

Baltic Way:
Towards using the potential of currents for the benefit of society

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Coping with Uncertainty
Sigutina 16-17 November 2009

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Ship routes in the Gulf of Finland -- a major highway

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Two major (in local scale) oil pollutions in Estonia in 2006

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March 2006: under ice
Runner 4 hit in convoy after icebreaker, sank, ~10-20 tons of diesel fuel + motor oil released

January 2006, ~<50 tons of oil, location and quantity estimated, only, no ice

The pollution fortunately hit small sections

Classical circulation pattern: the above oil spills had little chance to hit the southern coast because northern winds & waves were not present

Helsinki

River Kymi

River Neva

River Narva

Three large rivers

Wide outflow along the northern coast

Narrow inflow along the southern coast

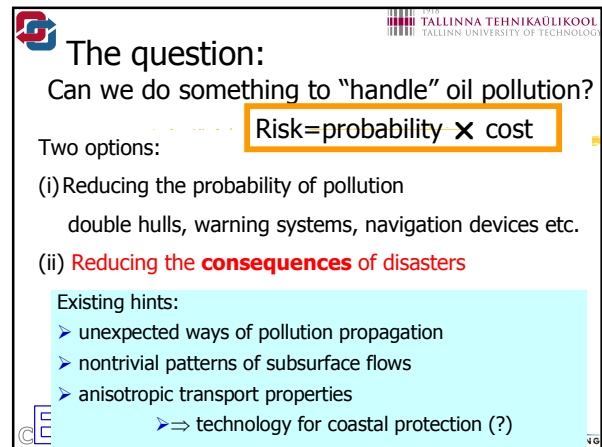
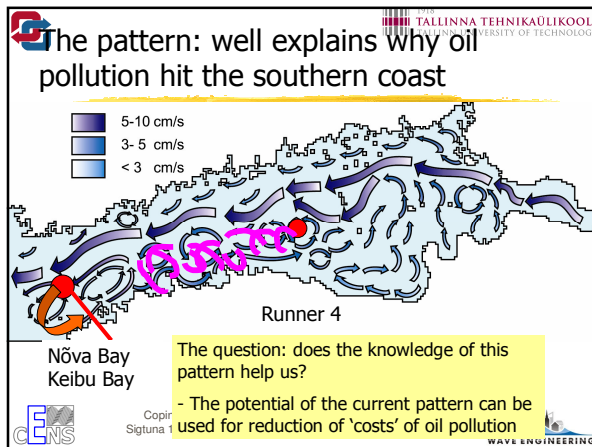
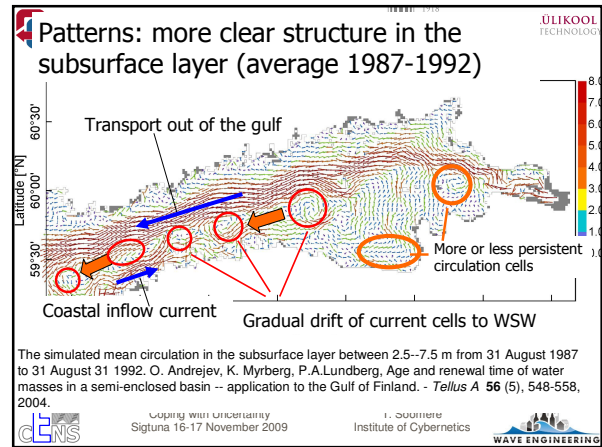
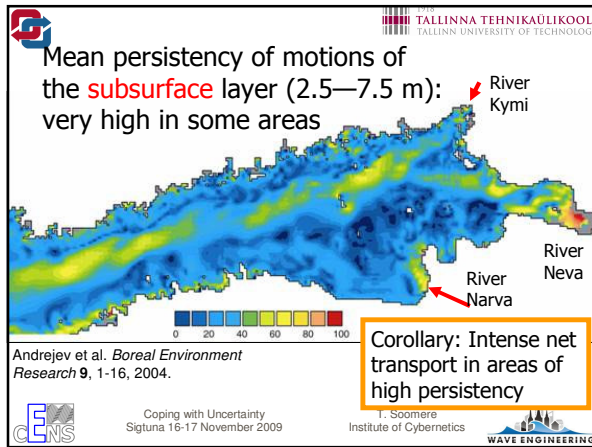
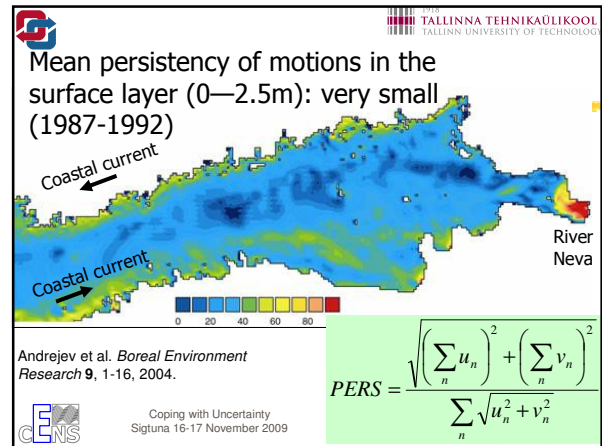
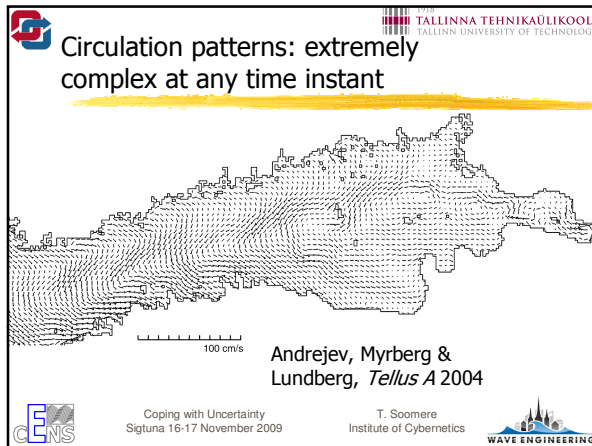
Transport of substances in the upper layer:

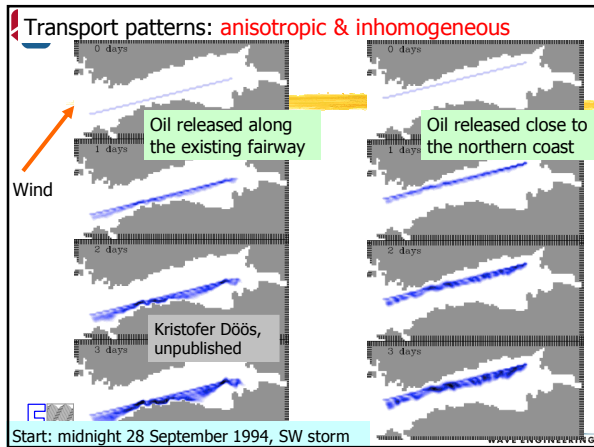
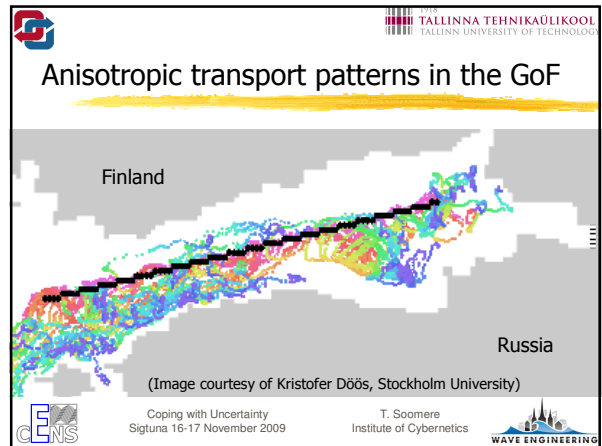
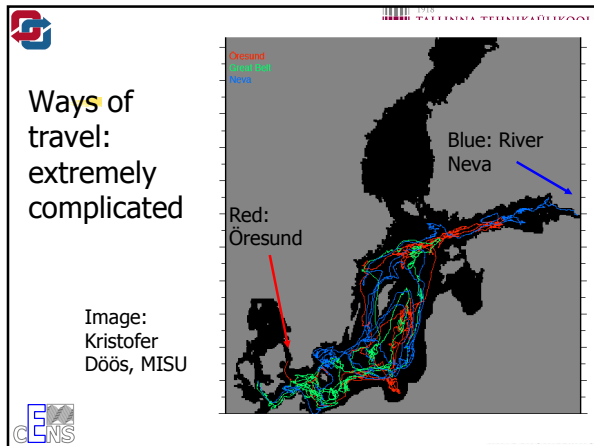
- wind } Properties relatively well understood & reliable forecasts exist
- waves } Transport basically downwinds / downstream
- currents } Created as an integral reaction of water masses to a number of factors

Exact transport direction nearly impossible to forecast

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Handling consequences

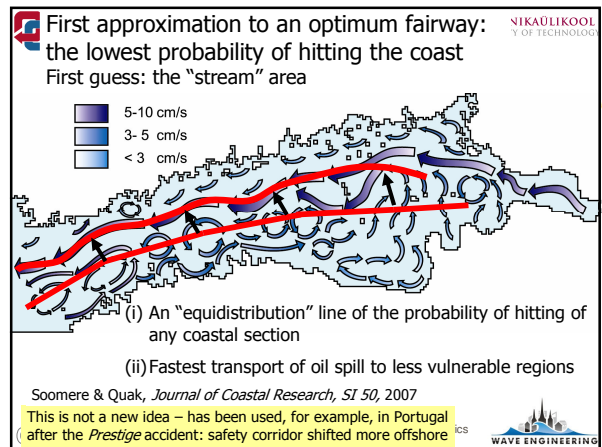
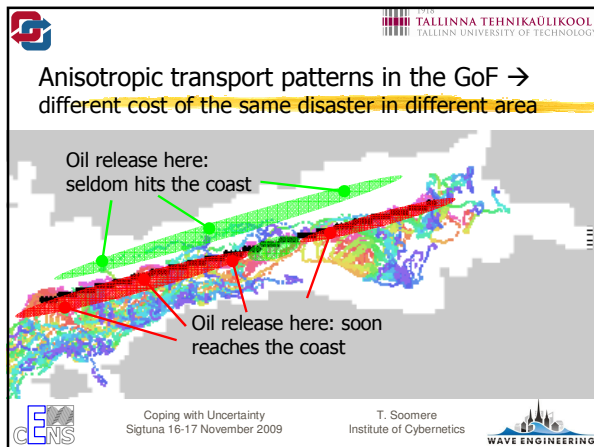
If we could organize human activities so:

that the probability of transport of the (potential) oil pollution to the high-value regions (e.g. coasts) will be smaller (than today),

the consequences of (potential) disasters would be smaller.

- (i) the pollution apparently will remain in less vulnerable areas (e.g. open sea) longer time
- (ii) probably will be carried out of the Gulf of Finland within reasonable time (3-4 weeks (?))

T. Soomere, *Scandinavian Shipping Gazette*, 2006



More questions than answers

- Fortunate patterns – e.g., subsurface stream – do they exist at all?
- Where are they actually located? How stable they are? What about seasonal & interannual variability?
- How & when the pattern affects the drift of oil pollution (that often is governed by wind and surface currents)
- The new fairway may enter territorial waters
- The probability of ship collisions may increase
- a large pool of mathematical questions have to be solved since this is essentially an inverse problem
- ...

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General formulation

- an inverse problem compared with estimates of risk of pollution for specific sites
- search for areas, **from which pollution does not propagate** to vulnerable sections (coasts, sea farms, fishing areas etc.);
- at least, not within a reasonable time – that is, the problem involves a specific **time scale** & is **site-dependent**
- they may be called 'islands' / 'corridors' of reduced risk
- usually the problem is unsteady: the islands/corridors are **time-dependent**

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First steps: BONUS BalticWay – preliminary results

Average net transport, 1987, whole year, layer = Surface, Tw = 4

Good news I:
there are patterns of transport even in the surface layer

Y-component, 1987, windy period (1.10 - 28.2), layer = Surface, Tw = 4

Good news II:
there are patterns of North-South transport in the surface layer

Unexpected regular transport across the gulf

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First steps: BONUS BalticWay

Equiprobability line area, annual 5y average 1987-91, layer = Surface, Tw = 20

Hits the N coast

Optimum: min. of hits

Hits the S coast

1987-1991 annual
Calculations: Raul Isotamm & Bert Viikmäe
Wave Engineering Laboratory

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BalticWay Objectives

- *Smart use* of the existence of semi-persistent **current patterns**
- for **protecting of vulnerable regions** (such as coastal spawning, nursing, tourist areas)
- through **identification of areas of reduced risks**

(where ship traffic should be directed or high-risk offshore structures be located)




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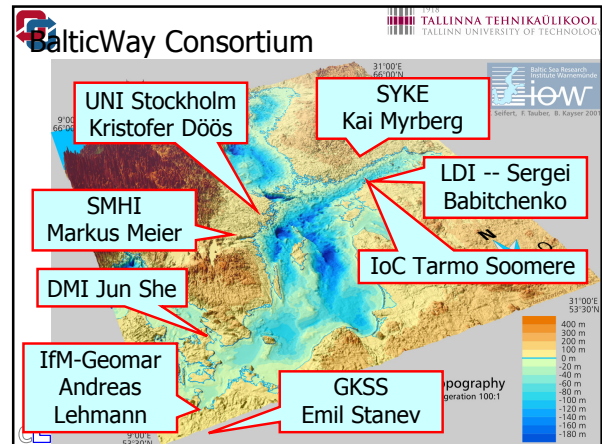
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Limits set for the project




- Two target regions: **Gulf of Finland** and **Western Baltic**
- One generic example of a "high-value" region: **coastal areas**
- One single adverse effect: **drift of oil pollution**
- One activity to manage: **ship routing**, i.e. advantageous fairway design
- One **platform for a technology** prototype for environmentally friendly management of shipping and offshore activities to be developed


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Scientific constituents

- Massive, high-resolution **numerical simulation** of Baltic Sea circulation;
- Analysis of **direct and inverse transport** problems for various tracers,
- including **experimental validation**;
- Use of specific properties of surfaces overlaying complex three-dimensional flows to analyze effects on the sea surface (= **mathematics**)


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