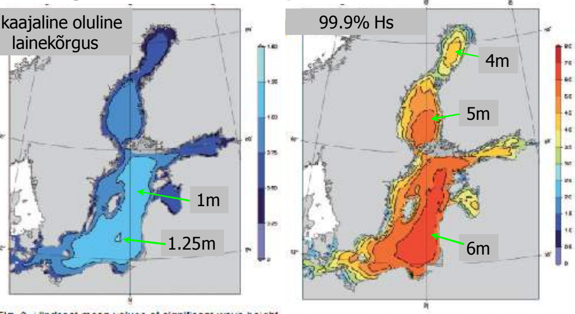


Fig. 6 Hindcast mean values of significant wave height in the Baltic Sea. Ice time included statistics ...

Fig. 11. Significant wave height exceeded 0.1% of the time in ice time included statistics, type I (ca. 8.8 hours in a year, type L1). According to the verification, the hindcast exceedance probabilities differ from the meas...

Lainetuse statistika 2001-2007
Tuomi, Kahma, Pettersson 2011

Läänemere lainekliima lühidalt:

- Lainekõrgus: tagasihoidlik (Hs~<1m)
  - väga tugevad tormid võimalikud (Hs ~10m)
- Perioodid: lühikesed (3-5 s)
- Suunad: enamasti kahetipuline jaotus
- Muutlikkus
  - Ööpäevane: puudub
  - Sesoonne: väga tugev
  - Eri merealadel: üsna tugev

KUK Mudelite seminar 26.03.2015 Tarmo Soomere

Teine osa

Laineteadus õhukesel jääl: arvutuste, mõõtmiste ja vaatluste ebakõlad

KUK Mudelite seminar 26.03.2015

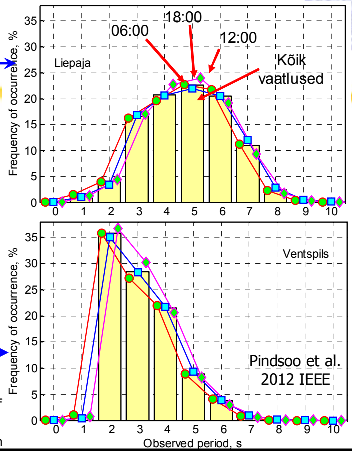
Tüüpiline avamerele

Perioodid: lühikesed

A feature, not a bug:
Sama kliima ilmneb erinevalt eri kohtades

Tüüpiline varjatud ranna-aladele

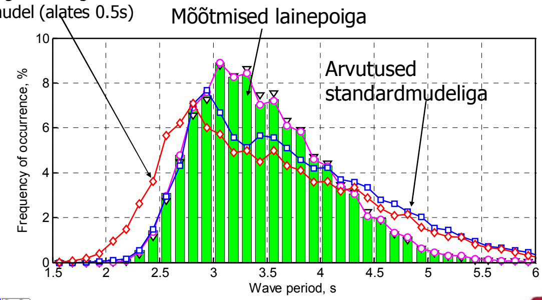
Soomere, 2013, Journal of Coastal Research



KUK Mudelite sem

"Kadunud" perioodid: Darss Sill

Järeldus: lühikeste (2-3 s) & järskude lainete roll mere dünaamikas oluliselt alahinnatud

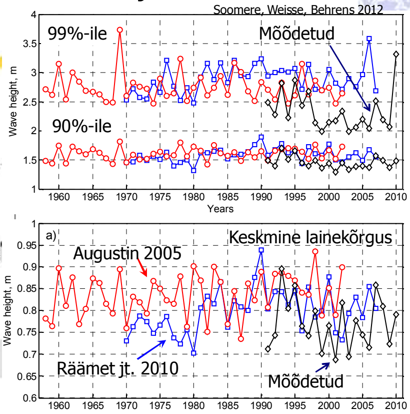


Soomere, Weisse, Behrens, 2012, Ocean Science

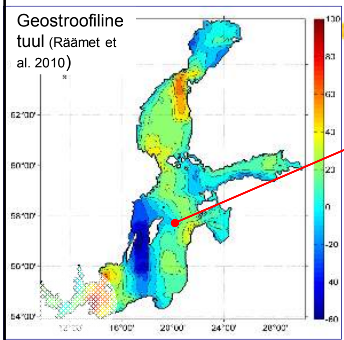
Tarmo Soomere

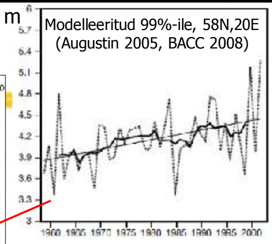
Laineuuringud õhukesel jääl:

Mõõtmised ja arvutused ei lähe kokku



Näide: muutused top 1% lainekõrguses

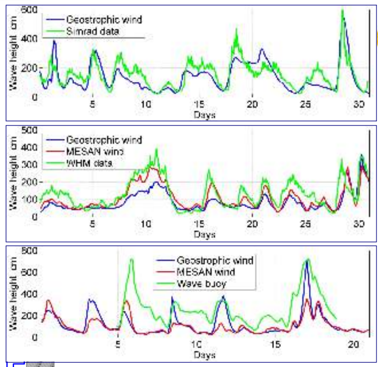




Muutused erinevad eri aladel

- Radikaalne kahanemine Rootsi ranniku lähistel
- Suurenemine mere idaosas ning Kuramaa ja Stockholmi vahel
- Ei klapi Augustin/Weisse arvutustega

Probleem: tuuleinfo kvaliteet



Almagrundet Detsember 1986

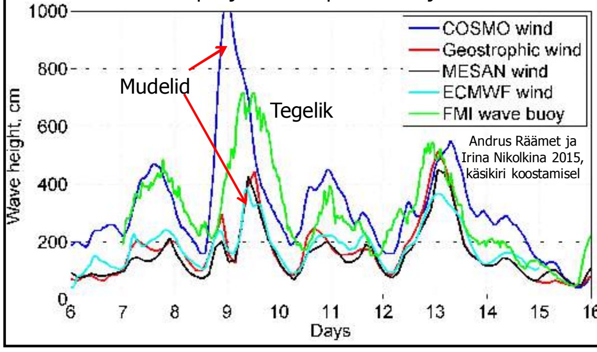
Almagrundet oktoober 2000: Rootsi andmestik (MESAN) – väga hea Rootsi lähistel

Mere põhjaosa detsember 1999: MESAN lootusetu, **geostroofiline tuul** märksa parem

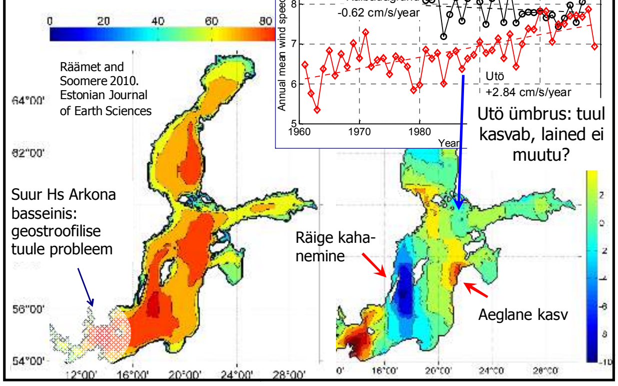
Räämet et al. 2009

Parem/uuem tuuleinfo ei aita

Läänemere põhjaosa lainepoi 2005 a jaanuaritormis

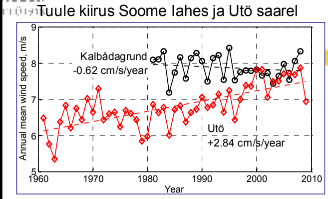


Lainekõrgused ja nende muutumine arvuti nägemuses



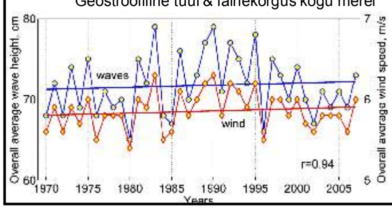
Tuule kiiruse ja lainekõrguse ebakõla?

Tuule kiirus Soome lahes ja Utö saarel



- Tuule kiirus kasvas Läänemere põhjaosas
- Soome laht: muutusi pole

Geostroofiline tuul & lainekõrgus kogu merel

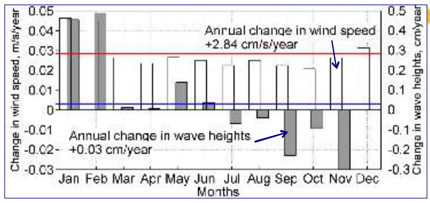


- Tuule keskmine kiirus: pole kasvanud 1970-2007
- Lainetuse keskmine intensiivsus: samuti pole kasvanud
- Küll aga olid lained kõrged 1980ndate algul ja 1990-1995
- Erinevus ~20%

Soomere and Räämet 2014

Muutused kogu-mere lainekõrguses: vaid vähestel kuudel

Räämet, Soomere, 2011 J.Coast.Res.



Tuule keskmine kiirus Utö saarel
Lainekõrgus kogu merel
(geostroofiline tuul)

- Tuule kiiruse muutus: sama kõigil kuudel
  - suhteliselt suur jaanuaris-veebruaris
- Lainekõrgus kasvas vaid jaanuaris-veebruaris
  - Kahanes oluliselt septembris ja novembris

Enamus asju tegelikult ei klapi

(kui just pole tegemist kohaspetsiifiliselt kalibreeritud lainemudeli ja tuuleinfoga)

Lahknevus

- Pikaajaline Hs: +/- 15%
- Kõrgemad Hs protsentiilid: kuni 30%
- Trendid: küsitavad
- Suunad: mudel ei näita midagi

Kooskõla

- Aastatevaheline muutlikkus
- Ruumilise muutlikkuse põhjooned

Järeldus: tasub fokuseeruda **muutuste** analüüsile

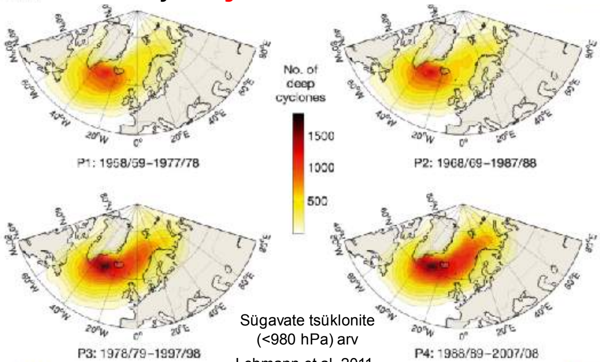
KUK Mudelite seminar 26.03.2015

Kolmas osa

Lainete omadused muutuvad koos kliima muutumisega

KUK Mudelite seminar 26.03.2015

Tsüklonite „perekonnapilt" muutub: nüüd on neid **rohkem** ja **mujal** kui 50 aasta eest



Sügavate tsüklonite (<980 hPa) arv

Lehmann et al. 2011

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Lihtne järeldus:

Tormid Eestis on nüüd teistsugused kui 20-30 aasta eest

Mis saaks muutuda?

- Kõrgused
  - keskmised?
  - ekstreemumid?
  - eri merealadel
- Perioodid / pikkused
- Levikusuund
  - Ristlainetuse sagedus
- Ummiklaine osakaal?
- hiidlainete sagedus/omaduses?
- ....

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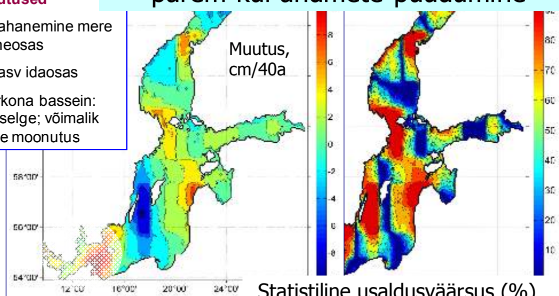
Lainekõrguse muutused: keerukas ruumiline muster

Charles Babbage: kehvad andmed on parem kui andmete puudumine

Peamised muutused

- Kahanemine mere lääneosas
- Kasv idaosas
- Arkona bassein: ebaselge; võimalik tuule moonutus



Statistiline usaldusväärsus (%)

Räämet, Soomere 2011

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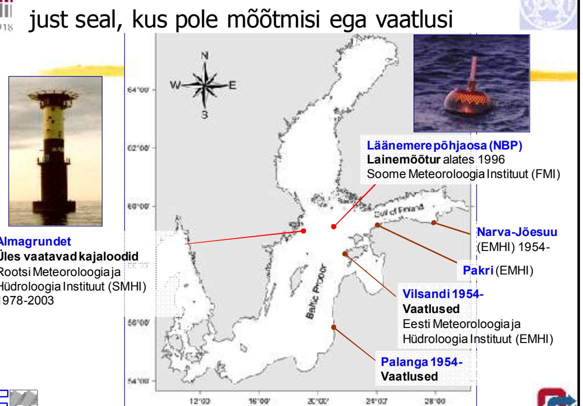
Saatuse iroonia aastal 2010: muutused just seal, kus pole mõõtmisi ega vaatlusi



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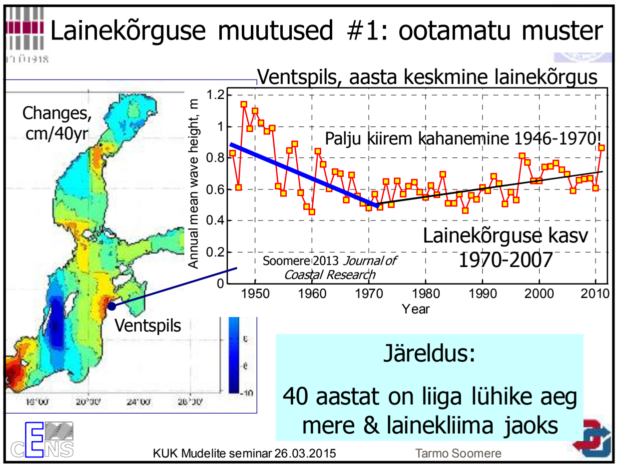
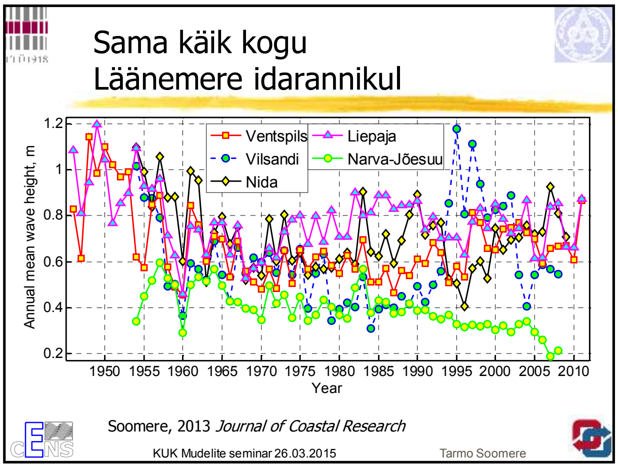
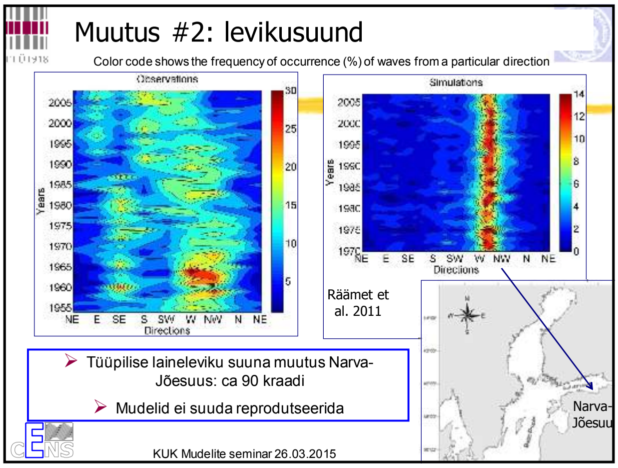
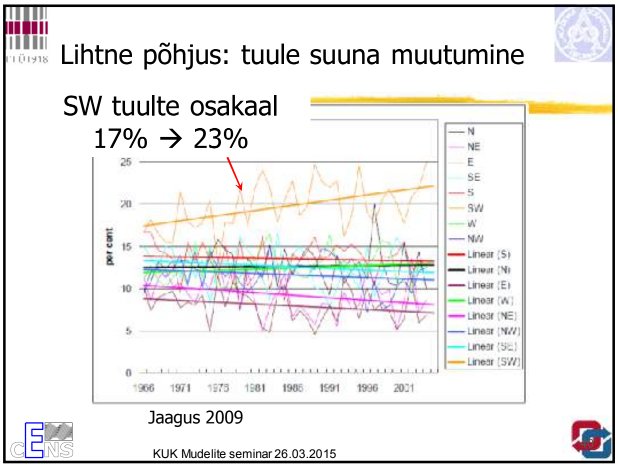
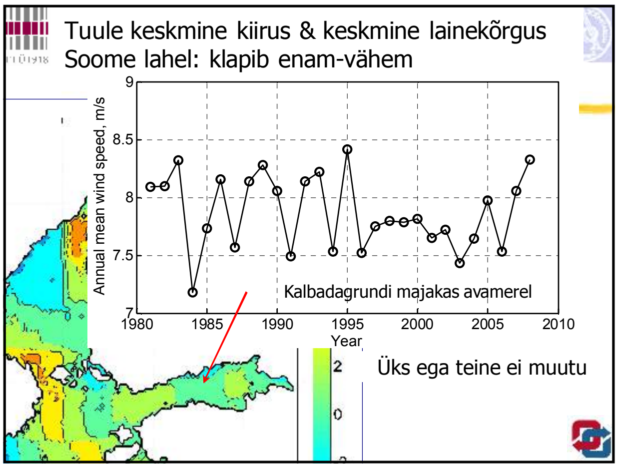
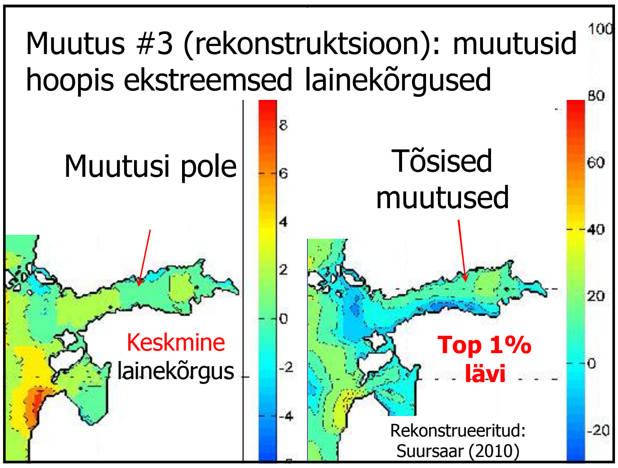

Lainekõrguse muutused #1: ootamatu muster
Ventspils, aasta keskmine lainekõrgus
Changes, cm/40yr
Ventspils
Annual mean wave height, m
Palju kiirem kahanemine 1946-1970!
Lainekõrguse kasv 1970-2007
Soomere 2013 Journal of Coastal Research
Year
Järeldus:
40 aastat on liiga lühike aeg mere & lainekliima jaoks
KUK Mudelite seminar 26.03.2015
Tarmo Soomere


Sama käik kogu Läänemere idarannikul
Ventspils
Liepaja
Vilsandi
Narva-Jõesuu
Nida
Annual mean wave height, m
Year
Soomere, 2013 Journal of Coastal Research
KUK Mudelite seminar 26.03.2015
Tarmo Soomere


Muutus #2: levikusuund
Color code shows the frequency of occurrence (%) of waves from a particular direction
Observations
Simulations
Years
Directions
Räämet et al. 2011
Tüüpilise laineleviku suuna muutus Narva-Jõesuus: ca 90 kraadi
Mudelid ei suuda reprodutseerida
Narva-Jõesuu
KUK Mudelite seminar 26.03.2015


Lihtne põhjus: tuule suuna muutumine
SW tuulte osakaal
17% → 23%
per cent
Jaagus 2009
KUK Mudelite seminar 26.03.2015


Tuule keskmine kiirus & keskmine lainekõrgus Soome lahel: klapib enam-vähem
Annual mean wind speed, m/s
Kalbadagrundi majakas avamerel
Year
Üks ega teine ei muutu


Muutus #3 (rekonstruktsioon): muutusid hoopis ekstreemsed lainekõrgused
Muutusi pole
Tõsised muutused
Keskmine lainekõrgus
Top 1% lävi
Rekonstrueeritud: Suursaar (2010)

Neljas osa

Lained ja veetase: sama mündi kaks külge

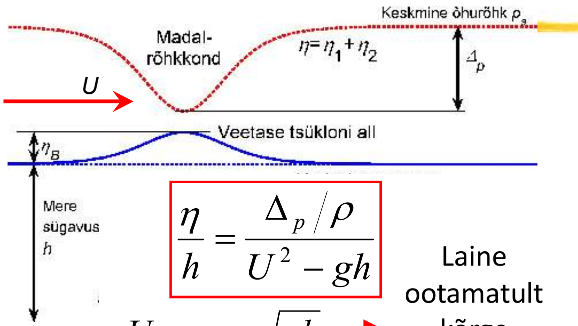
Tsunami Soome lahel?

EKSPRESS.EE

Nord Stream on kõikide pommide ema (33)

Ants Erm
26. juuni 2009 00:03

Kui tsüklon liigub



$$\frac{\eta}{h} = \frac{\Delta_p / \rho}{U^2 - gh}$$

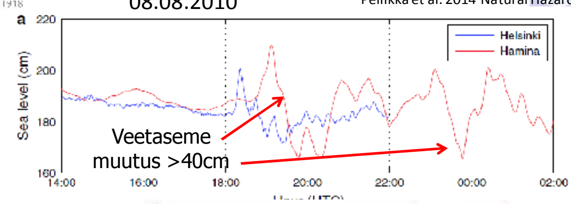
$$U = c_f = \sqrt{gh}$$ → Laine ootamatult kõrge

Meteoroloogiline tsunami

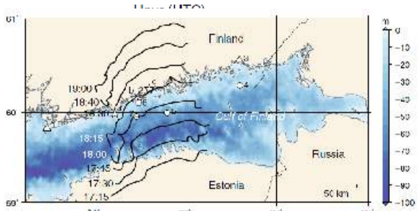
- Võib tekkida nii madal- kui ka kõrgrõhkkonna all
- Vaid siis, kui vesi on suhteliselt madal (=Soome lahes tavaline)
- Dünaamika: identne kiirlaevalainetega
- Võimatu sügavas ookeanis

Näide Soome lahelt 08.08.2010

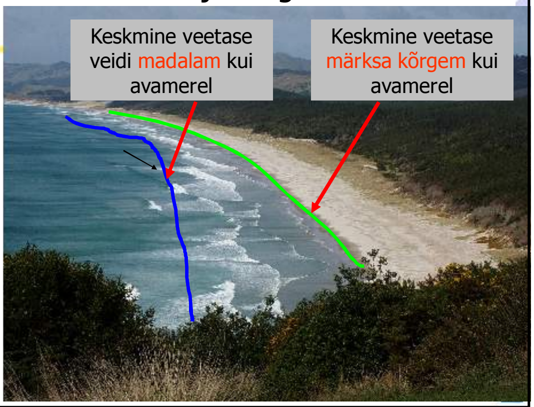
Pellikka et al. 2014 Natural Hazards



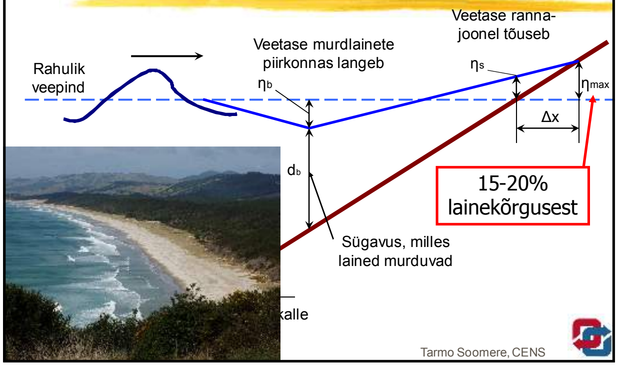
Front liikus sobiva kiirusega risti üle Soome lahe



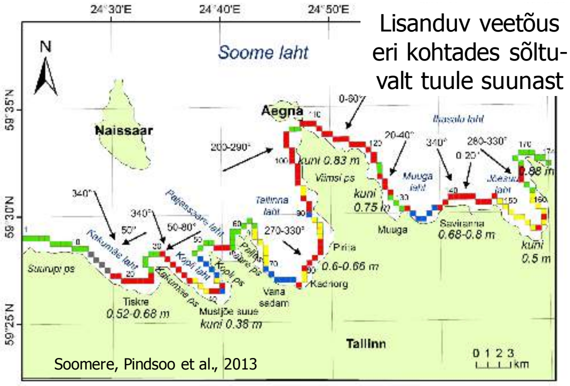
Lained tõstavad ja langetavad veetaset



Murdlainete tekitatud veetõus: impulsi vabanemine



Varjatud mure Tallinnas ja Muugal: lisanduv veetõus kuni 80 cm

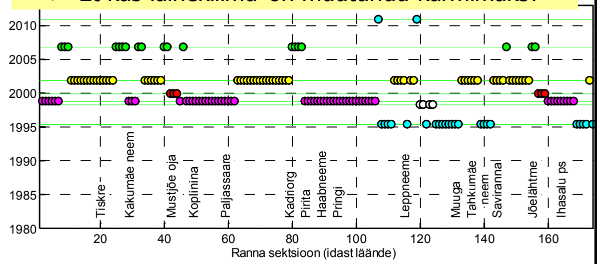


Lisanduv veetõus eri kohtades sõltuvalt tuule suunast

Tormid, mis tekitasid kõrgeimad lained

Soomere, Pindsoo et al. 2013, Nat. Hazard. Earth Syst. Sci.

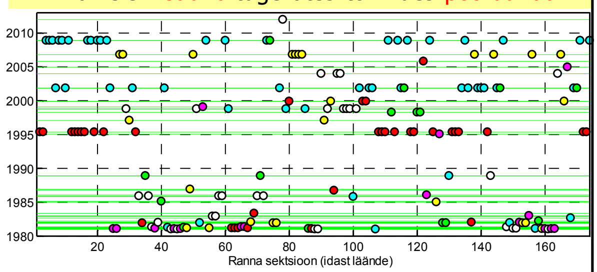
- 7 tormi kokku Tallinna + Muuga lahes
- Kõik alates 1995; mitte ühtegi 1981-1994
- Et kas lainekliima on muutunud karmimaks?



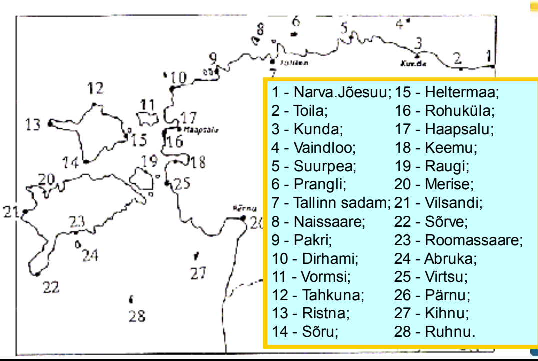
Tormid, mis tekitasid kõrgeima lisanduva veetõusu

Soomere, Pindsoo et al. 2013, Nat. Hazard. Earth Syst. Sci.

- >40 tormi; igal rannalõigul oma „ideaalne torm"
- Väga suur osa 1981-1994
- Lainelevi suund tugevates tormides pöördunud!

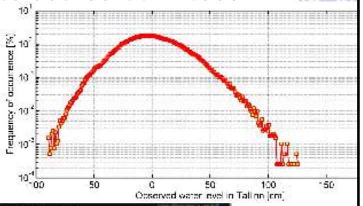


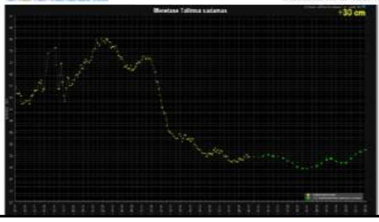
Veetaseme mõõtmine Eestis: pikka aega paljudes kohtades



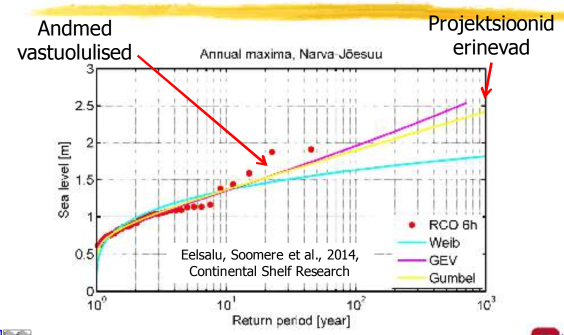
Palju aspekte usaldusväärselt teada

- Tõenäosusjaotused
- Pikaajalised keskmised
- Trendid
- Sesoonne muutlikkus
- Prognoos

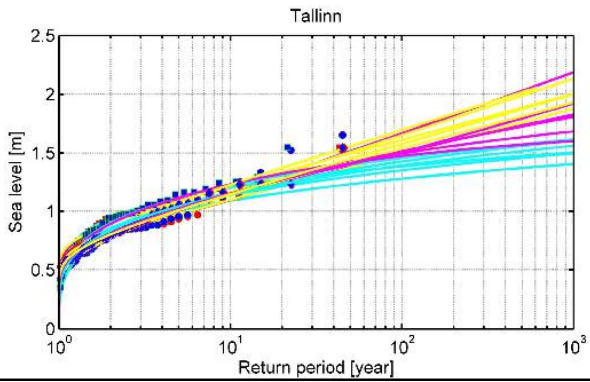




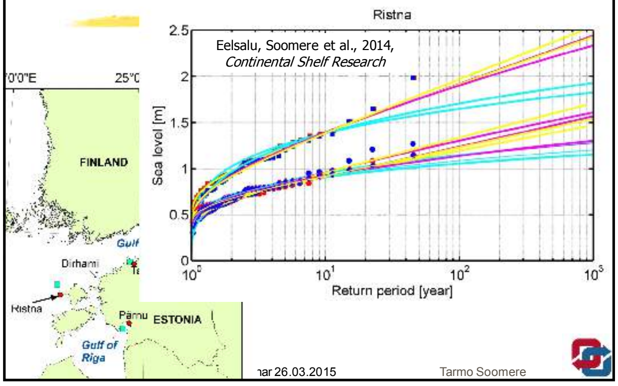
Veetasemete projektsioon tulevikku: mida uskuda (1x50a, 1x100a, 1x200a jne)



Veetasemete projektsioon tulevikku: parim lähend on ansambli keskmine



Ootamatu probleem: milline projektsioon on õige?



Probleemi allikas: murdlainete tõttu lisanduv veetõus

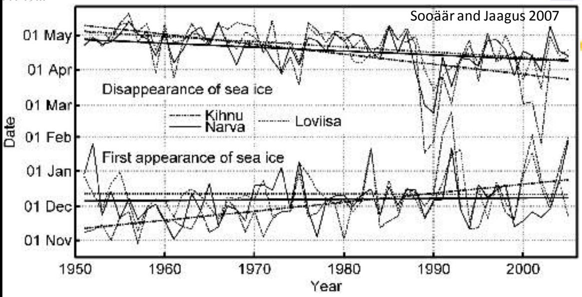
Eelsalu, Soomere et al., 2014, Continental Shelf Research

Neljas osa: Rannad

Merejää: segav tegur või õnnistus?

Ranna saladusi paljastamas

Varjatud oht: jääperiood lühenemine!



- Jääkatte tekib harvem (vähenemine 20% viimasel 100a)
- Jää kaob 10 päeva võrra varem (100a kohta, Utö saar)

(Jevrejeva and Leppäranta)

Liiva- ja kruusarandade tervis:

Pole jääd == rand pole kaitstud kõrge veetaseme ja tugevate lainete eest

- Veetase märksa kõrgem kui jääga kaetud merel
  - Lainete energia jõuab rannaseteteni
    - Rannasetted: pole külmunud

Eriti ohtlik: kõrge veetase + lained + lahtine liiv

(Komarovo, Neva Bight, 29 October 2006 11 January 2007) Ryabchuk *et al.* 2009, 2011

Tundub, et näiteks Valgerannas on liiva piisavalt

Tegelikult on seal vaid õhuke liivakiht kruusa ja savi peal

©Tarmo Soomere

Meie rannad on ebatavalised?

- Lainekõrgus ülimalt muutlik
  - 90% ajast loksub meri väga vaikselt
  - 9% ajast on arvestatav torm
  - Viie päevaga saabub >1/4 aasta energiast

  (Soomere, Eelsalu, *Renewable Energy*, 2014)
- Rannad põhjaranniku lahepärades: kaitstud paljude tormide eest
- Astmeline areng

Lihtne järeldus:

Niipea, kui muutuvad meie randu mõjutavad lained:

- toimuvad muutused meie randades
- ja kiiremini, kui arvata oskame

Meie rannad on ebatavalised II

- Lainekõrgus ülimalt muutlik
  - 90% ajast loksub meri väga vaikselt
  - 9% ajast on arvestatav torm
  - Kolme päevaga saabub >1/3 aasta energiast of beaches: highly intermittent wave regime
- Rannad põhjaranniku lahepärades: kaitstud paljude tormide eest
- Astmeline areng
  - Ülikiire reaktsioon ebatavalisest suunast saabuvale tormile
  - Aeglane areng aastate vältel
- Väljakutse: kuidas mõõta muutusi aeglase arengu staadiumis
- Vajalikud põhimõtteliselt uued tehnoloogiad

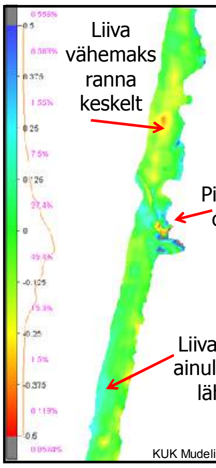
Laserskaneerimine: kiire ja täpne

- Kaugseire üks vorme:
  - terrestriline (TLS)
  - Lennukile paigutatud (ALS)
  - Mõõdab kaugust laserist objektini
- **Terrestriline skänner**: lahutusvõime ~1 cm
- Katvus: kuni 300 m
- **Lennukil skänner**: 0.1-20 punkti/m2
- Katvus: palju kilomeetreid

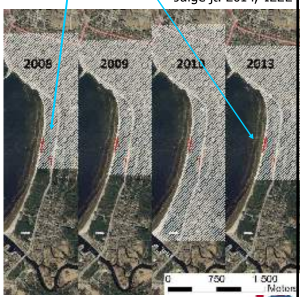
Testala: Pirita ranna keskosa

- Väikese oja suudme ümbrus
- Sisaldab riikliku rannikute seire profiili
- Pikkus ca 250 m

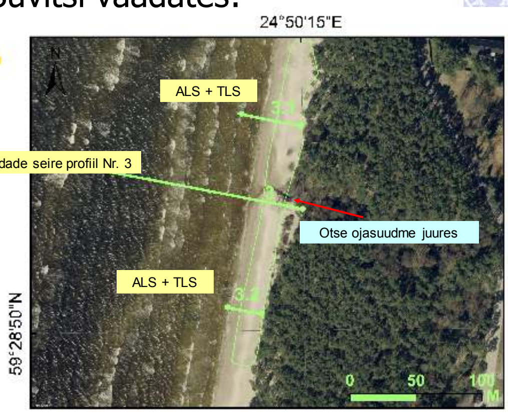
Muutused testalas 5 aastaga



Julge jt. 2014, IEEE

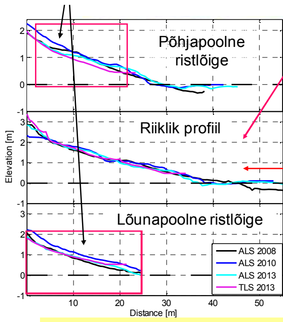


Süvitsi vaadates:



Profiil vaikib

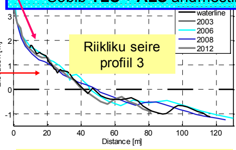
Selged muutused eri aastatel



ALS + TLS kombineeritud andmed

Julge jt. 2014, IEEE

Pealtnäha ei mingied muutusi
Põhjus: protsessid oja suudmes – märg liiv käitub teisiti kui kuiv liiv
Sobib **TLS + ALS** andmestikuga



Andmed: Eesti Geoloogiakeskus

2008-2010: **kiire kuhjumine** (kuni 5 m³/m kohta)

2010-2013: **kiire erosioon**

Nutrient fluxes from source to the sea

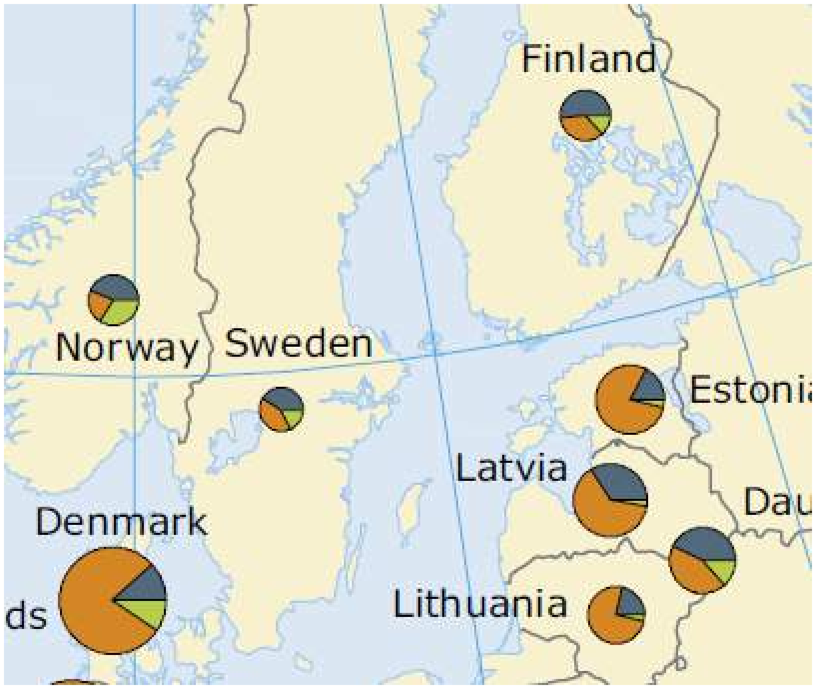
Per Stålnacke (Bioforsk)

per.stalnacke@bioforsk.no

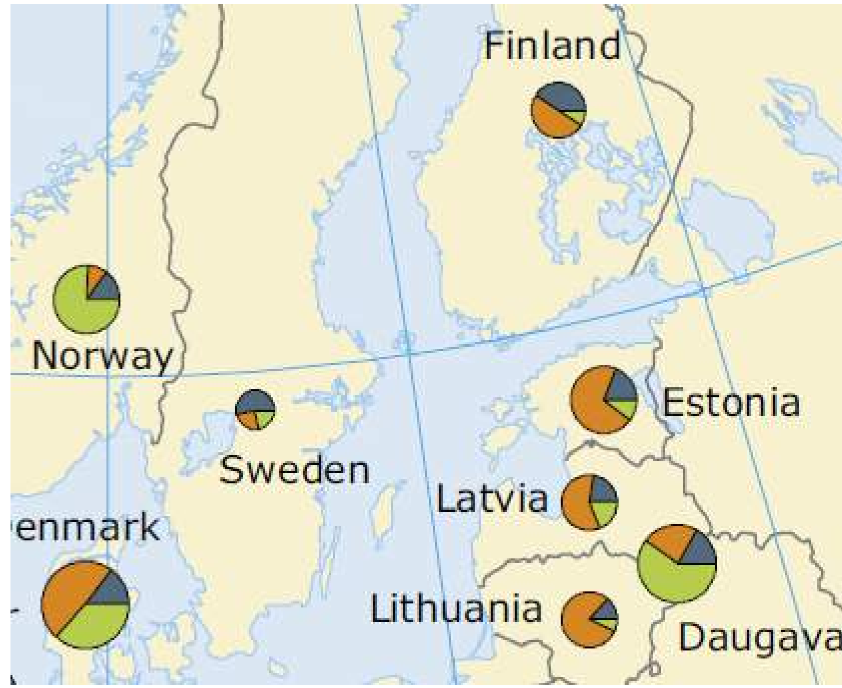
Bioforsk

Nutrient sources (EEA, 2005)

NITROGEN

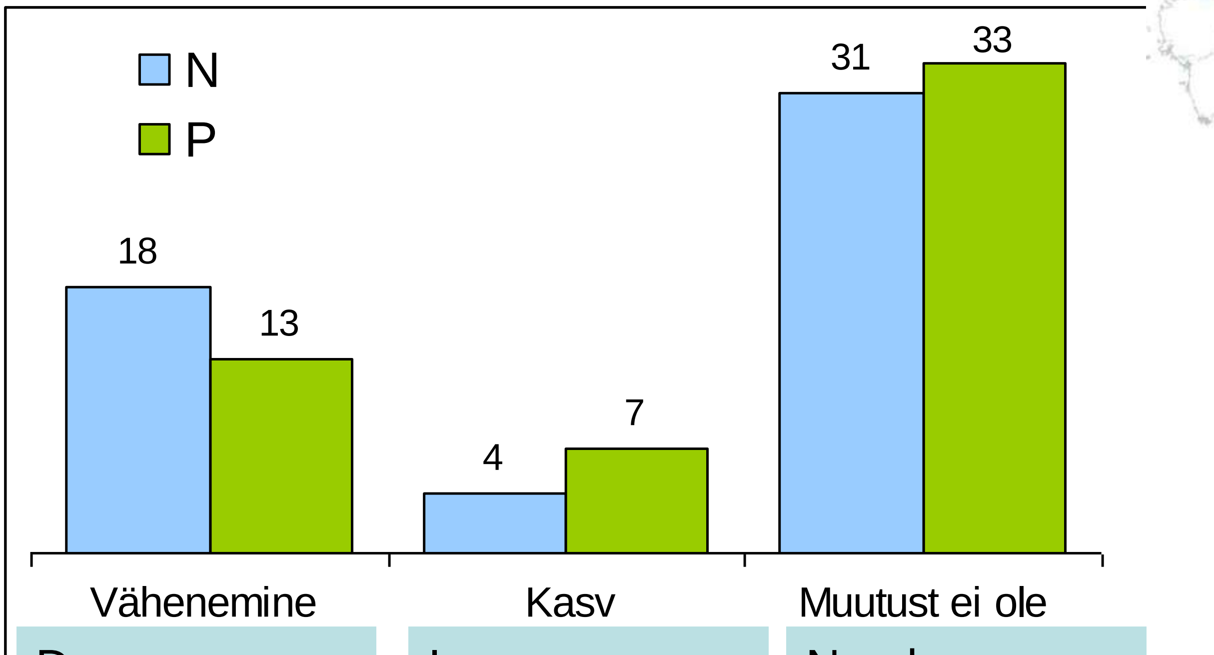


PHOSPHORUS



Point source
Agriculture
Background

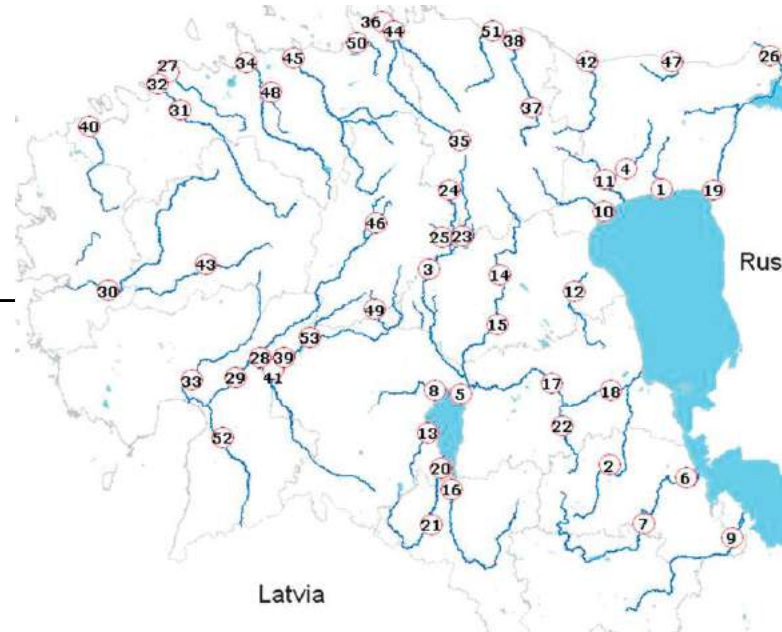
No. of TN and TP trends in 53 Estonian rivers/streams over the past 15-20 years (Iital et al, 2009; 2010)



Decrease

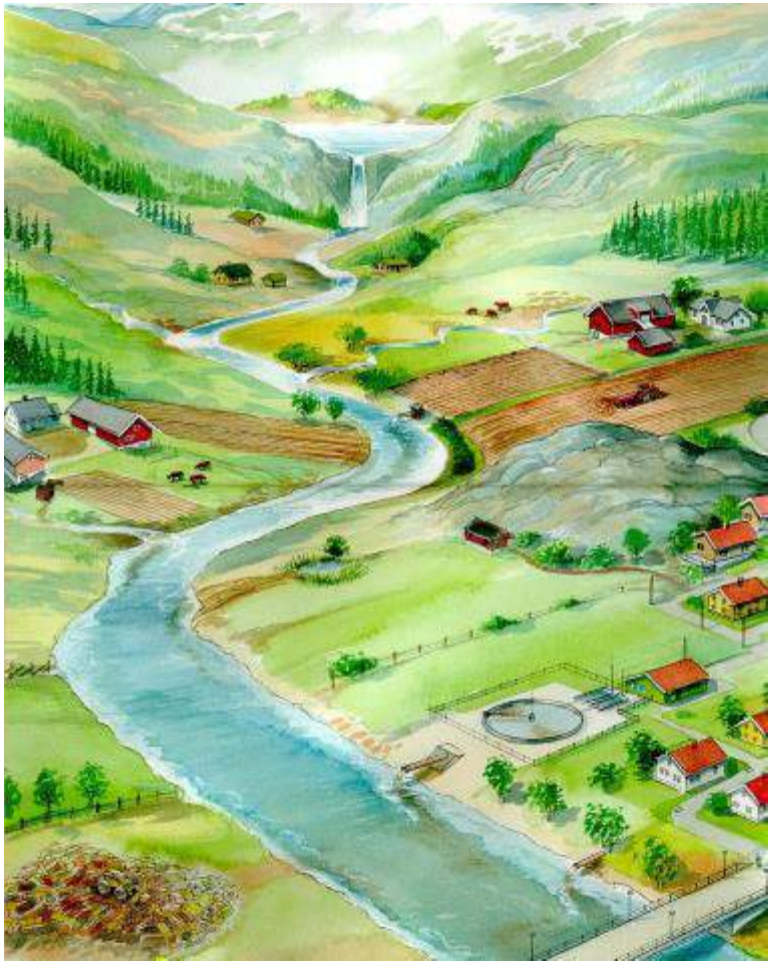
Increase

No-change



Outline with focus on nutrients from agriculture

1. Nutrient ‘characteristics’
2. Mitigation measures
3. Retention
4. Concluding remarks

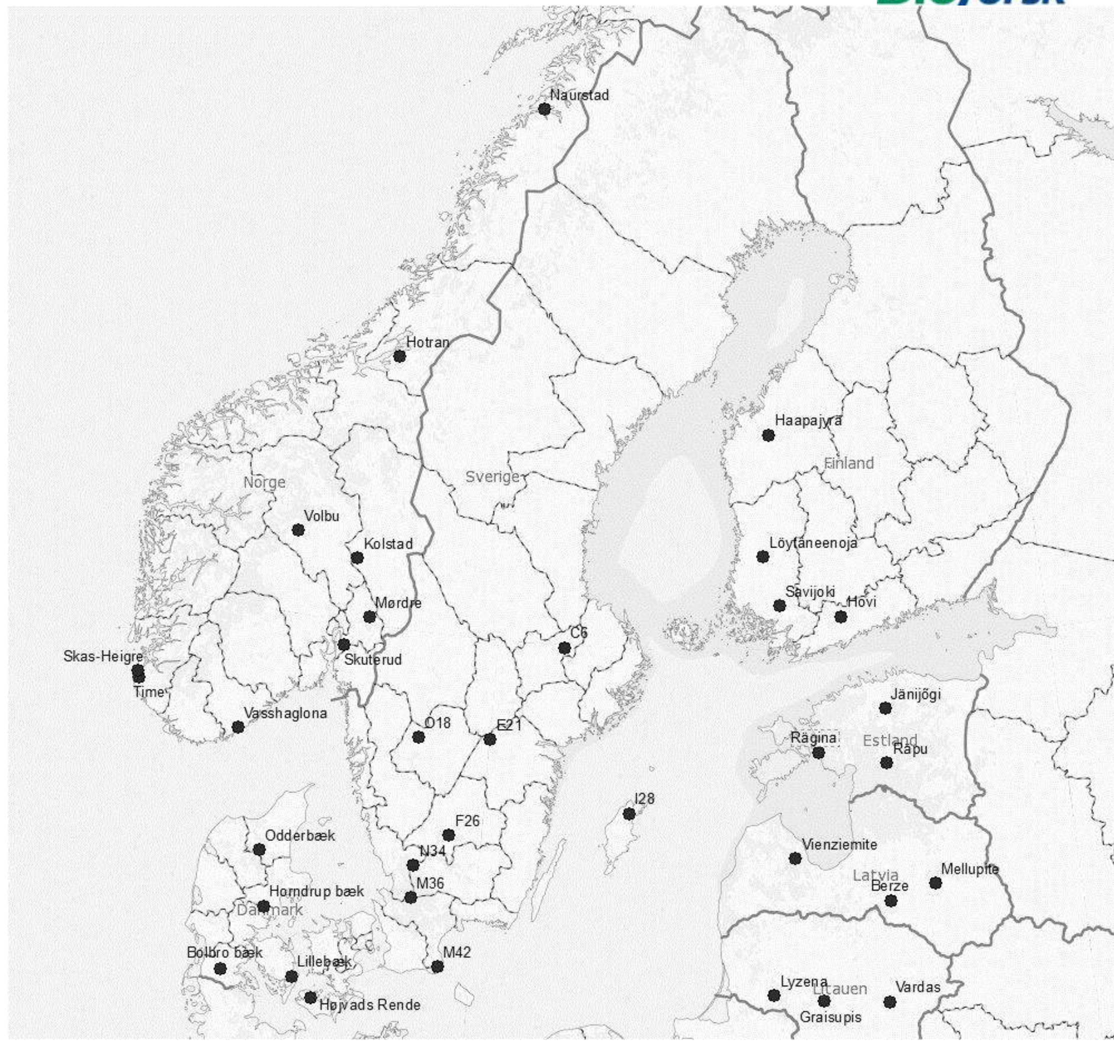


Part 1. Some major nutrient 'characteristics' in running surface waters

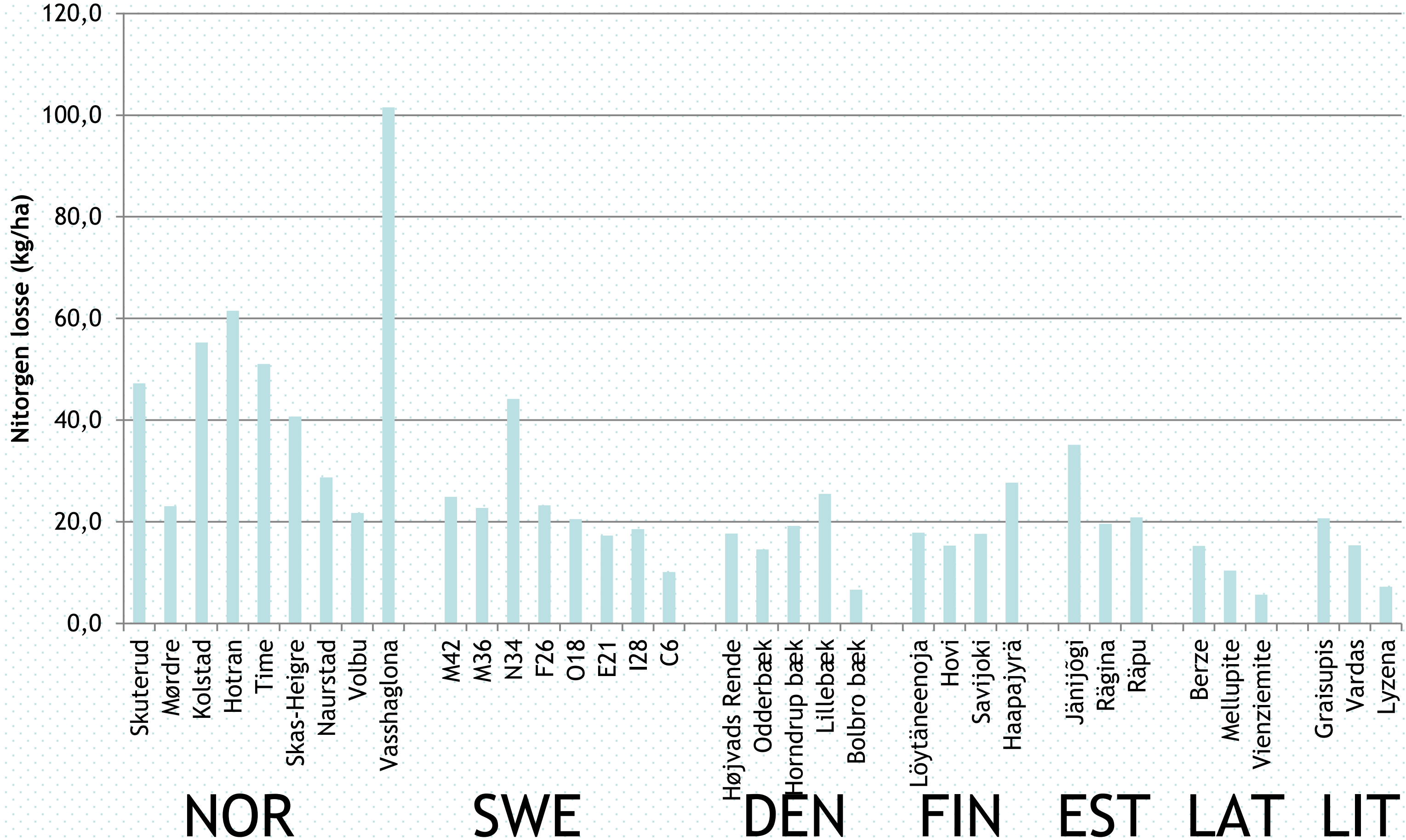
Between catchment variability

Background

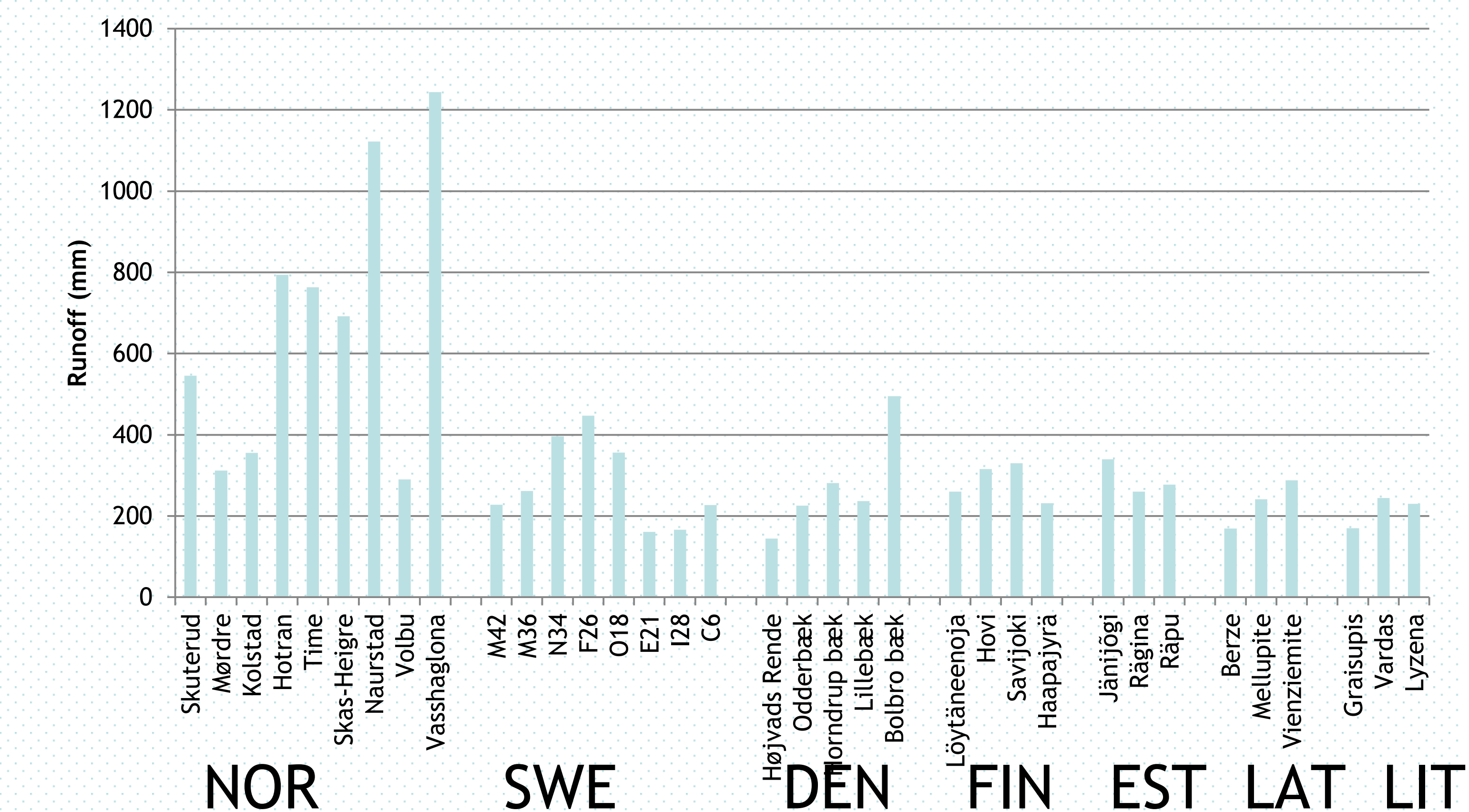
- Established Nordic-Baltic network since the mid 1990s
- 35 small agricultural catchments (0,1-33 km^2)
- Data on WQ (N, P, SS), Q, soil, agric pract., fertilizers, yields etc.



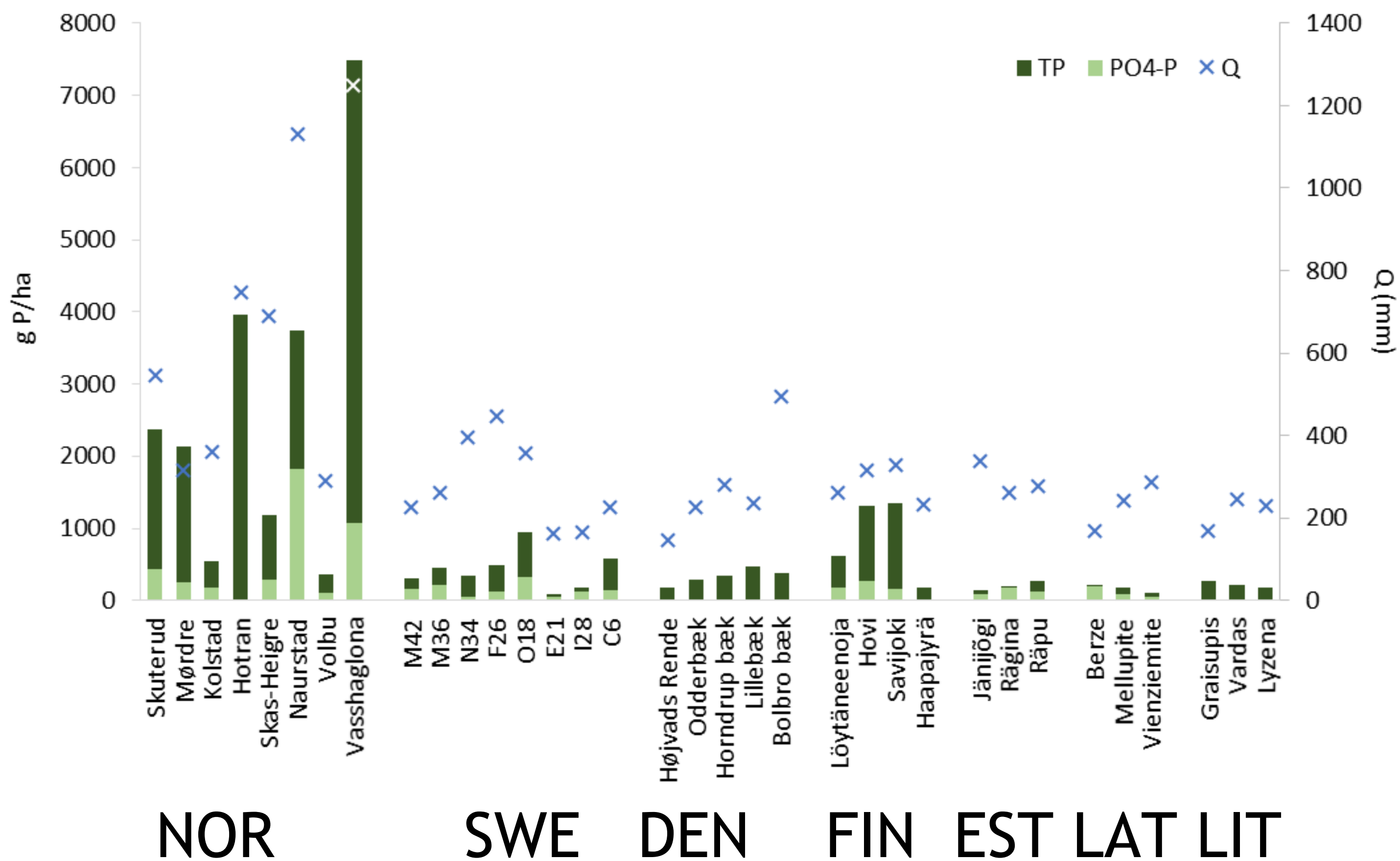
N-agricultural losses (long-term annual mean) from 35 small agricultural catchments
(Stålnacke et al, 2014)



Water runoff (long-term annual mean) from 35 small agricultural catchments
(Stålnacke et al, 2014)



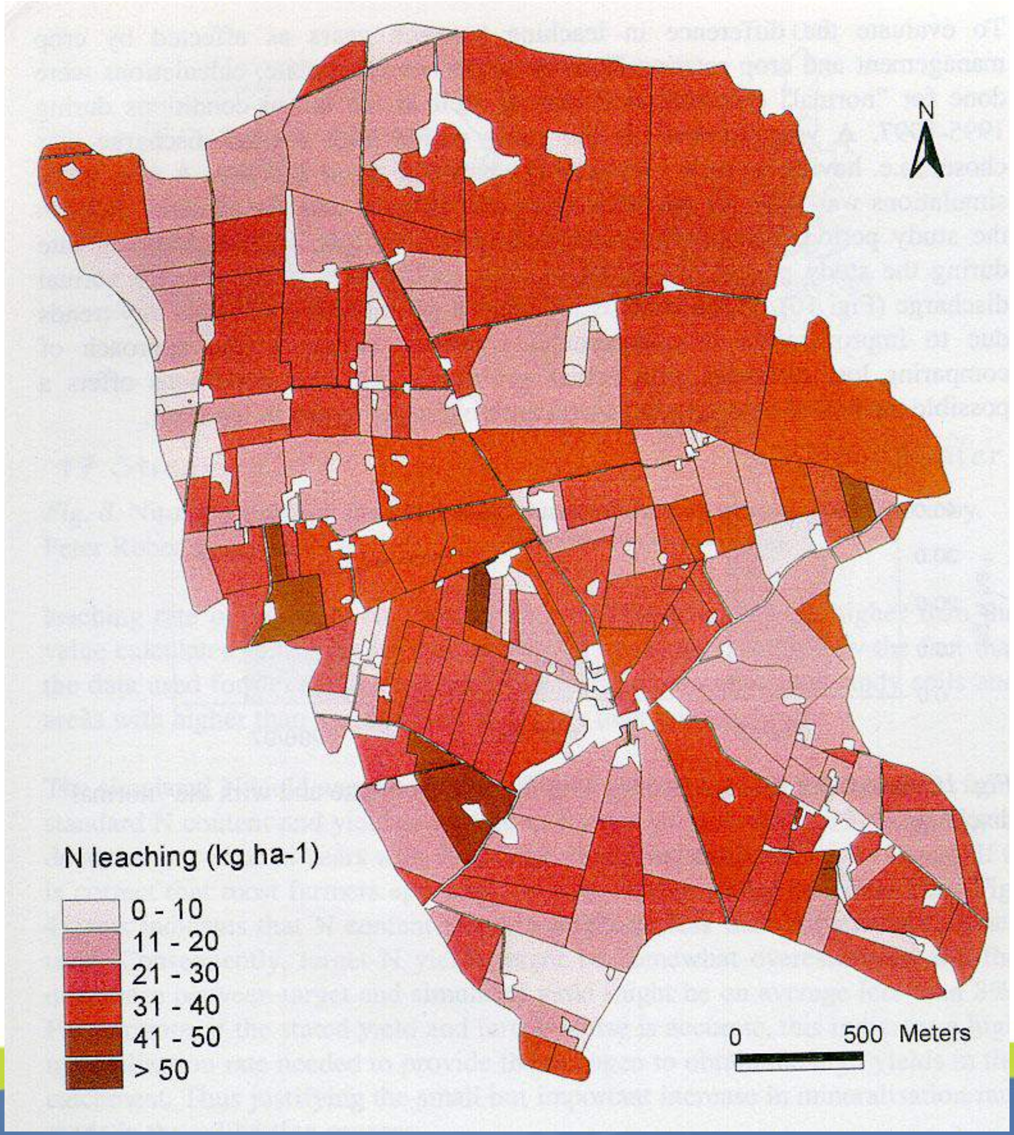
P-agricultural losses (long-term annual mean) from 34 small agricultural catchments (Pengerud et al, in press)



Note: Data on PO_4-P losses not available for Danish and Lithuanian catchments

Within catchment N-loss variability

(S Sweden; Hoffmann&Johnsson)



Winter episode (Øygarden, 2000)

January 30

Runoff: 25 mm

Soil loss: 2 kg ha^{-1}

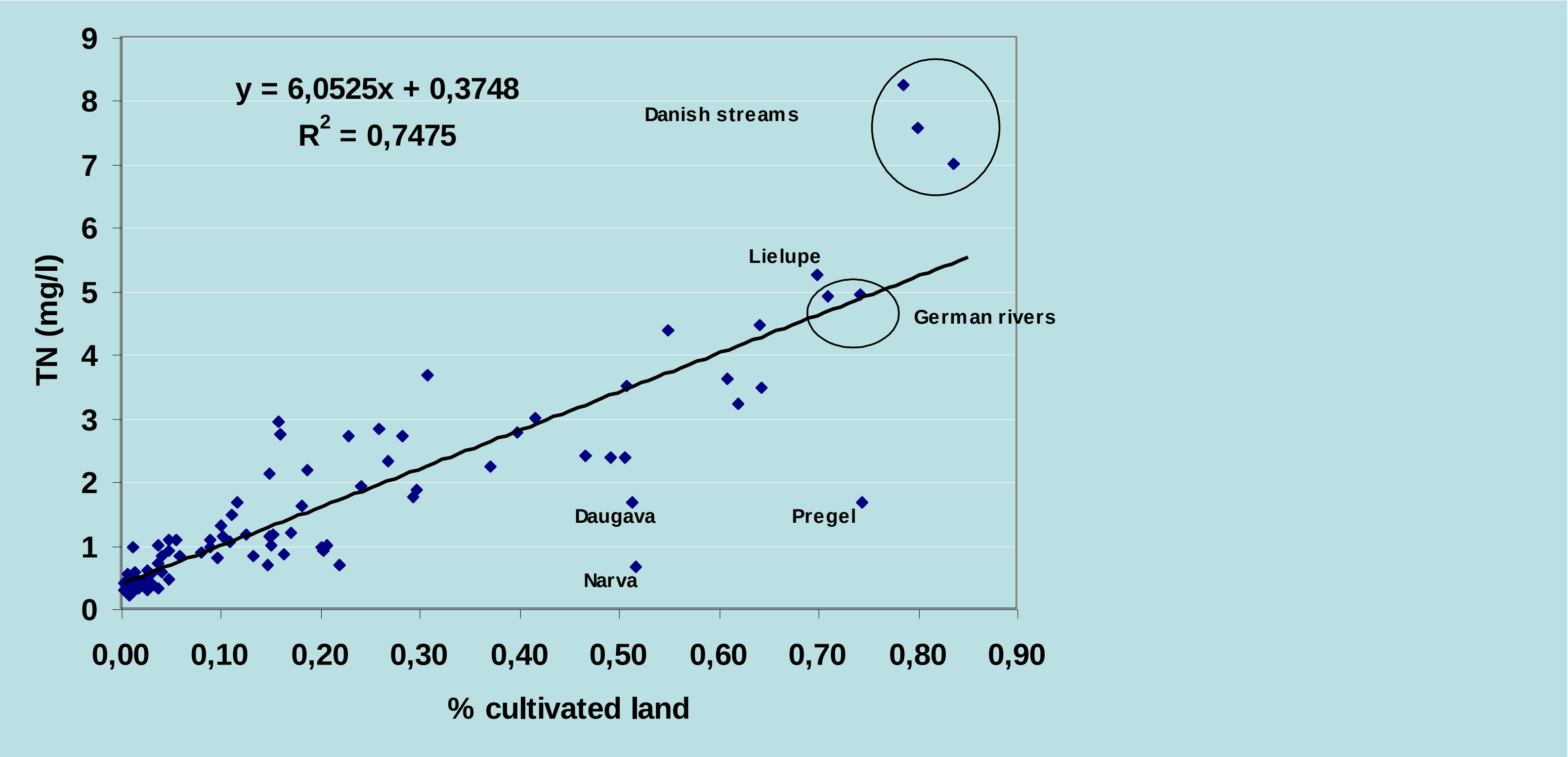
January 31

Runoff: 77 mm

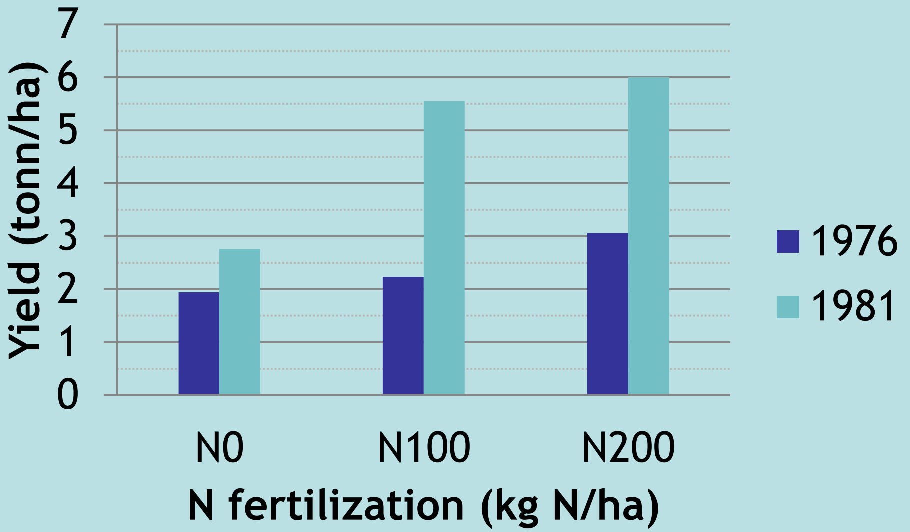
Soil loss: 3 050 kg ha^{-1}

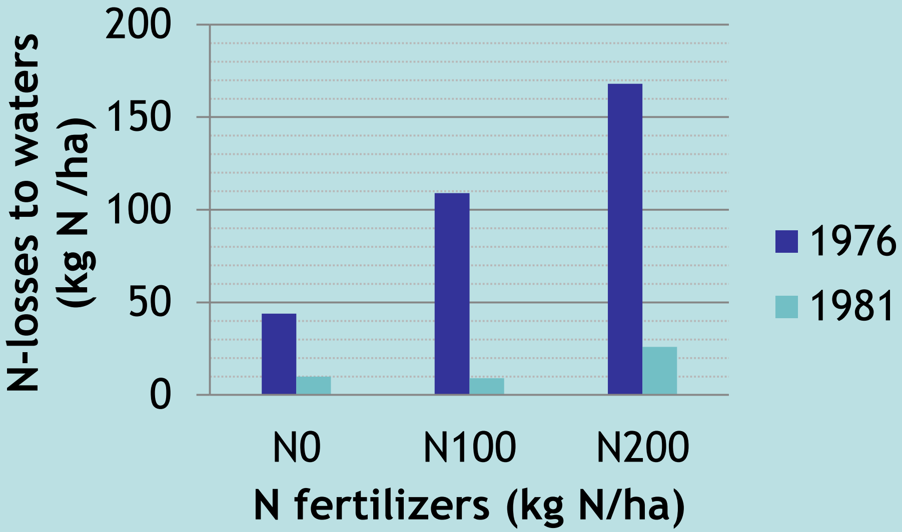
2. Mitigation measures

Nitrogen concentrations vs. land use in 107 Baltic Sea rivers (unpublished MARE/Baltic Nest-data analysed by Stålnacke, P.)

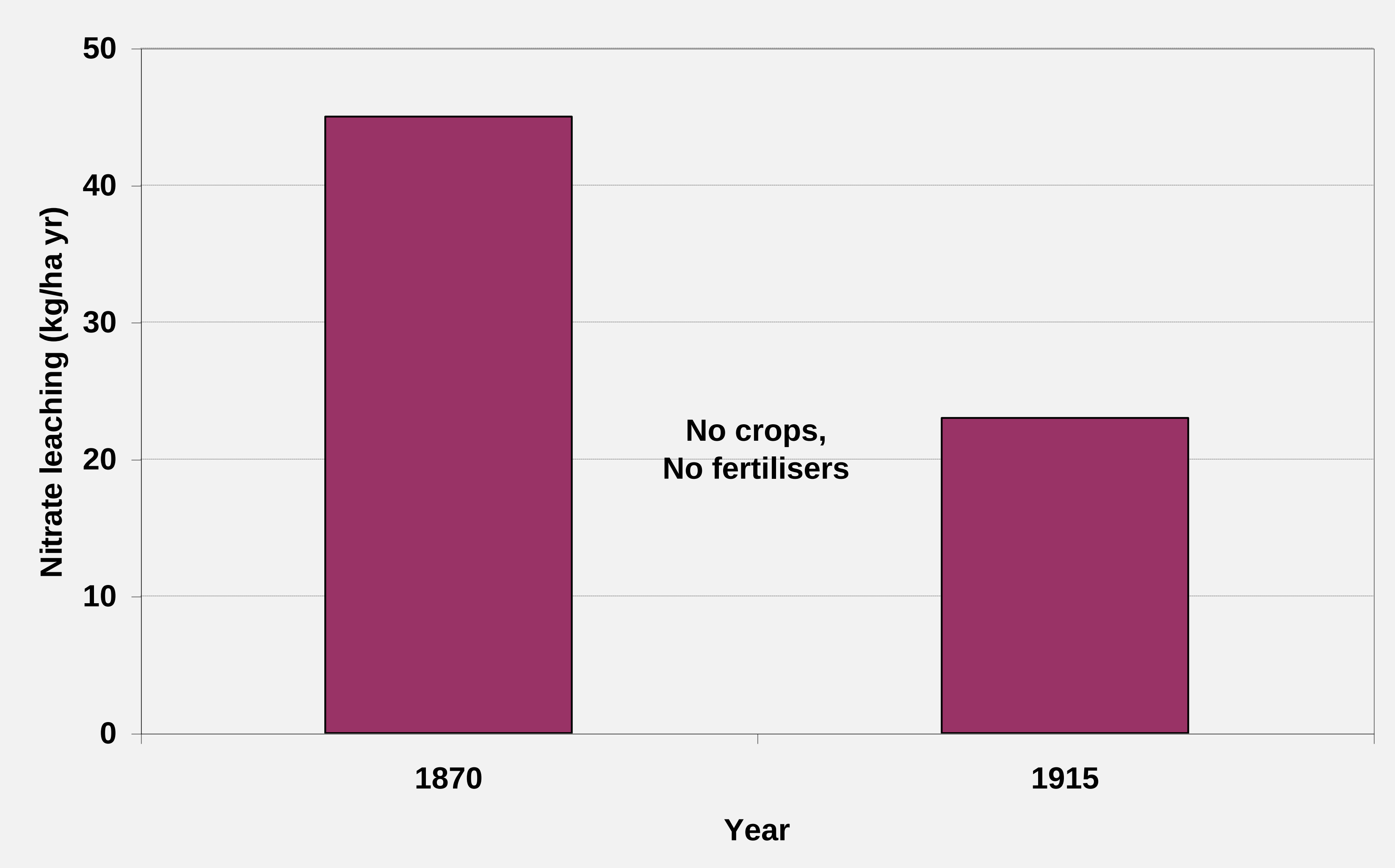


N fertilizers- yield response – losses to waters (Source: Uhlen, UMB)

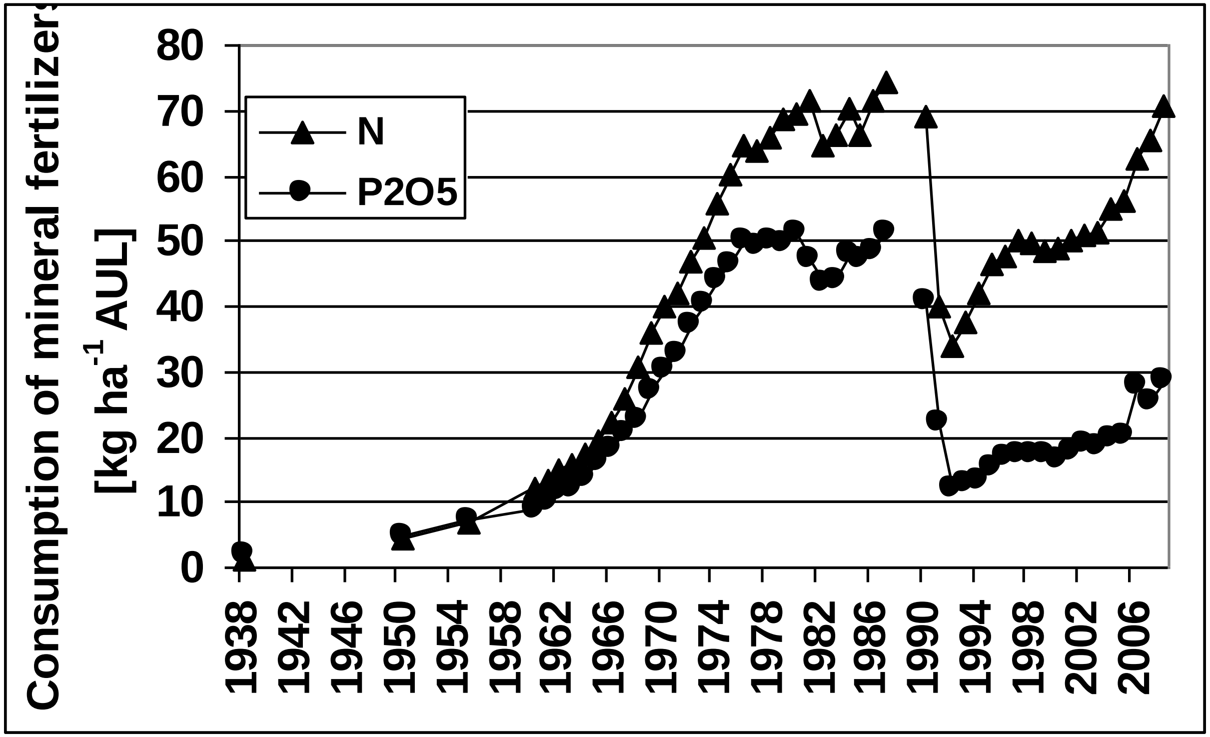




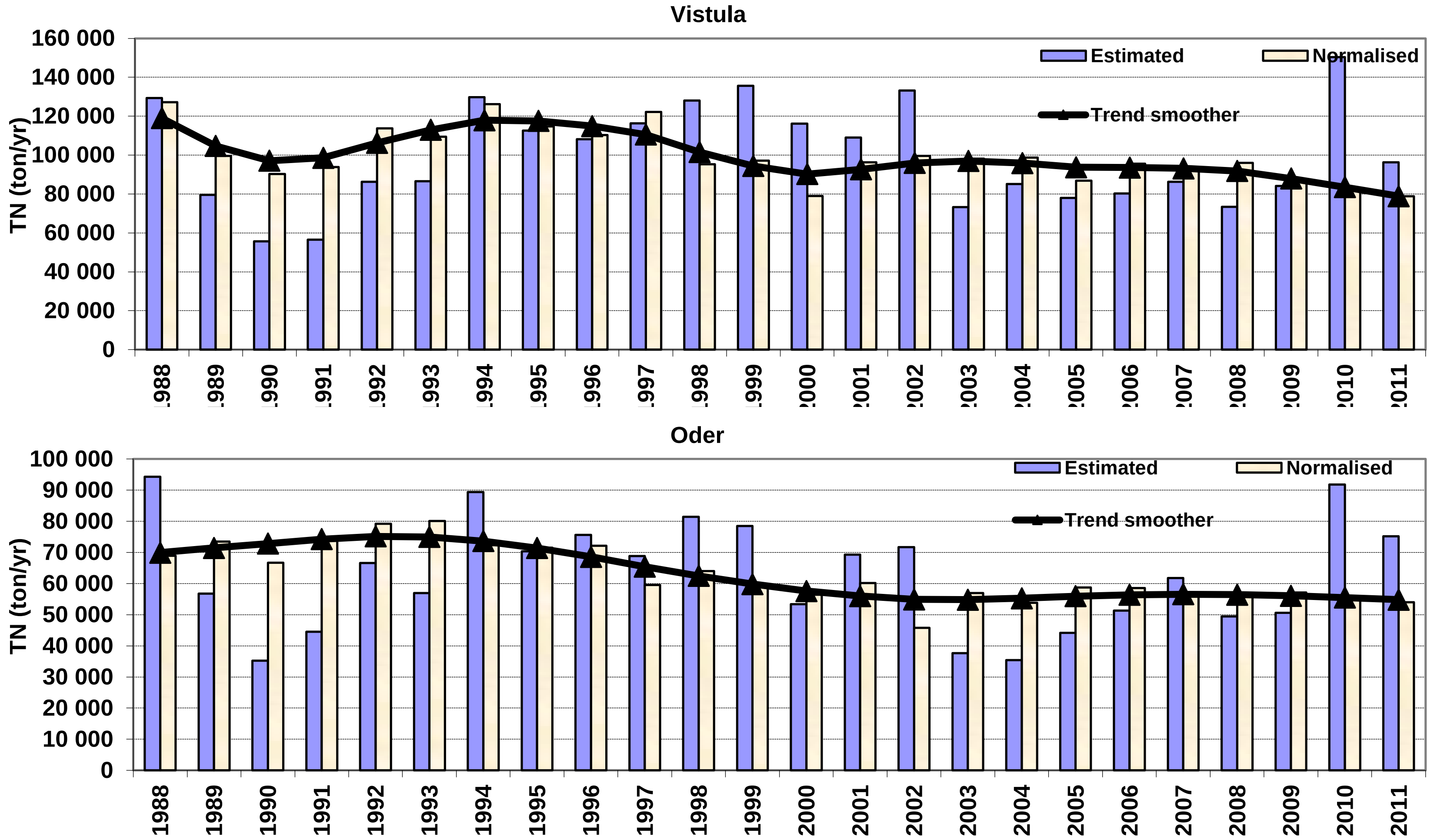
The Rothamsted experiment (UK)
(Addiscott, 1988)



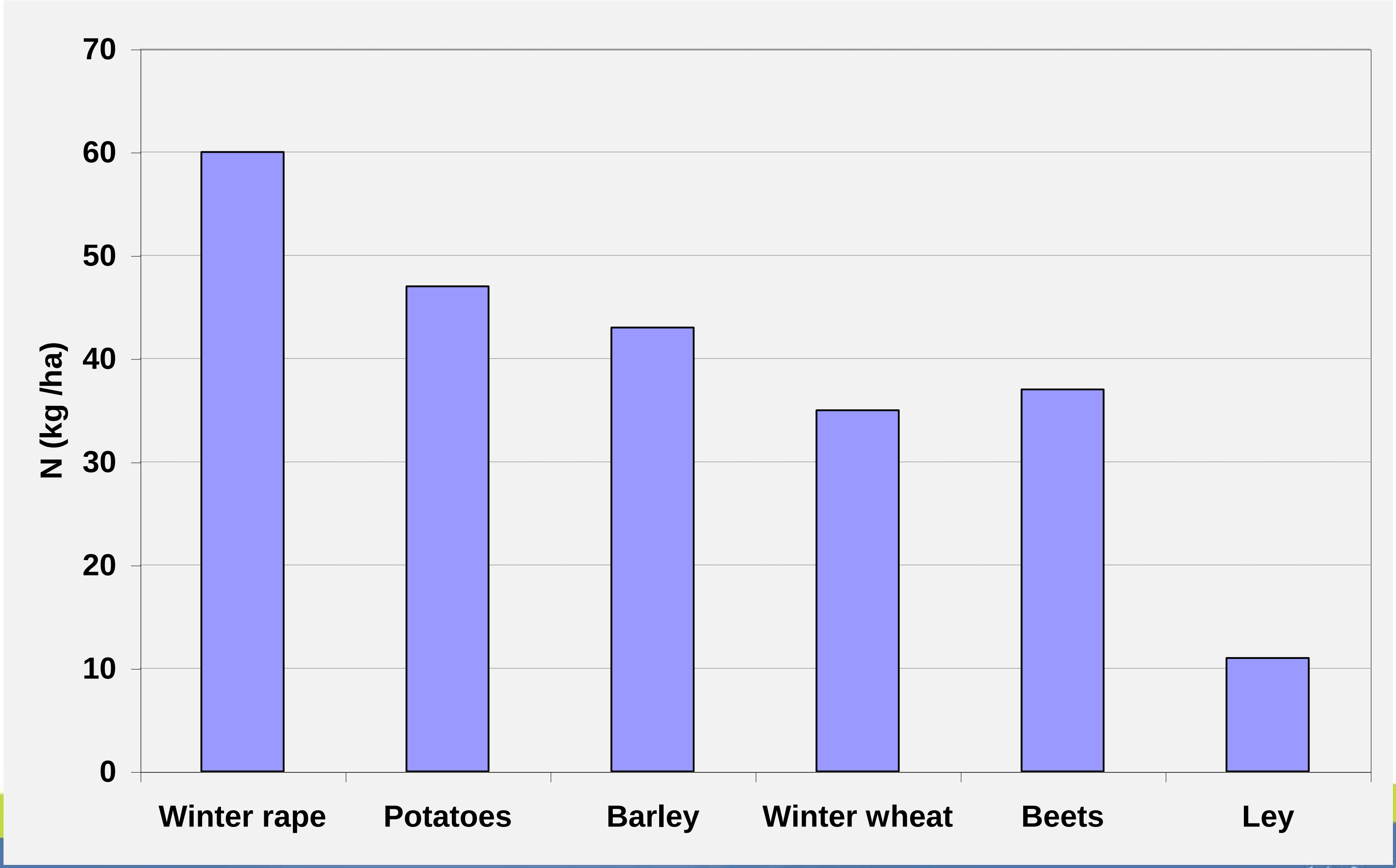
Nutrient application in the 2 large Polish rivers (Pastuszak, Stålnacke, et al., 2012)



Nitrogen river loads in the 2 large Polish rivers (Pastuszak, Stålnacke et al, 2012)



Variability due to different crops
N leaching in S Sweden (clay soils)
(Hoffmann & Johnsson, 1999)



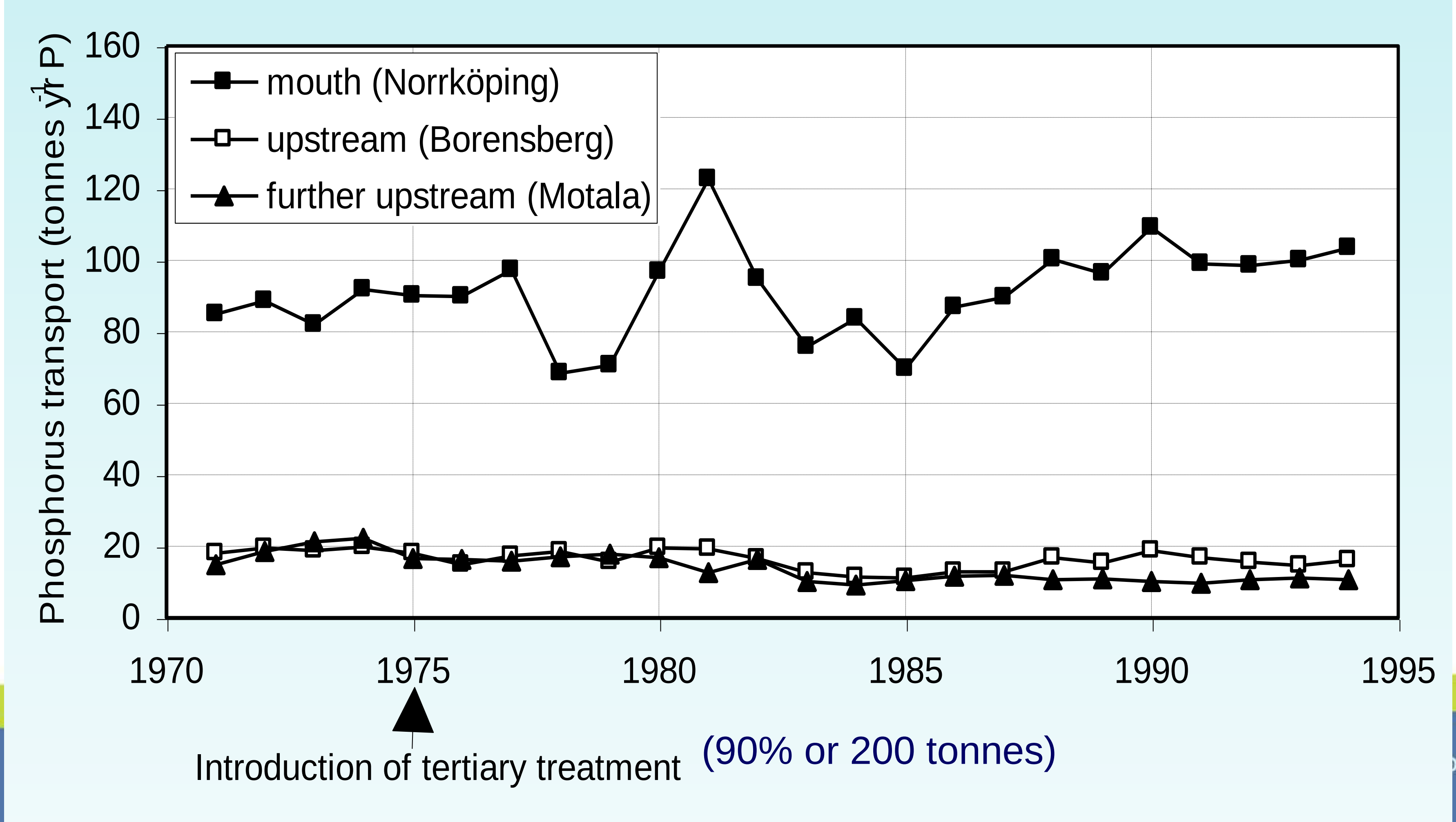
Time trends in 35 agricultural streams in the Nordic/Balrtic region

(Stålnacke et al., 2014)

			Water discharge	TN	
Country	Catchment	Timeperiod		Concentrations	Losses
Norway	Skuterud	1993-2011	(+) 0.370	(-) 0.028	(+) 0.016
	Mørdre	1992-2011	(+) 0.192	(-) 0.014	(+) 0.011
	Kolstad	1991-2011	(+) 0.211	(+) 0.021	(+) 0.026
	Hotran	1992-2011	(-) 0.652	(-) 0.005	(-) 0.030
	Time	1995-1999 2004-2011	(+) 0.232	(+) 0.034	(+) 0.016
	Skas-Heigre	1995-2011	(-) 0.078	(-) 0.013	(-) 0.002
	Naurstad	1994-2011	(-) 0.197	(+) 0.039	(+) 0.002
	Volbu	1992-2011	(+) 0.023	(-) 0.072	(-) 0.003
	Vasshaglona	1998-2011	(-) 1.424	(-) 0.001	(-) 0.094
Sweden	M42	1992-2010	(+) 0.007	(-) 0.177*	(-) 0.003*
	M36	1990-2010	(+) 0.061	(-) 0.201***	(-) 0.005**
	N34	1996-2010	(+) 0.039	(-) 0.332***	(-) 0.060***
	F26	1994-2010	(+) 0.218	(-) 0.196***	(-) 0.018***
	O18	1988-2010	(+) 0.041	(-) 0.081*	(-) 0.002
	E21	1988-2010	(+) 0.127	(-) 0.047*	(+) 0.003
	I28	1989-2010	(-) 0.032	(-) 0.092	(-) 0.002
	C6	1994-2010	(-) 0.003	(-) 0.069*	(-) 0.001
Denmark	Højvads Rende	1990-2011	(-) 0.556	(-) 0.033	(-) 0.002
	Odderbæk	1990-2011	(+) 1.671	(-) 0.058***	(-) 0.002***
	Horndrup bæk	1990-2011	(+) 0.519	(-) 0.178***	(-) 0.016***
	Lillebæk	1990-2011	(+) 0.266	(-) 0.227***	(-) 0.013***
	Bolbro bæk	1990-2011	(+) 1.584	(-) 0.011	(-) 0.001*
Finland	Löytäneenoja	1998-2009	(-) 0.062	(-) 0.032	(-) 0.005
	Hovi	1998-2009	(-) 0.101	(-) 0.070	(-) 0.010*
	Savijoki	1998-2009	(-) 0.111	(-) 0.040	(-) 0.001
	Haapajyrä	1998-2009	0,000	(+) 0.038	(-) 0.000
Baltic states	Jänijõgi	2002-2011	(+) 1.390	(+) 1.138*	(+) 0.259
	Rägina	2000-2011	(+) 0.070	(-) 0.080	(+) 0.007
	Räpu	1995-2011	(+) 0.801*	(+) 0.457**	(+) 0.106*
	Berze	1993-2012	(-) 0.001	(+) 0.247**	(+) 0.002**
	Mellupite	1994-2012	(+) 0.017	(+) 0.042	(+) 0.001
	Vienziemite	1993-2012	(+) 0.079	(+) 0.021	(+) 0.002
	Graisupis	1996-2010	(+) 0.05	(+) 0.037	(+) 0.002
	Vardas	1996-2010	(+) 0.05	(-) 0.017	0,000
	Lyzena	1997-2010	0,000	(+) 0.030	0,000

Riverine response to decreased point source P-emissions

Motala Ström in Sweden (Grimvall & Stålnacke



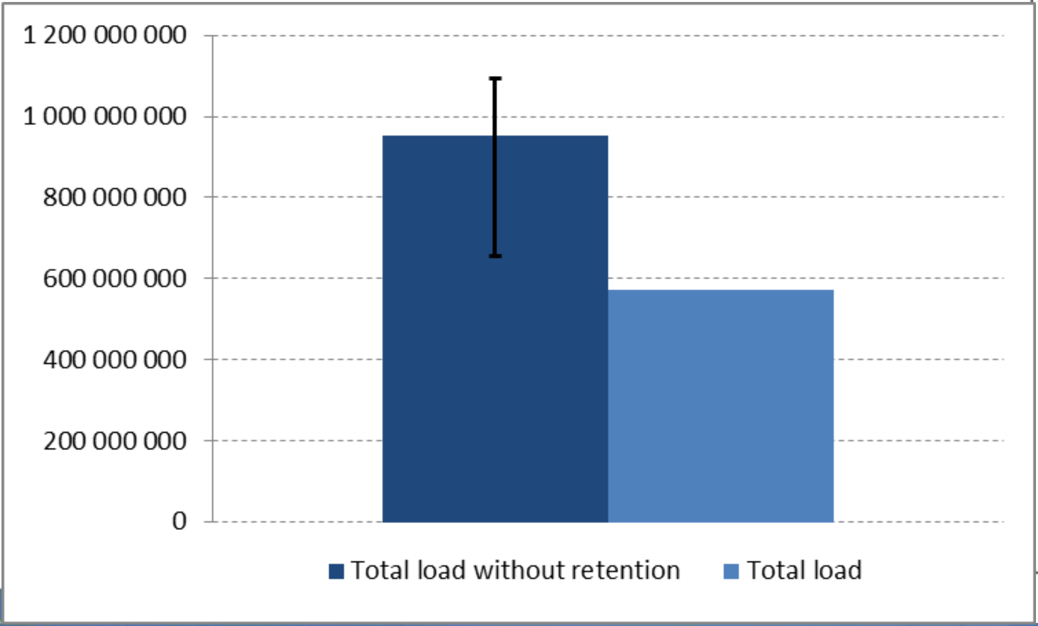
Part 3. Retention = natural mitigation measure

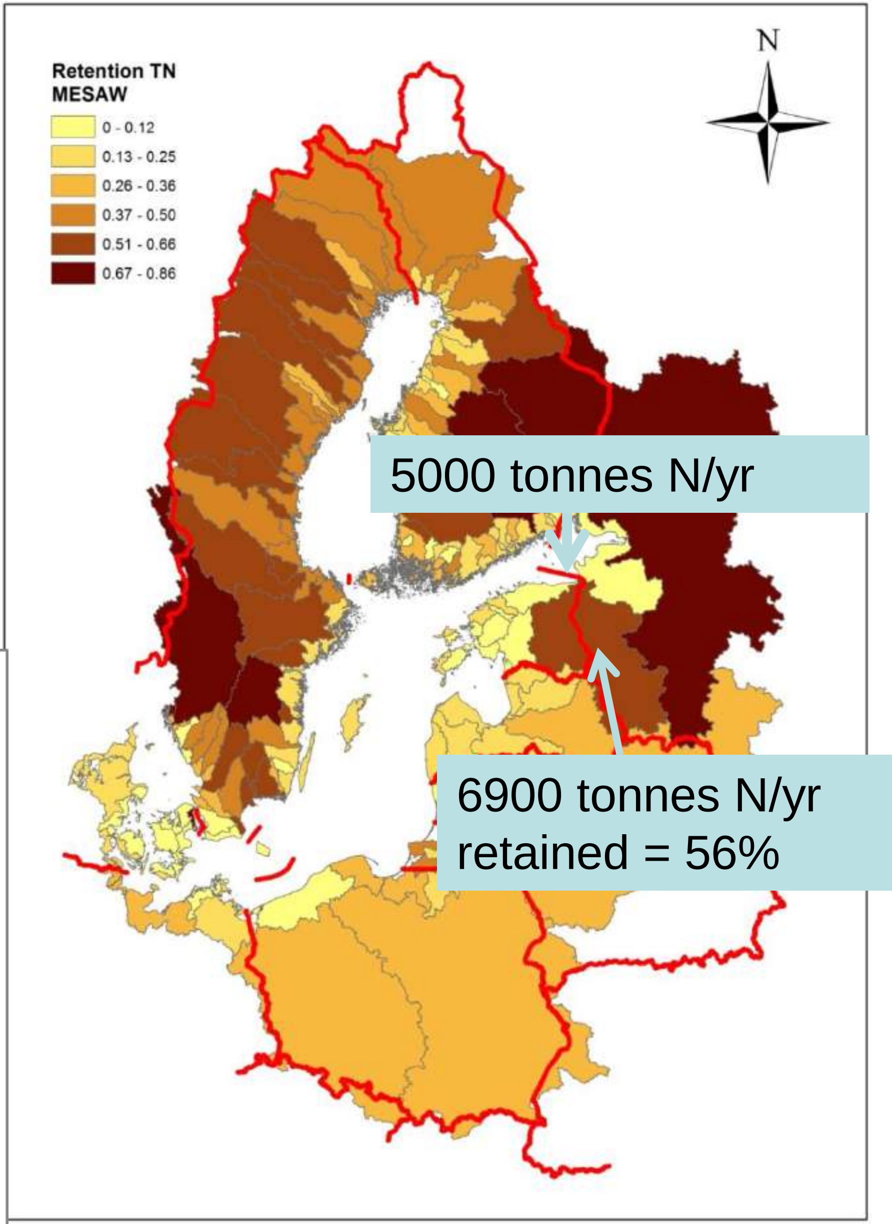
Bioforsk

Retention processes

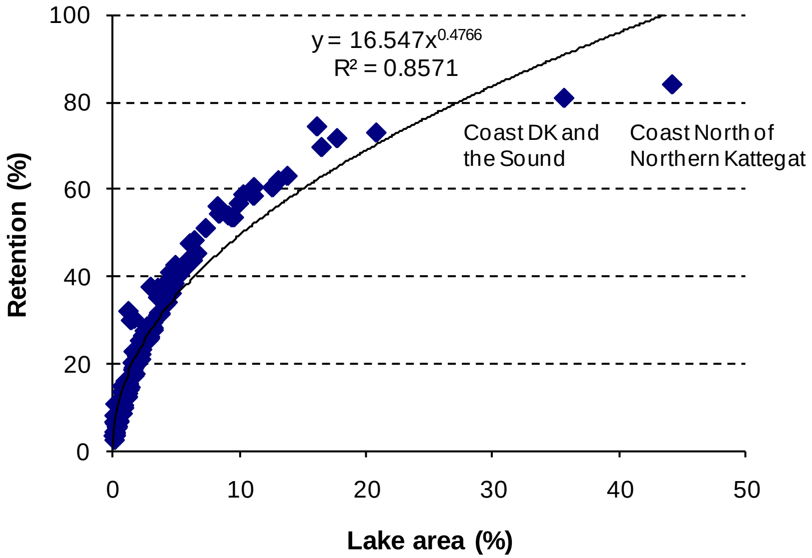
- Biomass uptake;
- storage in catchment soils and groundwater;
- denitrification in soil, groundwater, wetlands or riparian zones;
- in-stream processes of retention, either by benthic or planktonic denitrification or by storage in sediments.

Nitrogen surface water retention in 117 Baltic Sea river basins with MESAW (Stålnacke et al. 2015)

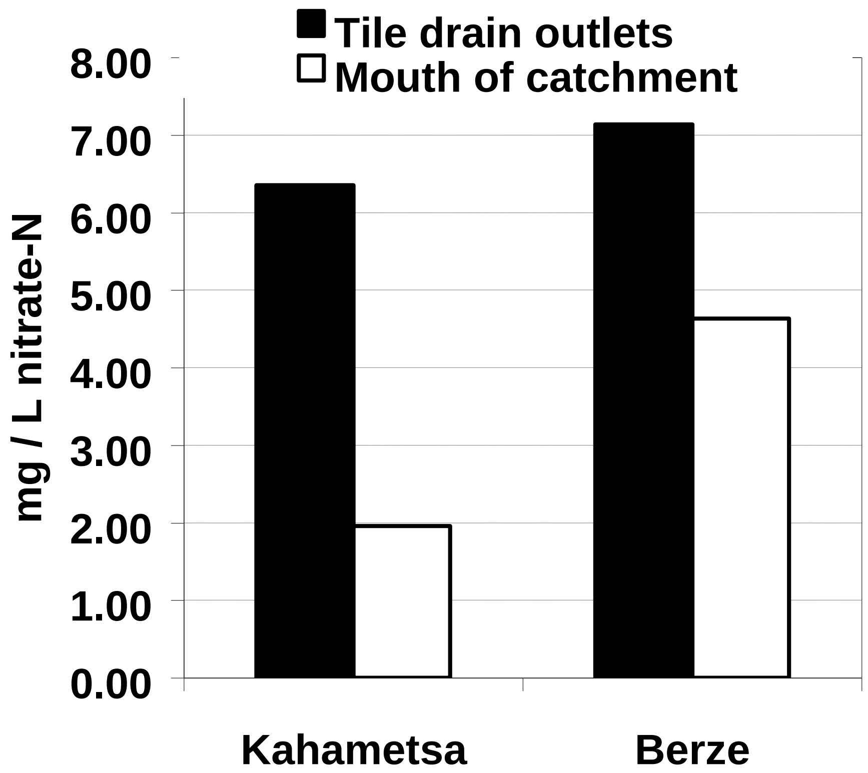




Modelled nitrogen retention (Baltic Sea rivers) as a function of lake area (Stålnacke et al. 2015)



Mean nitrate concentrations at the outlet of the tile drains and at main channel in outlet of two agricultural stream in Estonia and Latvia (Stålnacke et al., 1999)



Concluding remarks

- Nutrient losess show high variability
- Several ’external’ and governing factors:
- Pathways (e.g. hydrological) are important and site-specific
- Huge uncertainty in retention (from root-zone to stream)

-> Huge challenge to plan and model the optimal mitigations measures

Thank you for your attention!

Estonian Environmental Research Centre

ICELAND
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NORWAY
eea grants

Development of data-modeling system and the decision support tool for the integrated marine and inland water management

Erik Teinemaa, Tiia Kaar

Kesklabor
Central Lab

Project

- Name: Development of data-modeling system and the decision support tool for the integrated marine and inland water management
- Project promotor
  - Estonian Environmental Research Centre
- Project partners
  - Estonian Environment Agency
  - Environmental Inspectorate
  - Environmental Board
  - Bioforsk (Norway)
  - IT Centre of the Ministry of the Environment

Project budget

- Project budget: 2044000 EUR
  - Estonian Environmental Research Centre 765705
  - Estonian Environment Agency 200520
  - Environmental Inspectorate
  - Environmental Board 120175
  - Bioforsk (Norway) 342000
  - IT Centre of the Ministry of the Environment 615600

- End of project 30.04.2016

Cooperation

- Experts from major Estonian universities are involved in project:
  - Tallinn University of Technology
  - University of Tartu
  - Tallinn University of Technology, Marine Systems Institute
  - University of the Life Sciences
  - Tallinn University

Planned outcomes

- The main aim of the project is to establish a **web based modelling system as a decision support tool** for the integrated marine and inland water management:
  - Updating and establishing new integrated databases to provide information on marine and inland waters
  - Ensuring and creating interoperability with and links to other relevant registers to obtain relevant data

Planned outcomes

- Elaboration of surface water models to assess the status, loads and impacts of measures
- Elaboration of user oriented applications to perform data queries, compile reports, policy and environmental scenarios and to provide background information for decision support
- System will be available as web based tool for all institutions related to assessment or management of surface water quality in Estonia and for the public use as well

Purpose of the seminar

- Overview of the best practises for inland water management in other countries
- Learn from other experiences
- Exchange best practices and knowledge
- How to handle and disseminate data related to water management in best way
- Obtain contacts for future cooperation

Conclusions

- Technical solutions and developments are important but it is just a tool which helps experts to make decisions
- Main benefit of the project is cooperation among institutions and experts working with water management
  - Qualified user network
- Cooperation and data/knowledge sharing will be key to have sustainable system

Estonian Environmental Research Centre

Thank you for attention!

http://www.klab.ee/veemudelid/

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