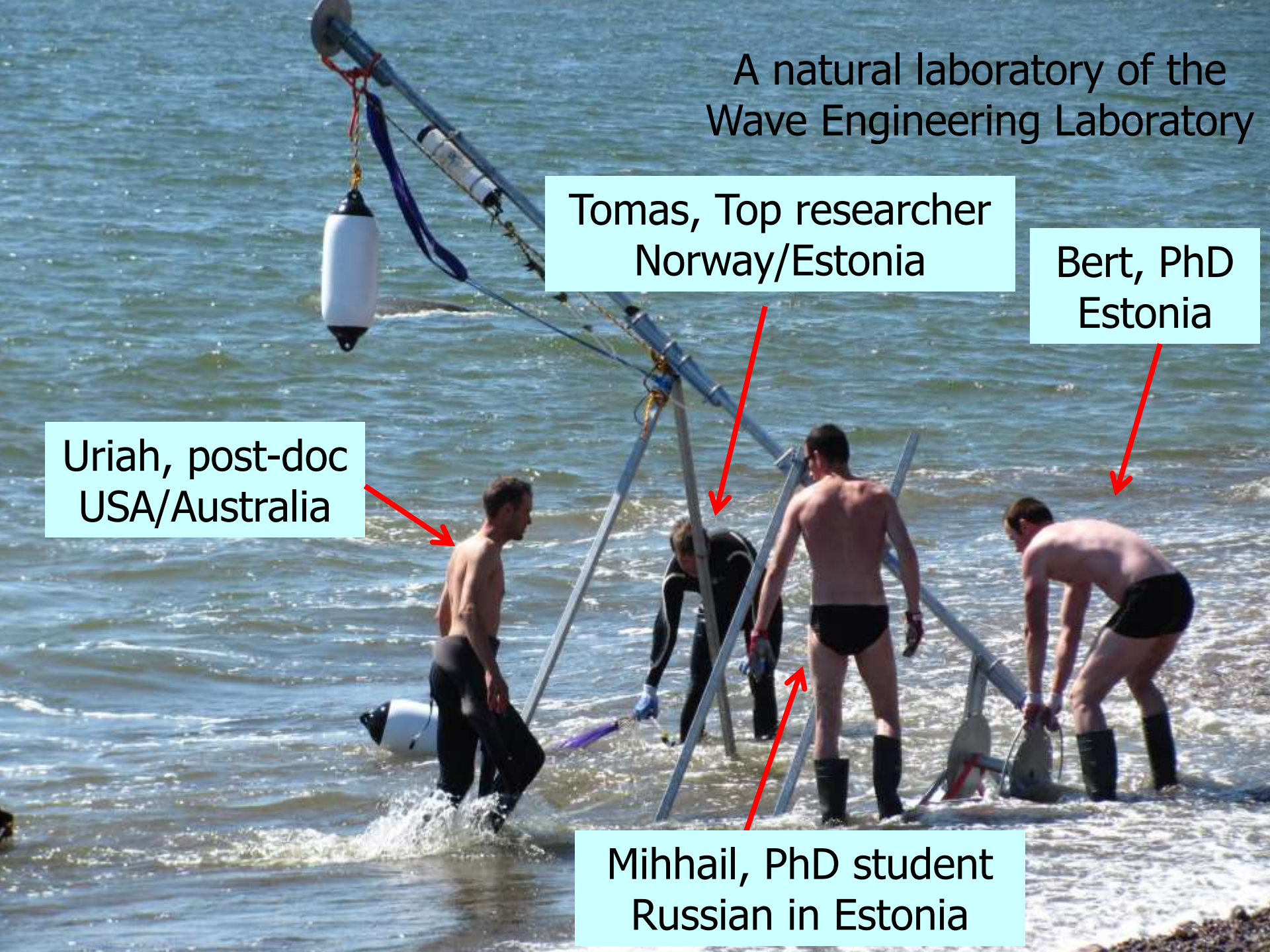

A natural laboratory of the
Wave Engineering Laboratory
Tomas, Top researcher
Norway/Estonia
Bert, PhD
Estonia
Uriah, post-doc
USA/Australia
Mihhail, PhD student
Russian in Estonia

Wave dynamics and Lagrangian transport for coastal and maritime engineering

Tarmo Soomere

and the Wave Engineering Laboratory team

Institute of Cybernetics at Tallinn University of Technology

Seven years of the Wave Engineering Laboratory

Currently

- 2 senior scientists
- 6 scientists with PhD
- 3+2 PhD students
- 1 MSc student
  - 16 persons
  - 7 mother tongues

2009--2015

- 12 PhD promotions
- 9 MSc promotions
- 120+ ISI-listed papers
- 2 books (Springer)
- Plinius Medal 2010
- Young sci. of TUT 2010
- Scientist of the year TUT 2011
- Best sci. popularisator in Estonia 2011
- National Research Award 2013 in engineering
- High state decoration 2014

Research directions

- Wave dynamics & climate
  - Long waves, freak waves, internal waves, run-up, set-up, ship waves
  - Extremes, spatio-temporal variations
- Coastal processes
  - Sediment transport, structural stability, renewable energy
- Lagrangian transport
  - New view on the role of currents, preventive pollution control, coastal protection

Marine coastal hazards: often of wave nature

Kalk Bay, 2005
(Photoshop)

Mavericks Beach
(California, USA)
13.02.2010
Slyunyaev et al. 2011

Waves shaping the coast

- Coasts of the Baltic Sea: often unexpecdly fast retreat

Kiipsaare, Saaremaa

2004

2009

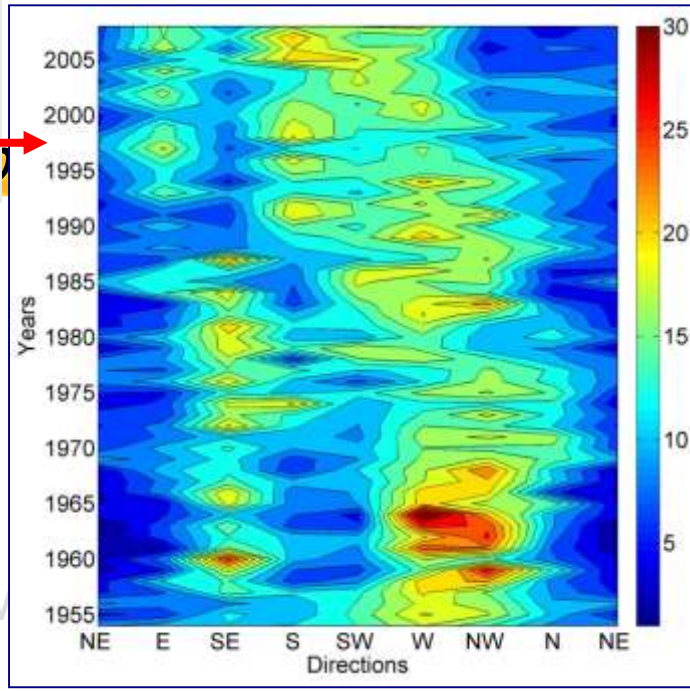
Input to engineering I: Long waves

- Waves offshore and nearshore
  - Long waves (*runup, overtopping, impact*)
  - Wave climate, climate changes
  - Wave-coast interactions
- Marine hazards
  - Tsunami, extreme storms
  - Monster waves, ship waves, internal waves
- [illegible]

The use of waves from high-speed ships for tsunami research in safe and controlled conditions

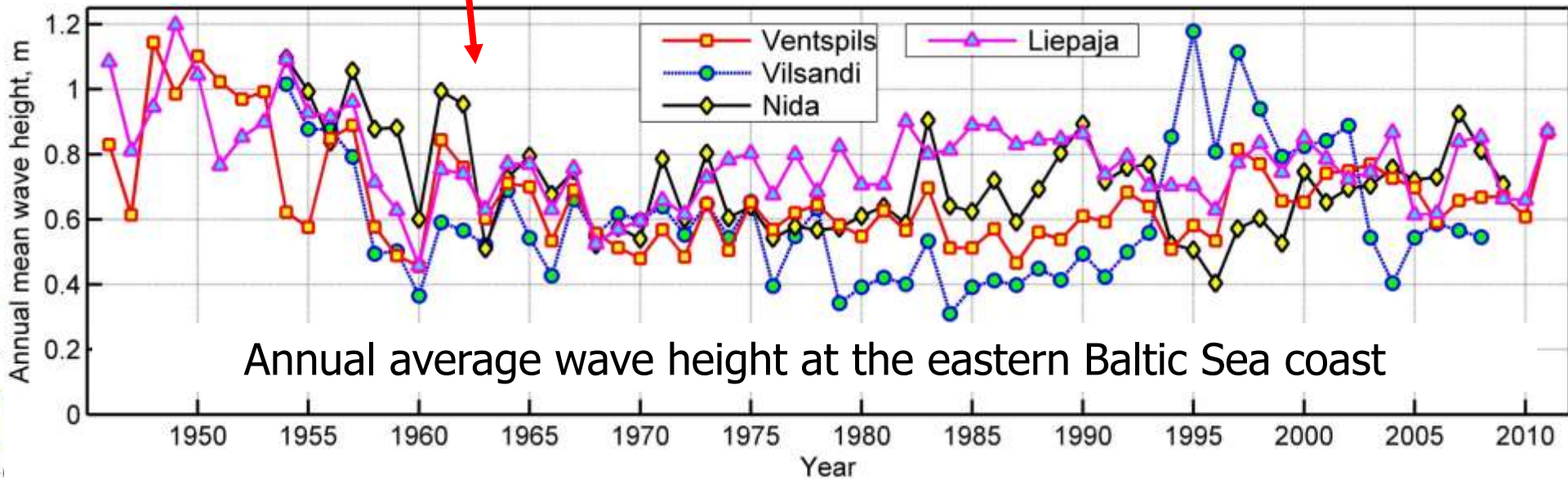
Input to engineering II: Waves climate / changes

Major observed changes in the wave approach direction in the eastern Gulf of Finland in 1954-2007 (Soomere et al. 2010)



- Wave climate, climate changes
- Extension of the observed Baltic Sea wave climate back to 70 years

Surprise: inverse "hockey-stick" course of wave activity

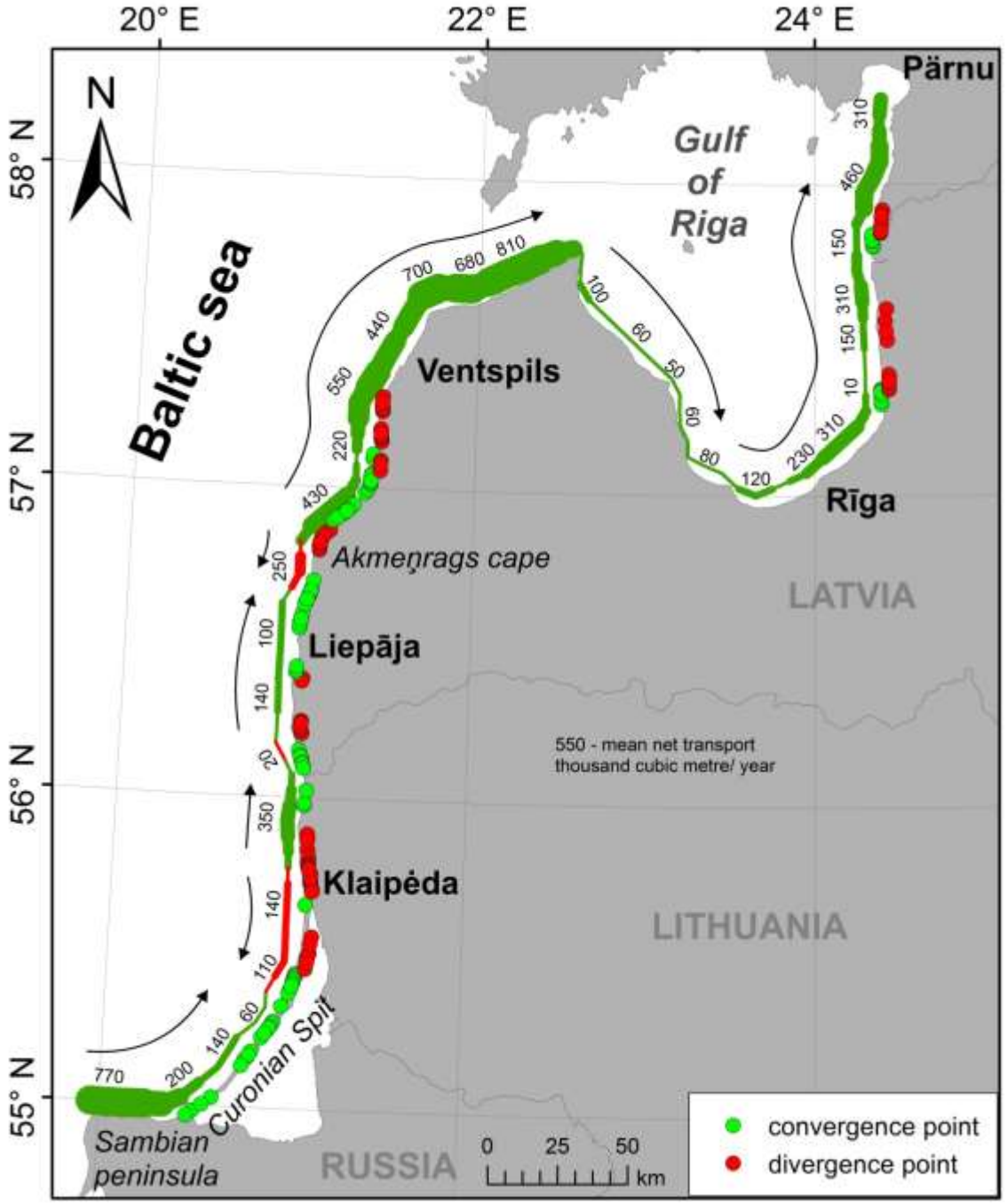


Annual average wave height at the eastern Baltic Sea coast

Input to engineer
Waves shaping th

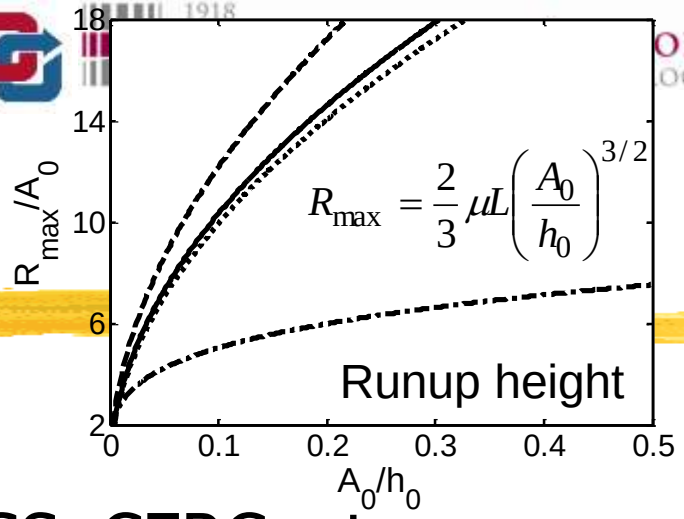
- The Questions: Whe

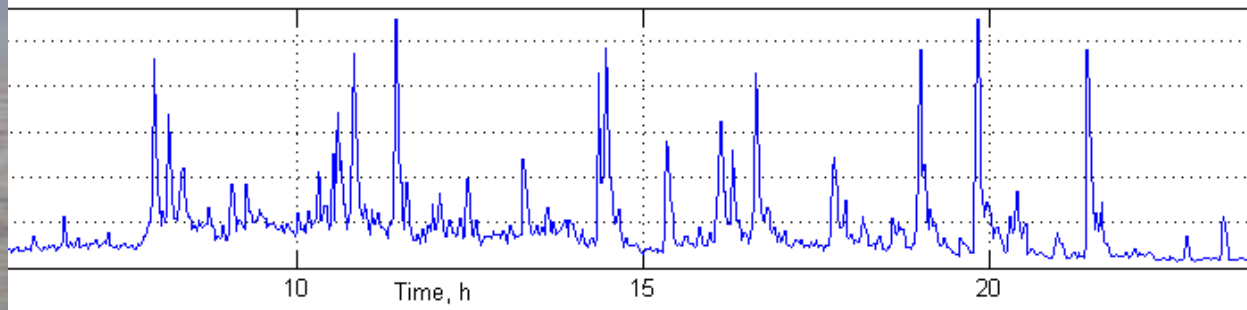
Answers: Wave-driven sediment transport: convergence – divergence – changes in time



Methods

- Analytical solutions
- Numerical modelling
  - WAM, COULWAVE, TRACMASS, CERC, etc.
- Field experiments
  - wave measurements
  - runup properties
  - drifters in the Baltics



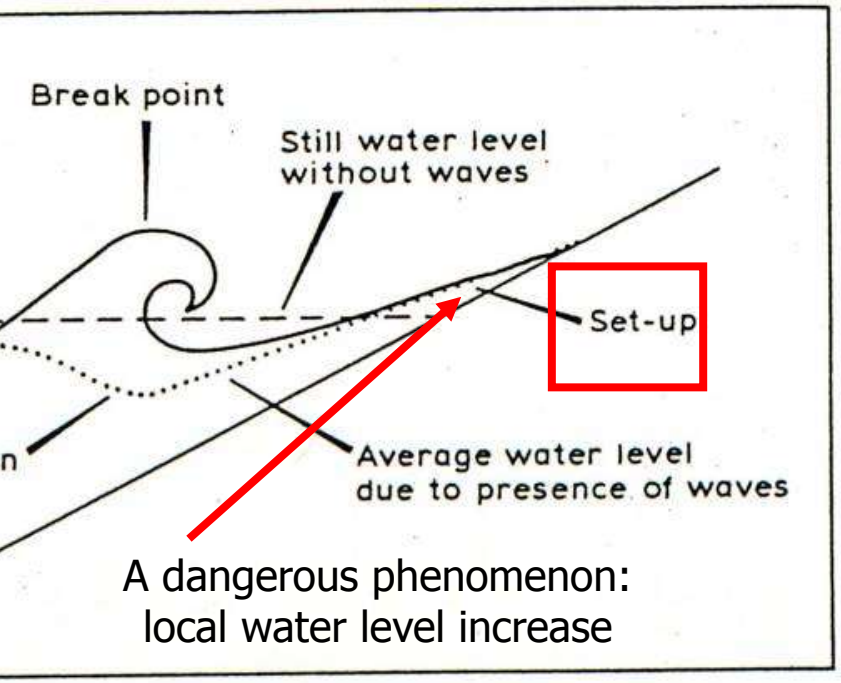


Ship waves near Aegna

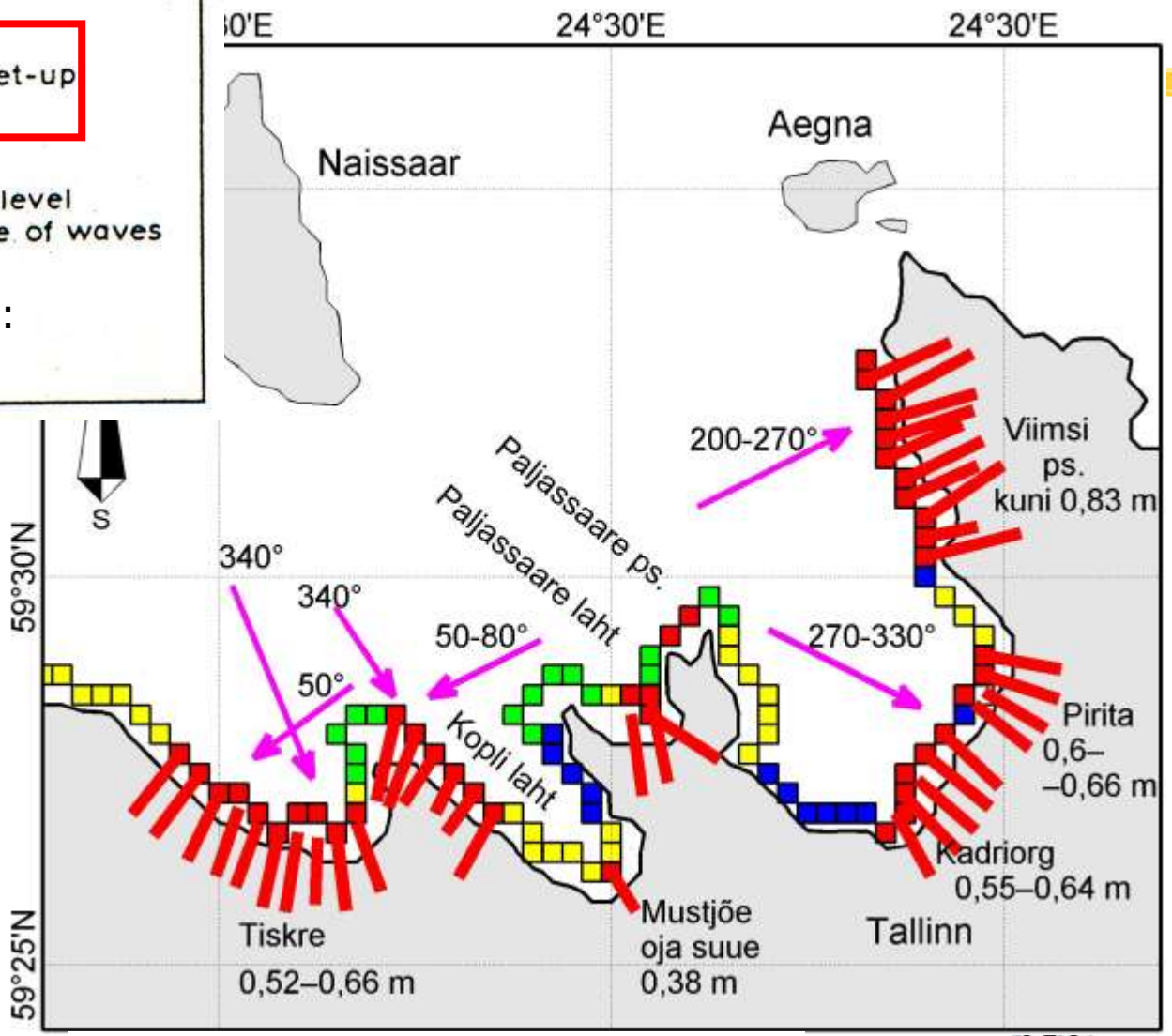
WAVE ENGINEERING


SELVA
TALLINK Shuttle

Input to management I: Waves – blessing or curse?



A dangerous phenomenon: local water level increase



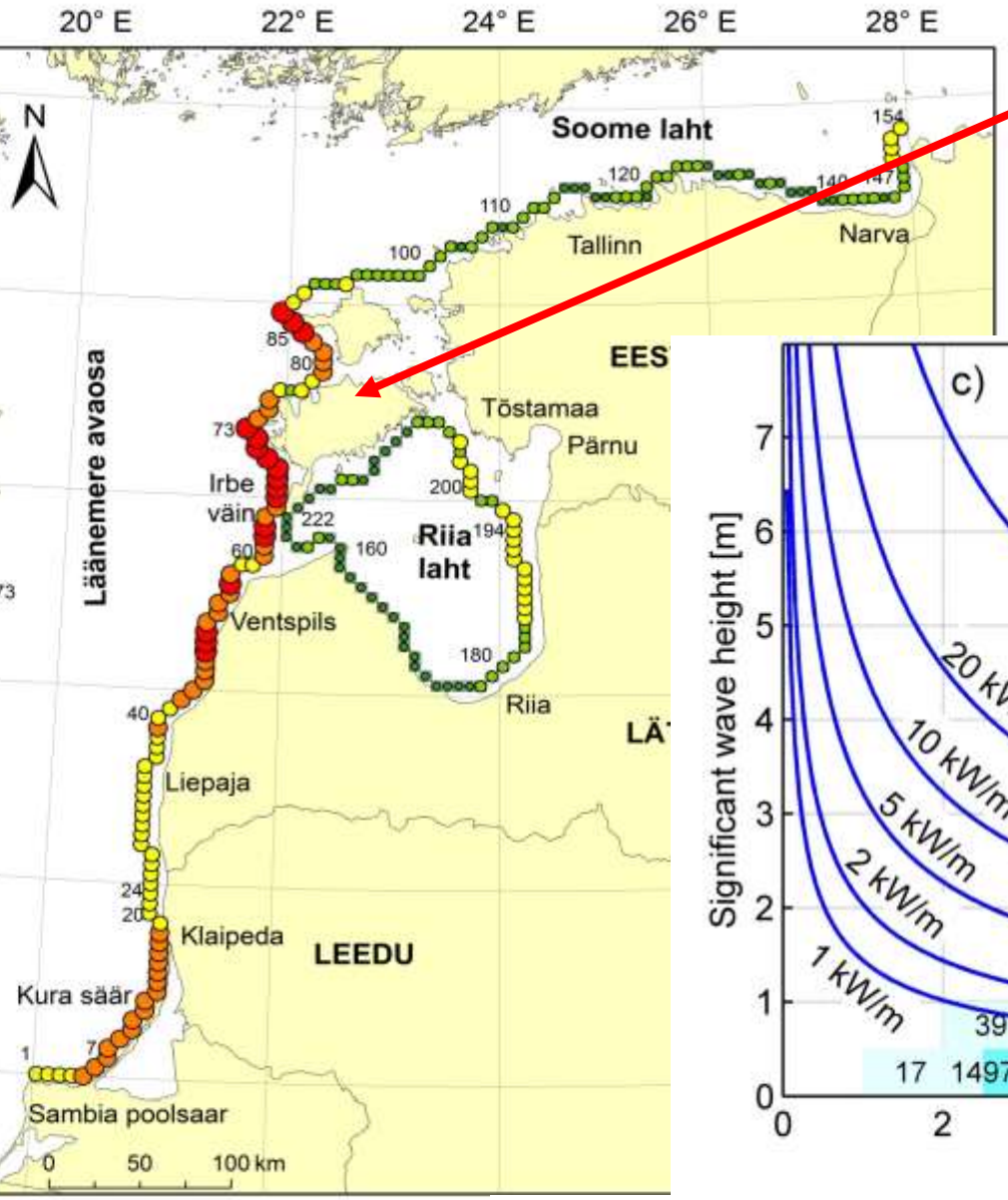
Soomere, Pindsoo et al. NHESS, 2013

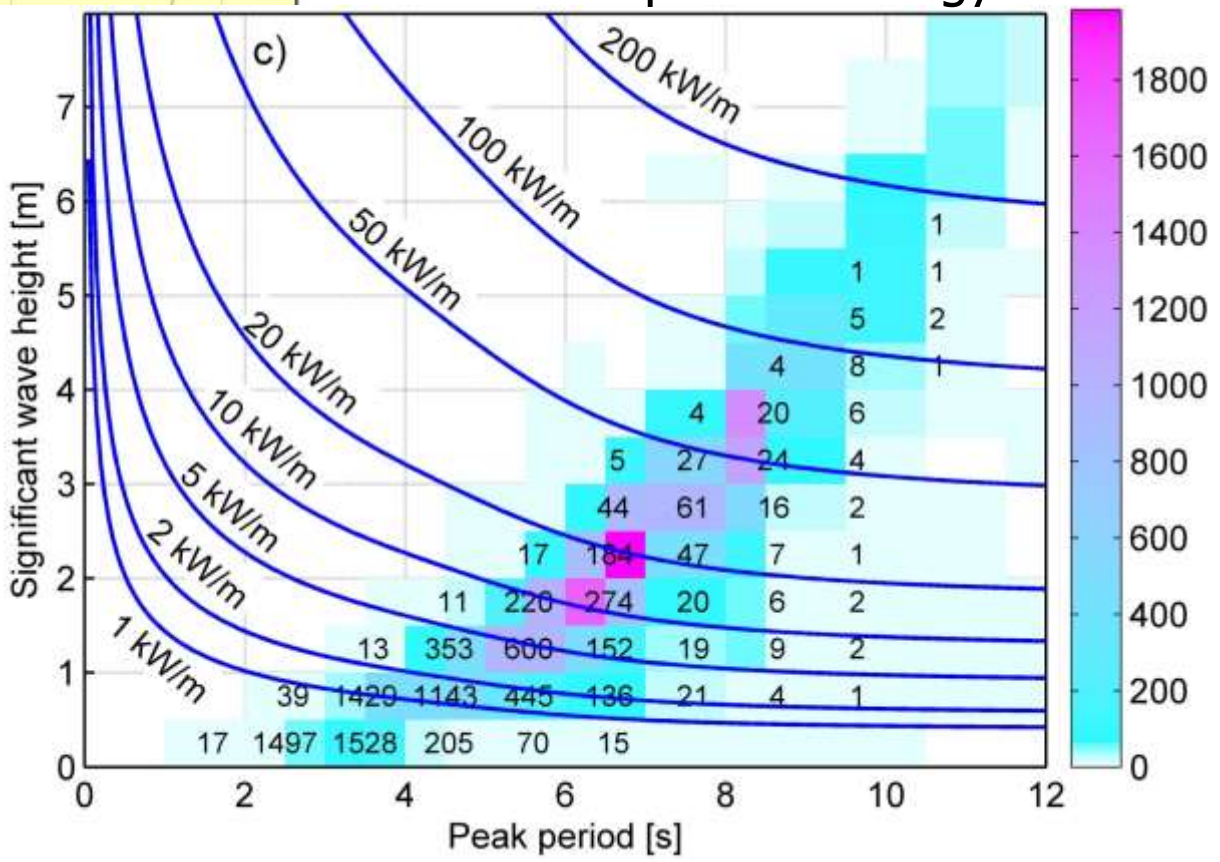
WAVE ENGINEERING

Input to management II: Waves – blessing or curse?

Where the wave energy is in space

Which wave conditions provide energy





Soomere, Eelsalu, *Renewably Energy*, 2014

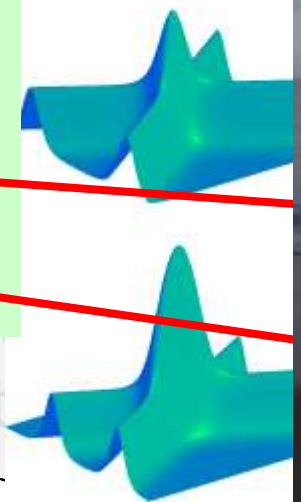
WAVE ENGINEERING

Input to management III: Marine and coastal hazards

- Waves offshore and nears
  - Long waves (*runup, overto*
  - Wave climate, climate chan
  - Wave-coast interactions
- Marine hazards
  - Tsunami, extreme storms
  - Monster waves, ship w
  - Solitons & interactions

Shallow-water soliton

Soliton interactions as a source of long-living **rogue waves**: 4-fold increase in wave height; 8-fold increase in steepness



When scientists HAVE to interfere

Coasts under unfair pressure

The question:

Can we do something to "handle" oil pollution?

Risk=probability × cost (van Dantzig)

The goal: Reducing the consequences of disasters

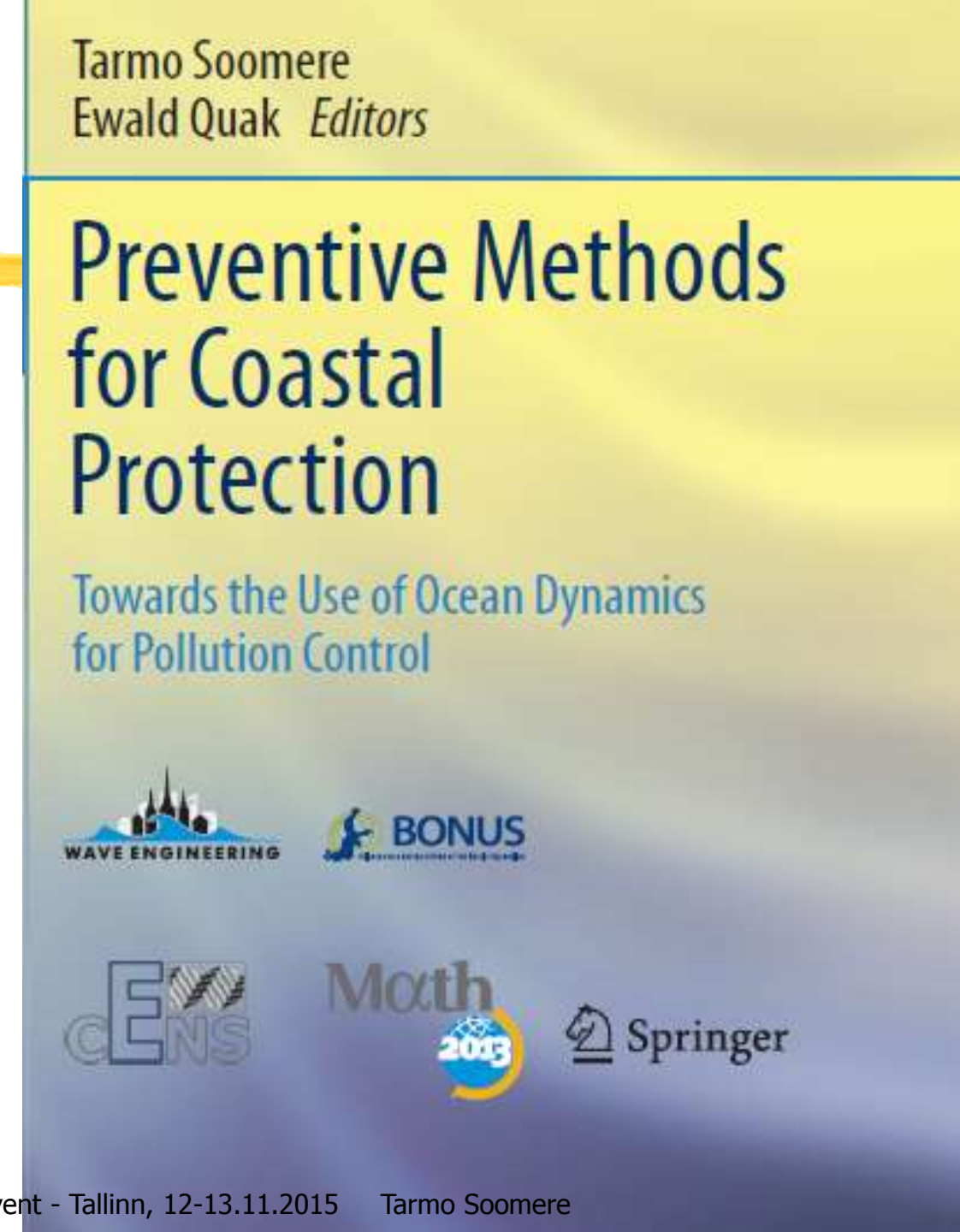
- by smart adjusting the location of human activities
- so that the pollution will not hit the coasts

The method: solving the inverse problem:

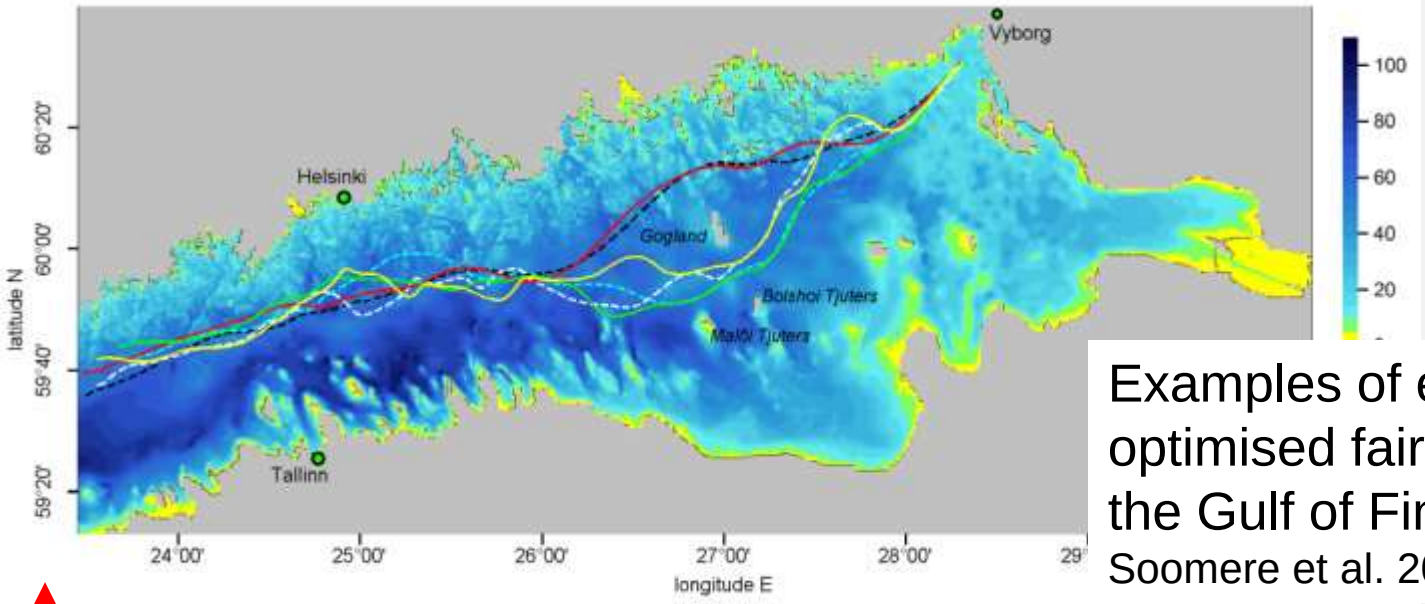
- quantification of offshore areas
- in terms of their 'ability' to supply coastal pollution
- through current-driven transport

July 2013

A short description of an approximate solution



Input to offshore engineering: Technologies for environmental management & fairway design

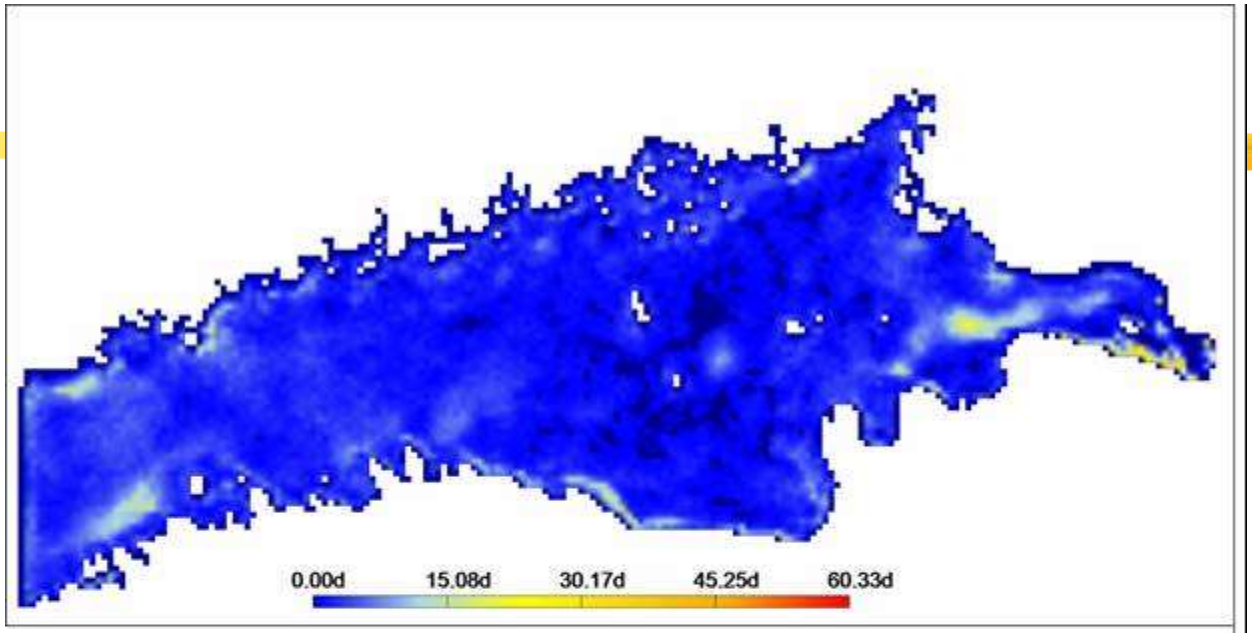


Examples of environmentally optimised fairway designs for the Gulf of Finland (Andrejev, Soomere et al. 2011)

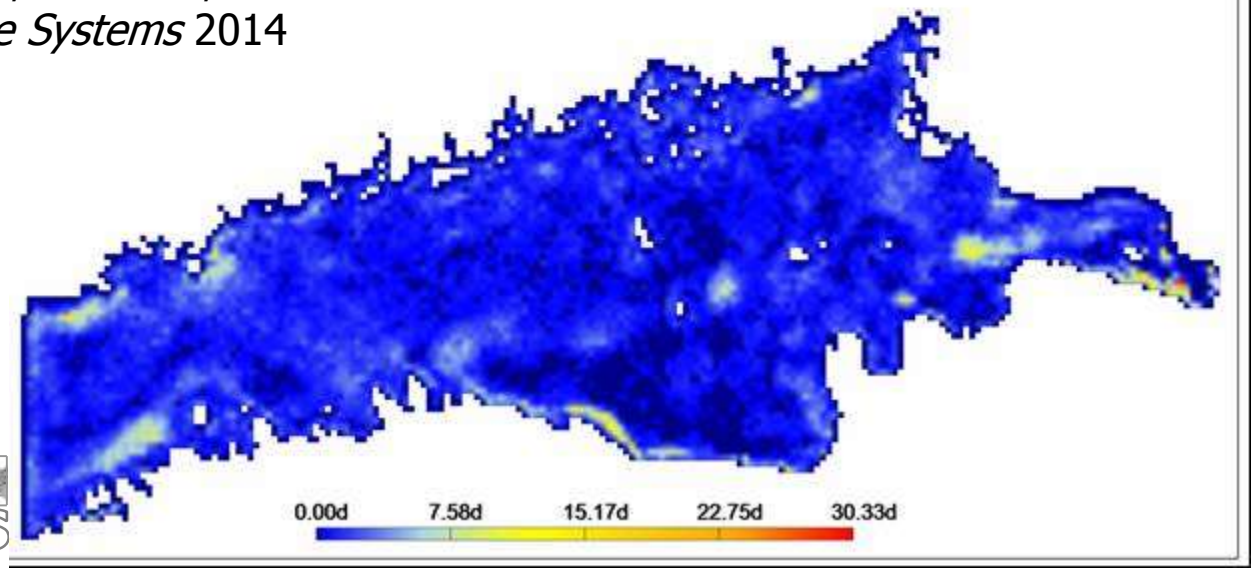
- Inverse problem of current-driven transport
  - Lagrangian transport
  - Optimal fairways
  - Maritime spatial planning
  - Preventive methods for coastal protection

Reducing the consequences of offshore disasters by smart adjusting the location of human activities so that the pollution will not hit the vulnerable regions

Where the pollution tends to gather?

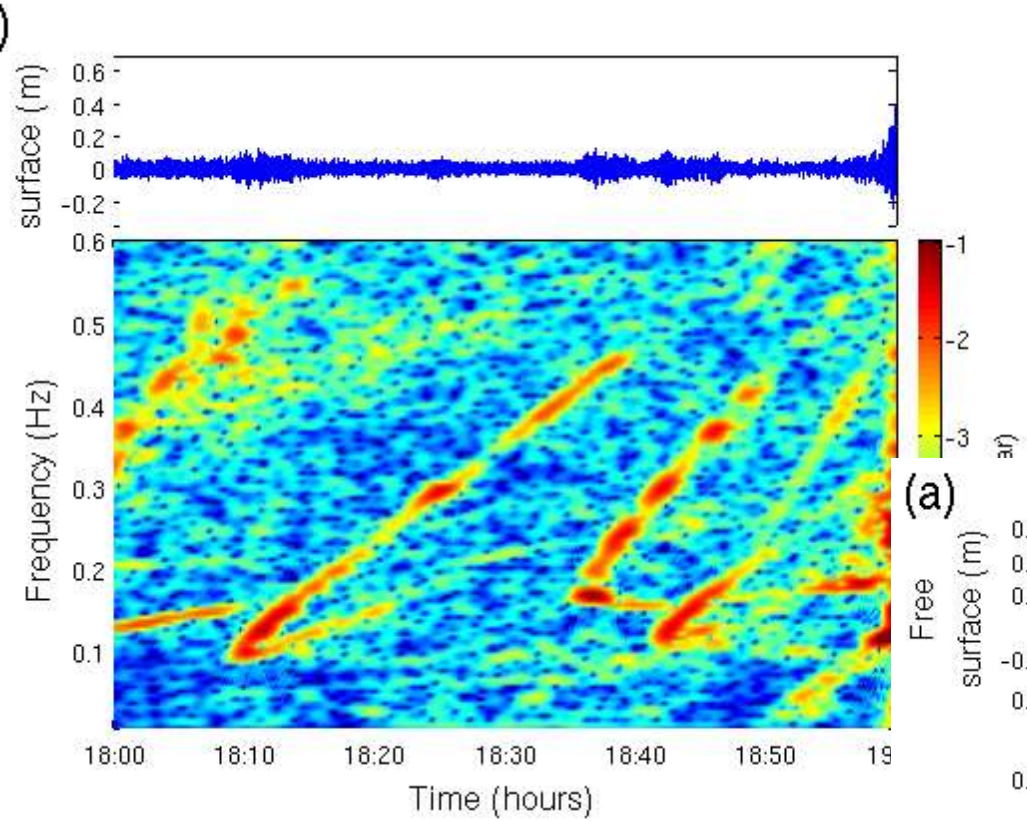


Giudici, Kalda, Soomere, *Journal of Marine Systems* 2014

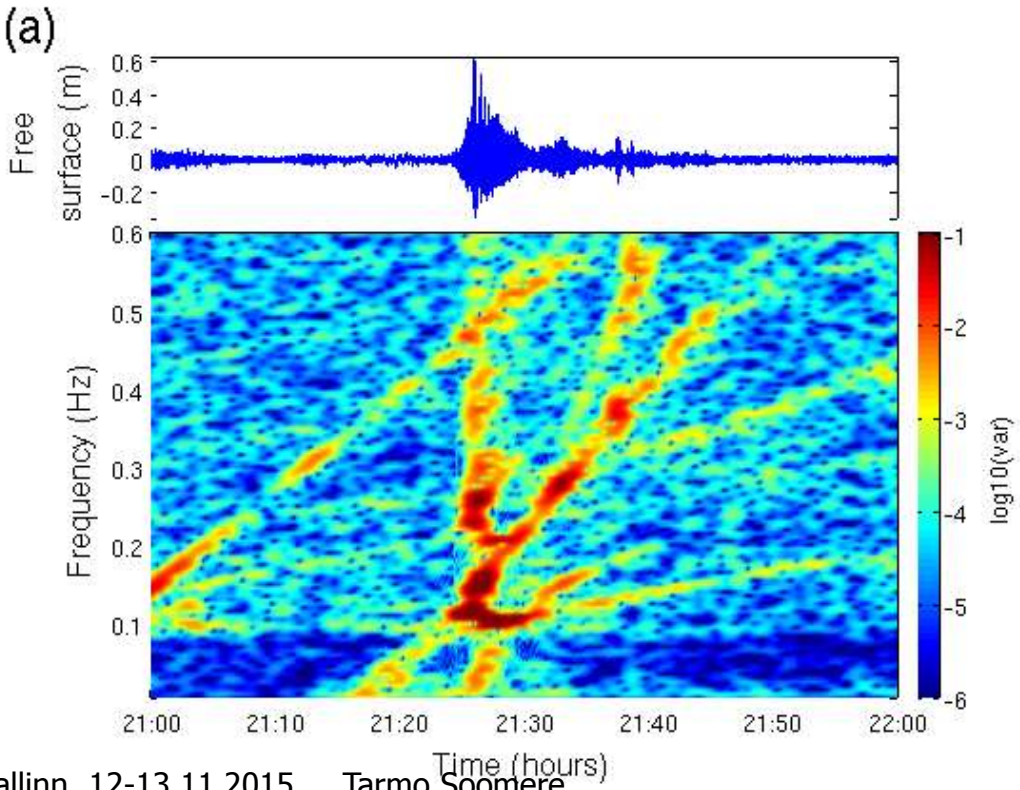


WAVE ENGINEERING

Portraits of ship waves



Usual ships



Fast ferries

Torsvik et al. 2013 *Journal of Coastal Research*; 2014 *Journal of Fluid Mechanics*

Life is a beach? Shaped by waves? Enjoying winds of change?

SESREMO team

Senior members:

- Tarmo Soomere, Tomas Torsvik, Ira Didenkulova (PhD or higher)

Researchers:

- Bert Viikmäe, Andrea Giudici, Nicole Delpeche-Ellmann (PhD)

Junior members:

- Maris Eelsalu, Katri Pindsoo (MSc) Maarika Org (BSc)

SESREMO activities

Training event: Tallinn-Klaipeda, November 2014

- Additional participants from Lithuania, Latvia, Estonia
- Presentation of three curricula (Klaipeda, 02-13.11.2014)
  - Environmental Mathematic Modelling fo Wave Dynamics
  - Coastal Processes and Environmental Management
  - Preventive Methods for Coastal Environmental Protection
- Pre-publication of lecture notes for these curricula
- Master classes (Tallinn, 01. nov. 2014, I.Didenkulova, T.Torsvik)
- Master class (T.Torsvik, Preventive Methods for Coastal Protection, Baku, 07.10.2014)

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SESREMO activities under planning

Master classes:

- Baku, February/March 2015 (T.Soomere)
- Kazakhstan, spring 2015
  - Location to be defined
  - B.Viikmäe, A.Giudici, N.Delpeche-Ellmann
- (?) Israel, late winter/spring 2015 (T.Soomere)
  - Location to be defined
- (?) Publication of lecture notes of two curricula

Thank you for your attention