

**Application of AIS data  
for modelling the ship safety  
in the Gulf of Finland**

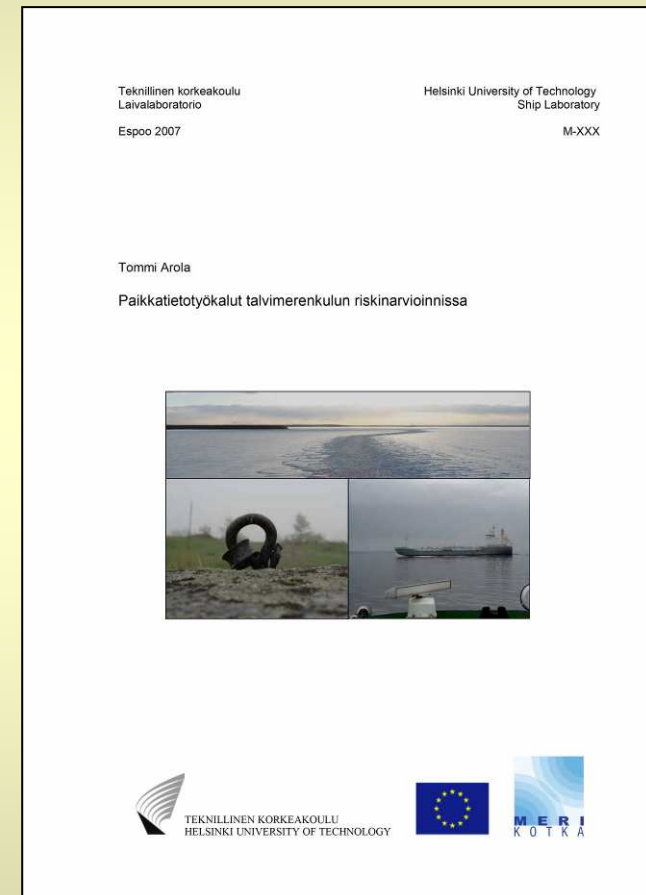
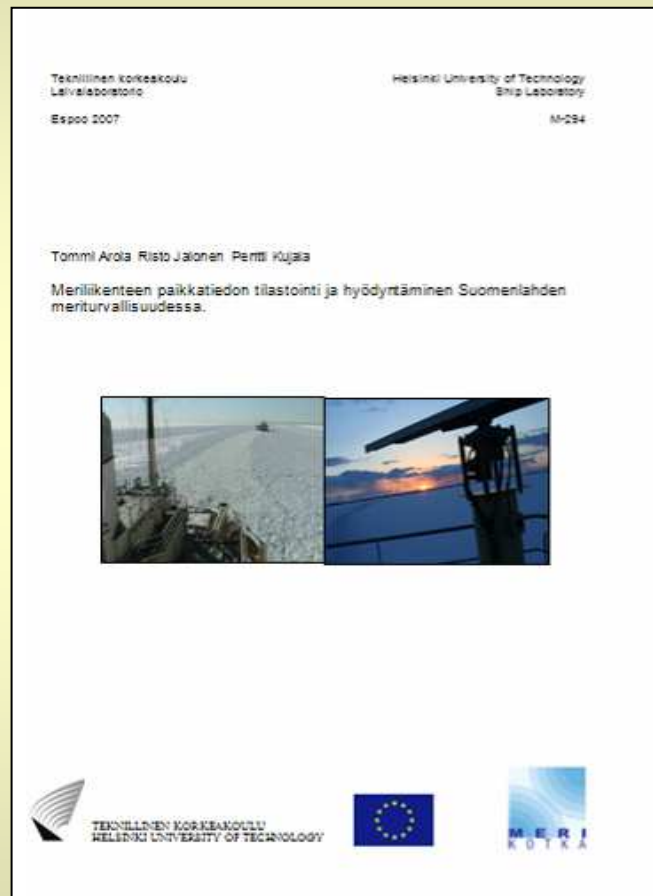
Tommi Arola  
Helsinki University of Technology



# Backgrounds

- No available specified risk model for the maritime environment in the Gulf of Finland (GOF)
- MS GOF –project started a pioneering work between maritime safety and spatial data modelling in the GOF
- Description of the AIS-system and it's applications as a basis of risk modelling
- How the maritime traffic scheme can be interpreted from the spatial data?

# Reports based on research activity in MS GOF WP 1



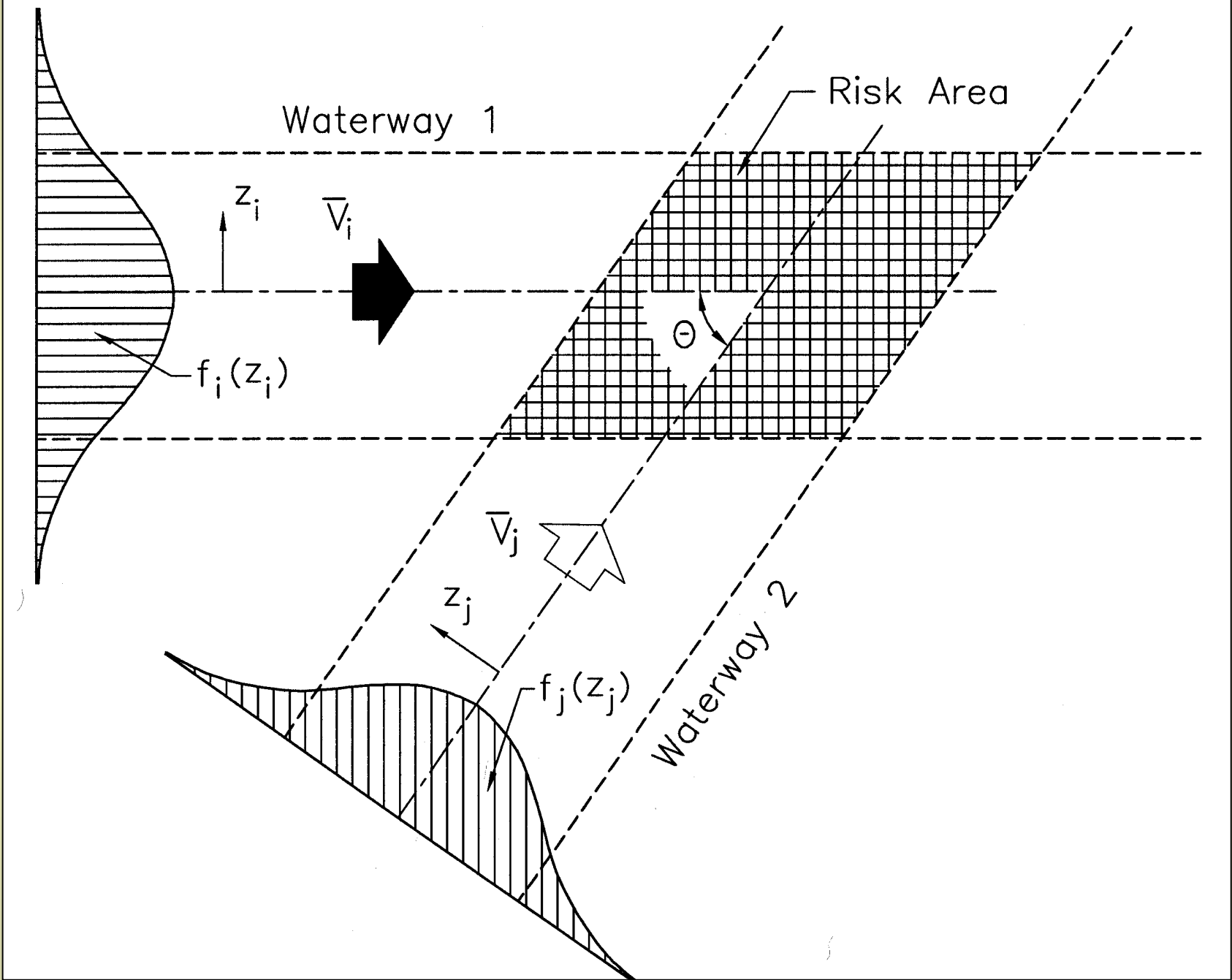
Reports will be published in Finnish for free at:  
<http://www.merikotka.fi/julkaisut.htm>

# The main concern in GOF

- Oil spill due to ship-ship collision or grounding
- Rising amount of ships entering GOF
- How the critical situations can be noticed?
- Situation awareness must be improved => risk modelling+IT-systems

# Pedersen-riskmodel

- Widely used in maritime risk modelling around the world (Denmark, Japan, UK..)
- Based on Fujii –riskmodel from Japan
- Two traffic flows are crossing with the following parameters:
  - Amount of ship passages over the time
  - Distribution of the ship width+length
  - Spatial distribution of location in the channel
  - Average speed
  - Relative speed between two traffic flows
  - Geometrical collision diameter



# Pedersen-riskmodel, parameters

- The parameters are used in following equation to calculate amount of collision candidates  $N_a$ :

$$N_a = \sum_i \sum_j \iint_{\Omega(z_i, z_j)} \frac{Q_{1i} \cdot Q_{2j}}{V_i^{(1)} \cdot V_j^{(2)}} \cdot f_i^{(1)}(z_i) f_j^{(2)}(z_j) V_{ij} D_{ij} dA \Delta t$$

Ship passages / month

Average speed

Spatial distributions

Relative speed between  
two ship trafficflow

Geometrical collision diameter

Considered area of  
crossing traffic

Time scaling factor

# Pedersen-riskmodel, parameters

**Geometrical collision diameter**

$$D_{ij} = \frac{L_i^{(1)}V_j^{(2)} + L_j^{(2)}V_i^{(1)}}{V_{ij}} \sin \theta$$

Average length

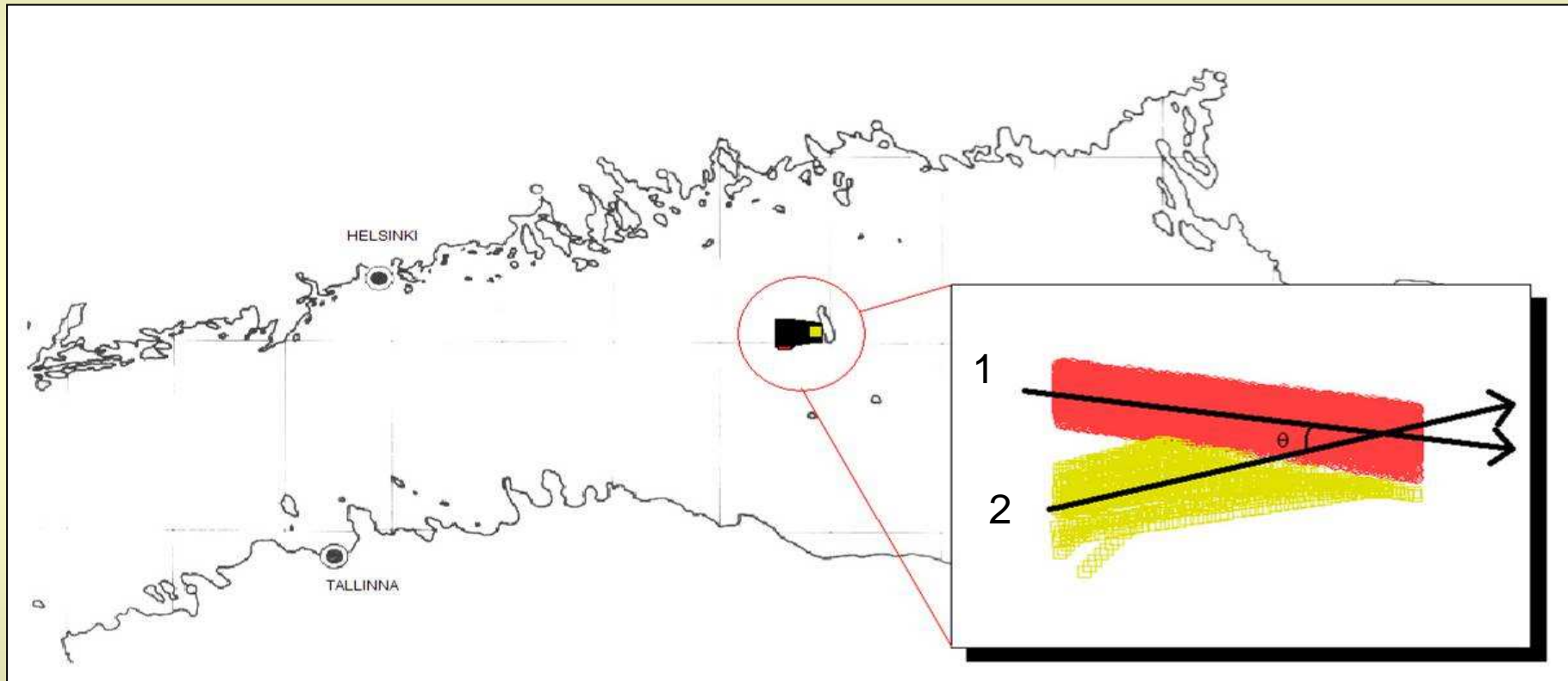
$$+ B_j \left\{ 1 - \left( \sin \theta \cdot \frac{V_i^{(1)}}{V_{ij}} \right)^2 \right\}^{1/2} + B_i \left\{ 1 - \left( \sin \theta \cdot \frac{V_j^{(2)}}{V_{ij}} \right)^2 \right\}^{1/2}$$

Average breadth

**Relative speed between two traffic flows**

$$V_{ij} = \sqrt{(V_i^{(1)})^2 + (V_j^{(2)})^2 - 2V_i^{(1)}V_j^{(2)} \cos \theta}$$

# Case 1: Crossing traffic around the Gogland in the GOF



# Methodology

- All the ship's AIS-data gathered during the march 2006 and july 2006 around the Gogland
- AIS-data is spatial information of the ship's attributes during the voyage (speed, heading, coordinates, MMSI, shiptype..)
- Voyage consists of 'dotted'-information between starting point A and ending point B

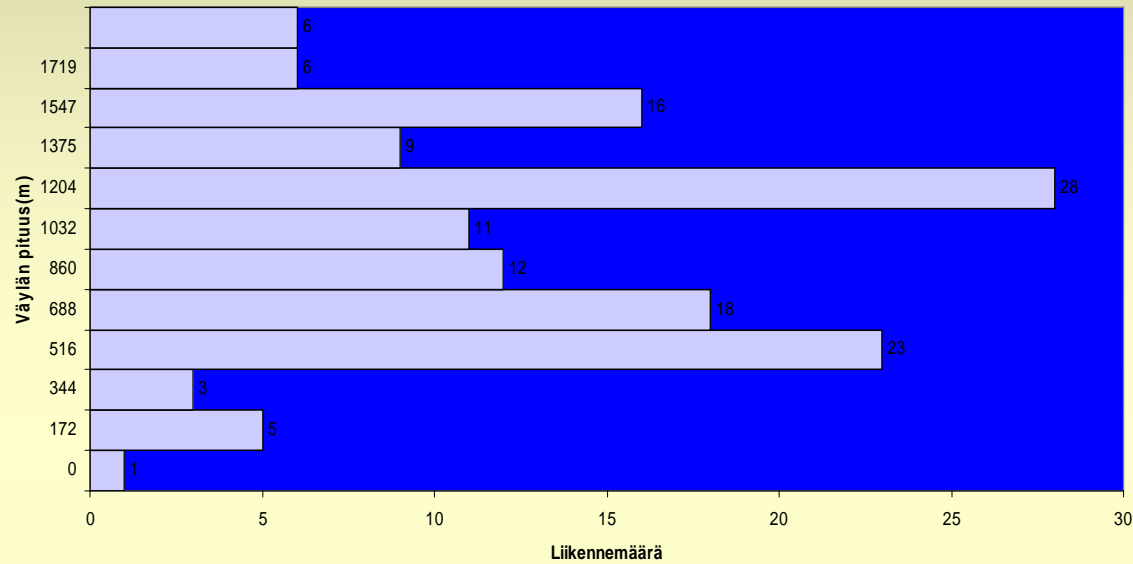
# Methodology

- All the AIS-data were filtered so that we have two traffic flows: one going south-east (1) and one going north-east (2)
- **To simplify Pedersen-model we used average parameters in the model**
- For the both channels we calculated the parameters using Esri ArcGis –software
- Whole AIS-dataset is run through Esri Personal Geodatabase (AIS-observations joined with 'MMSI'-number to ship information table)

# Calculated parameters

# Spatial distributions, march 2006

Laivaliikennejakauma väylällä 1, maaliskuu 2006

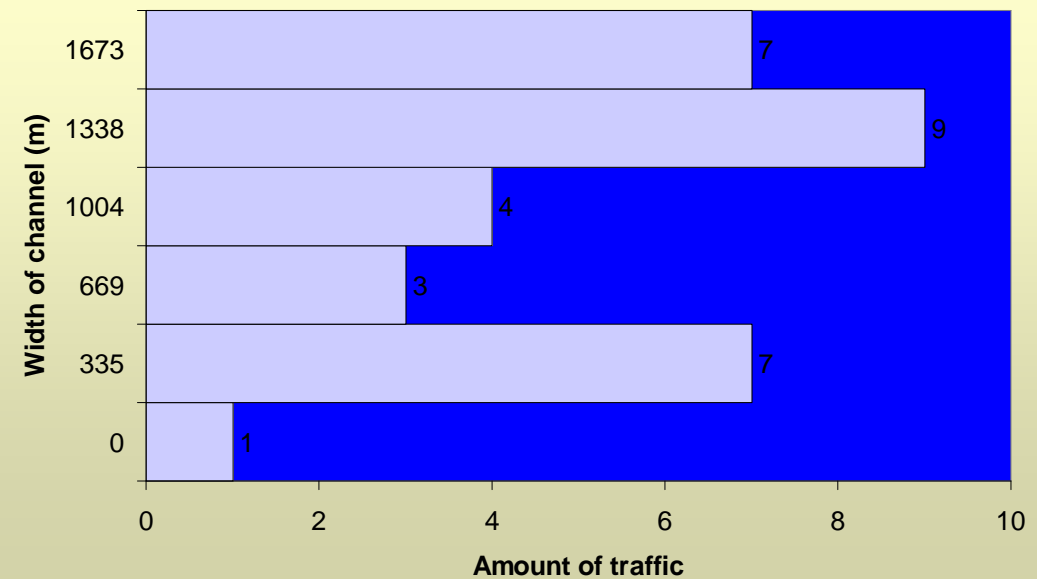


Channel (1)

Amount of ships in a function of width of the channel.

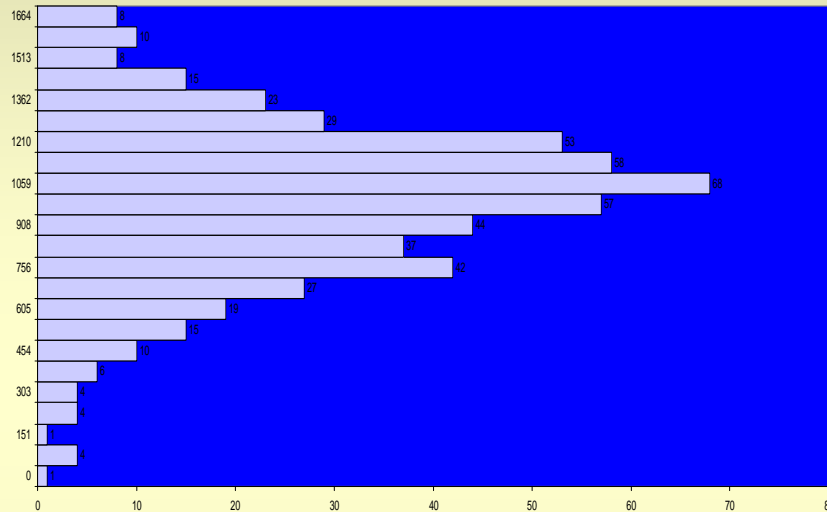
Channel (2)

Amount of ships in a function of width of the channel.



# Spatial distributions, july 2006

Laivaliikennejakauma väylällä 1, heinäkuu 2006

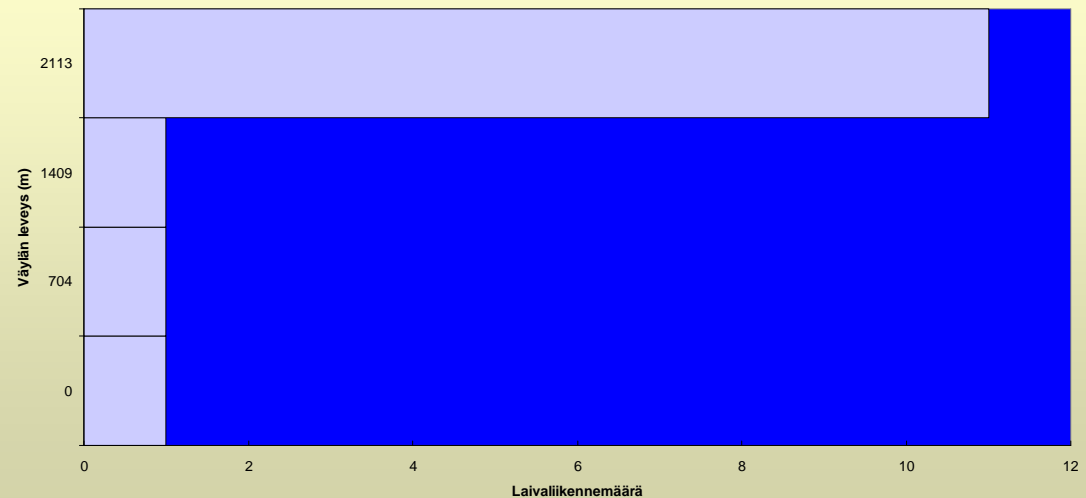


Channel (1)

Amount of ships in a function of width of the channel.

Channel (2)

Amount of ships in a function of width of the channel.



# March 2007 (winter traffic profile)

- Channel (1)
  - 138 ship passages / month
  - Average speed 11,2 knots
  - Average length along the ships 140 m
  - Average breadth along the ships 21 m
- Channel (2)
  - 42 ship passages / month
  - Average speed 11,57 knots
  - Average length along the ships 137 m
  - Average breadth along the ships 21 m

# July 2007 (summer traffic profile)

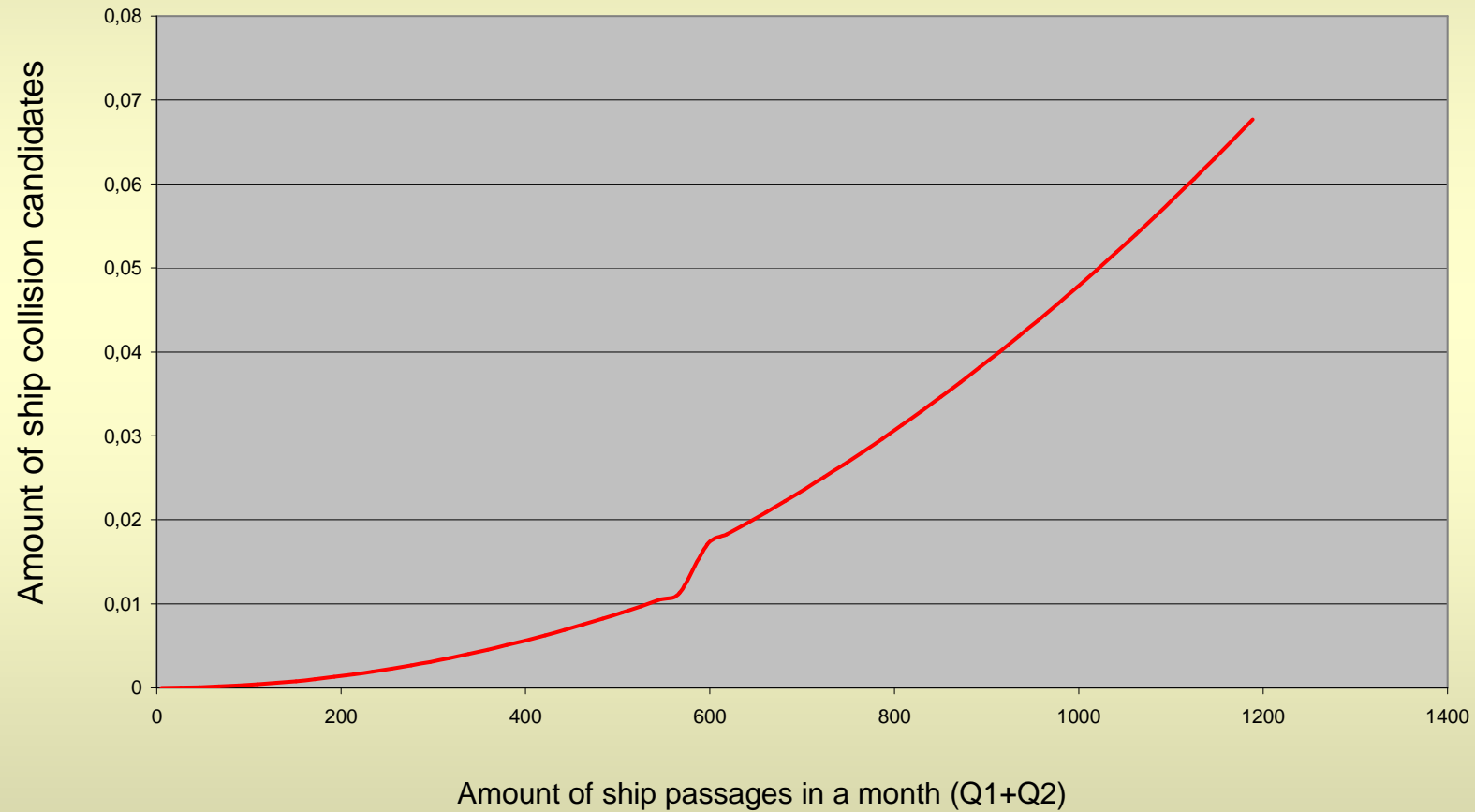
- Channel (1)
  - 545 ship passages / month
  - Average speed 12,23 knots
  - Average length along the ships 130,3 m
  - Average breadth along the ships 19,1 m
- Channel (2)
  - 22 ship passages / month
  - Average speed 11,024 knots
  - Average length along the ships 87,7 m
  - Average breadth along the ships 13,4m

# Results

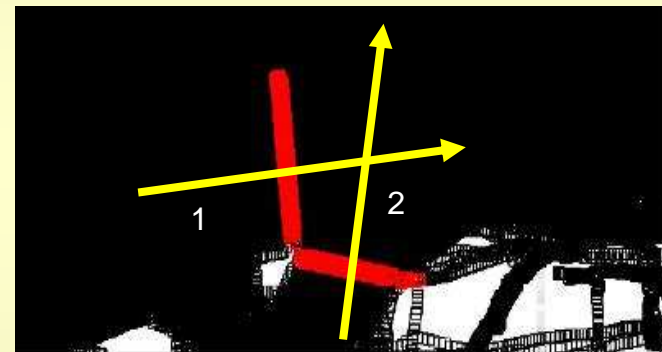
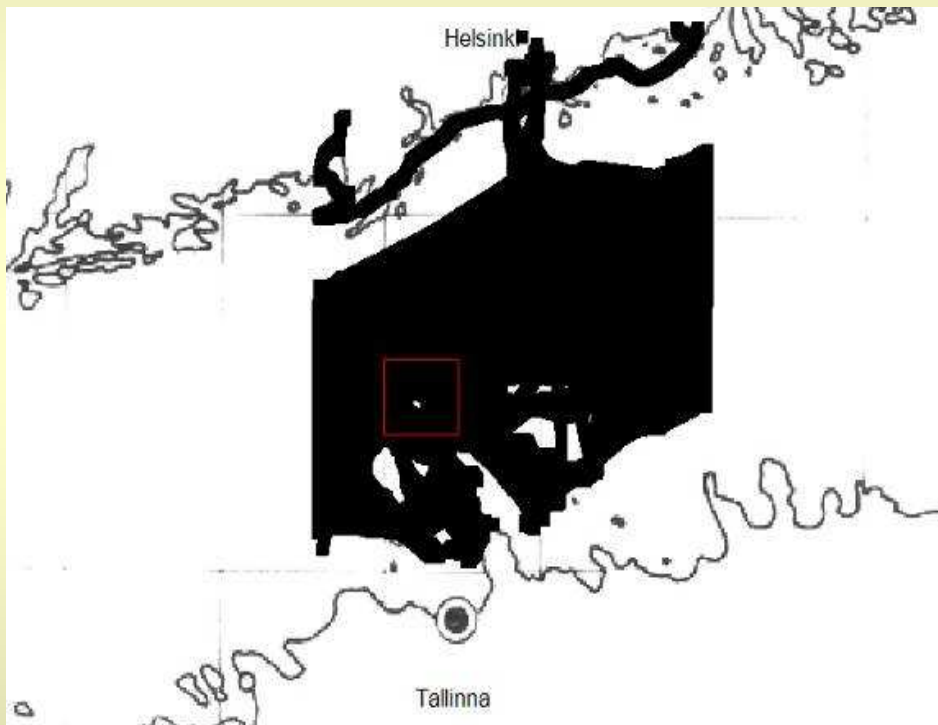
- Amount of collision candidates / month:
  - March 2006: **0,0184 candidates** / month
  - July 2006: **0,0113 candidates** / month

- NB! Model does not include collision frequency calculation  $\Rightarrow f(\text{coll}) = N_a \times (1 - P(\text{evasive}))$
- $1 - P(\text{evasive})$  is the probability of not making an evasive manoeuvre due to human or technical failures (according to local collision statistics)
- From Drogen-channel (Denmark) research results are  $P(\text{evasive}) = 2,5 \times 10^{-5}$

# Collision scenario extrapolation



# Case 2: Crossing traffic between Helsinki-Tallinn



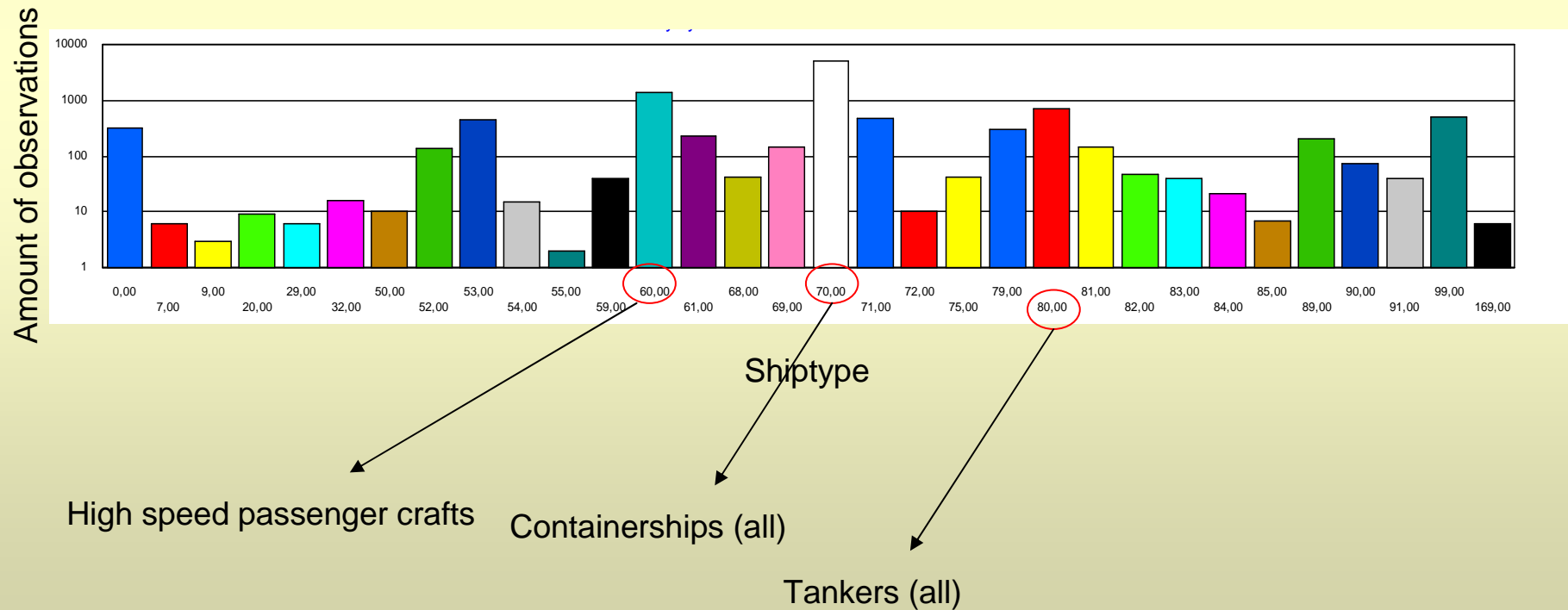
# Results

- Amount of collision candidates / month:
  - March 2006: **0,11 candidates** / month
  - July 2006: **0,18 candidates** / month
- March 2006:
  - Channel (1): 363 ship passages / month
  - Channel (2): 26 ship passages / month
- July 2006
  - Channel (1): 650 ship passages / month
  - Channel (2): 53 ship passages / month

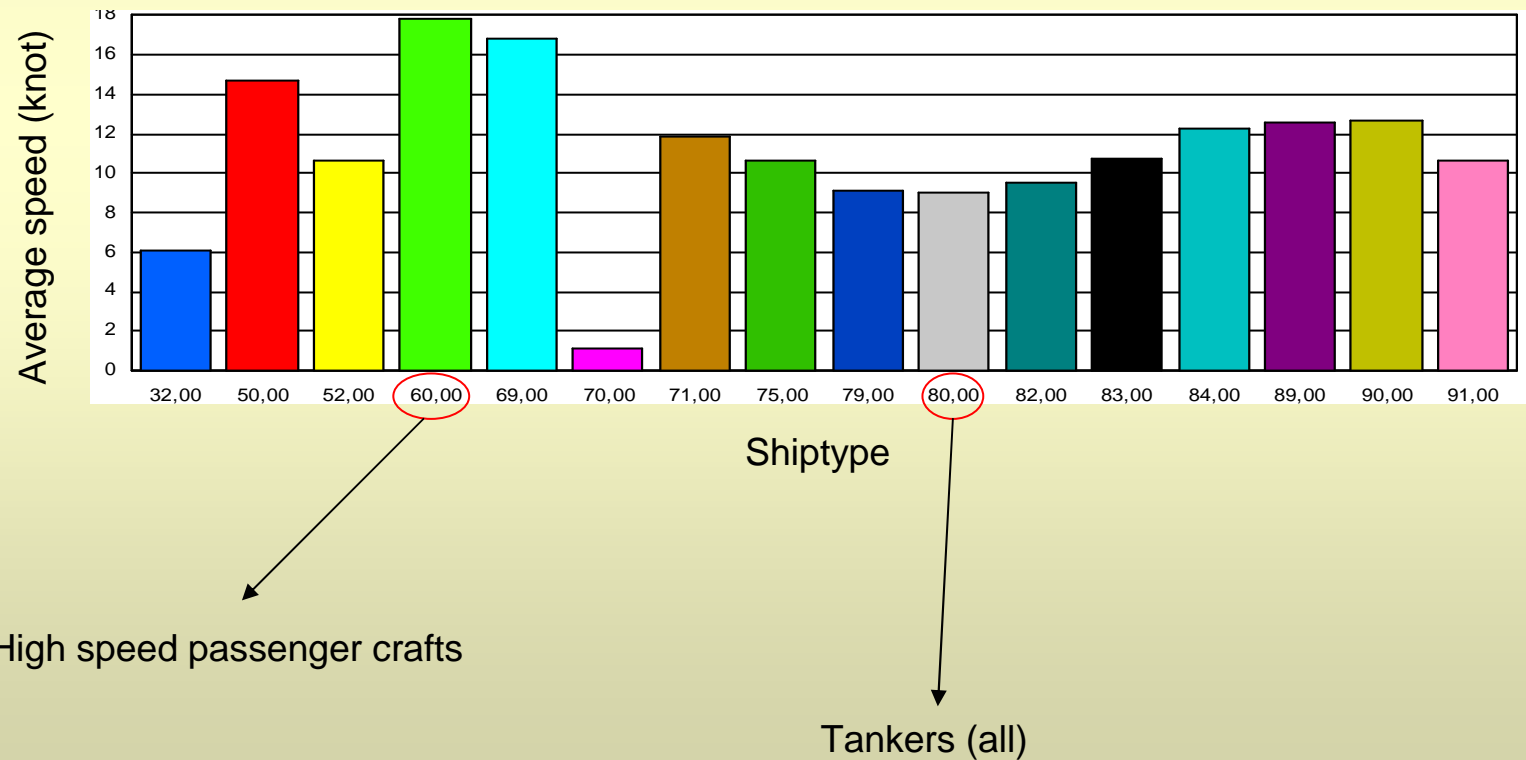
# Another AIS-applications

Traffic statistics, Helsinki-Tallinn  
traffic pattern, july 2006

- Shiptype distribution



- Average speed along the shiptypes



# Future developments

- Pedersen-riskmodel can be applied to any crossing traffic in the GOF
- The GOF specified risk model will be reasearched in future!
- Special conditions must be taken account(ice, weather+geographical conditions...)
- Traffic simulation platform
- Geoinformation tools for maritime environment/risk analysing
- Collision statistics