Annual Meeting of US PIANC Section, Portland/Oregon, Oct. 2003

# PIANC WG27:
# „Guidelines to reduce Environmental Impact of Vessels“

TOR and Results of the 1st meeting in Brussels, February 2003

Bernhard Söhngen

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Karlsruhe Germany

# PIANC-InCom Working Group 27 on „Guidelines to reduce Environmental Impacts of Vessels“

- Setting up 5th Nov. 2002 by letter of InCom President C. Jamet
- 1st meeting in Brussels, February 8th 2003
- 2nd meeting in Portland, October 31rd 2003

Members (2003):

| | |
|---|---|
| Bernhard Söhngen (Chairman) | Fed. Waterways Engineering and Research Institute, Germany |
| Jochen Koop (Vice Chairman) | Federal Institute of Hydrology, Germany |
| Sandra Knight (InCom-Representative) | U.S. Army Corps of Engineering |
| Jorma Rythönen (EnviCom-Representative) | VTT Industrial Systems, Finland |
| Caroline Tandy → (Paul Beckwith) | British Waterways |
| (Dick de Bruin) | Rijkswaterstaat, Netherlands |
| Nicola Ferravi | Servici Technici, Italy |
| Thomas Keevin | U.S. Army Corps of Engineering |
| (Philippe Roux) | Service de la Navigation de la Seine, France |
| (Jose Iribarren) | SIPORT XXI, Spain |

# InCom WG27 - Terms of Reference

Background

- In evaluating, designing and operating waterways
  ⇒ need to address environmental issues regarding impacts from vessels
- To minimize potential impacts and provide an environmentally sustainable waterway ⇒ need to predict vessel effects and their potential ecological impacts

Objective

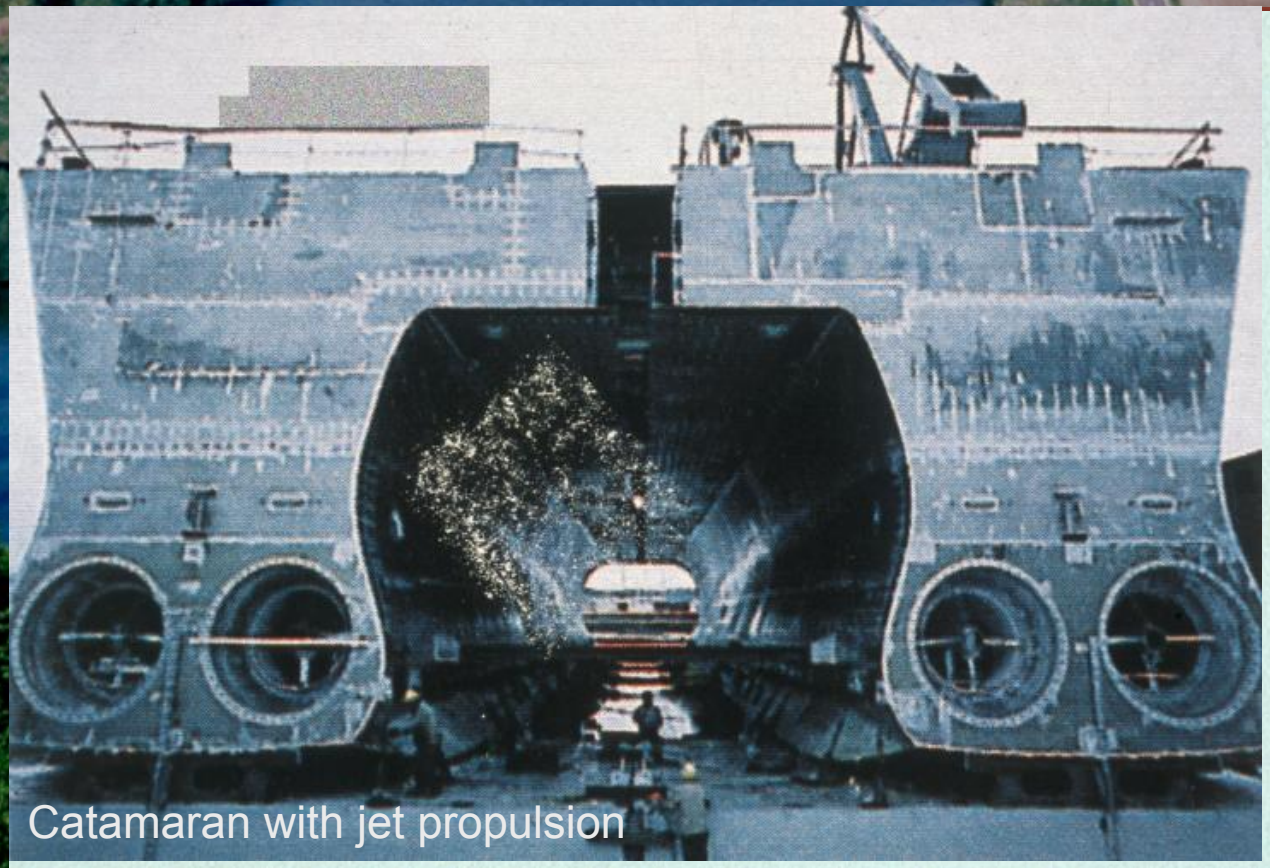
- Collect, evaluate and develop guidelines on methodologies available for quantifying physical effects to ecological endpoints ⇒ management guidelines

What are the most important problems? (impacts) → What are the most severe effects on ecosystem? (damages) → Which approach can be recommended? (methods) → What can be done to avoid/reduce impacts? (guidelines)

# InCom WG27 - Terms of Reference

Field of Review

- Vessel types (size, form, speed, propulsion)



Catamaran with jet propulsion

# InCom WG27 - Terms of Reference

Field of Review

- Vessel types (size, form, speed, propulsion)
- Water bodies (canals, rivers, lakes, oxbows, lagoons)

Danube river, W

Main-Danube-canal
Altmühl valley

# InCom WG27 - Terms of Reference

Field of Review

- Vessel types (size, form, speed, propulsion)
- Water bodies (canals, rivers, lakes, oxbows, lagoons)
- Habitats (sediments, banks, forelands, water body)

Impact types, area, strength, duration, frequency
⇓
environmental effects

- Existing literature, methodologies, PIANC-guidance, relevant WG activities
  ⇒ state-of-the-art review for
  - predicting relevant impacts
    (return currents + propeller jet, drawdown + wave heights) shear stresses, scouring ... drying, fluidization ...)
  - identification of ecological endpoints
    (fish larvae mortality, adult fish population reduction, light extinction effecting plant growth, effects on benthic habitats...)

# InCom WG27 - Terms of Reference

- Input for ecological models
- Potential mitigation measures
  - ⇒ optimization of permitted vessel speed
    navigation channel proximity to sensitive areas
    structure enhancements to protect habitat areas
- Identify research needed

<u>Products</u>

- Report(s) summarizing literature survey, important quantifiable vessel effects, case studies, recommendations for mitigation alternatives, further research needed
- Workshop to present findings

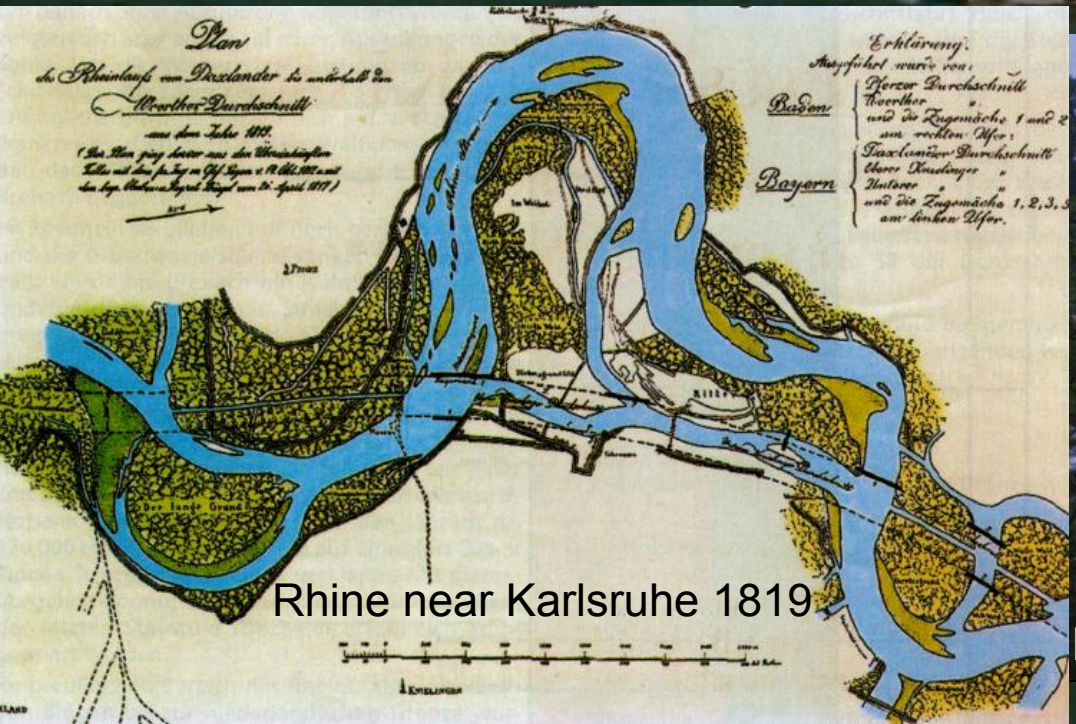
# InCom WG27 - Results of the 1st meeting

Precision of the TOR

What should not be considered?

Indirect environmental effects of preparing water bodies for navigational use

- River training measures: cutting banks, narrowing width, stabilization of banks, regulation with groynes or parallel dykes ...
  ⇒ increased slopes, velocities, sediment transport: erosion
  ⇒ water level lowering, coarsening bed sediments ...

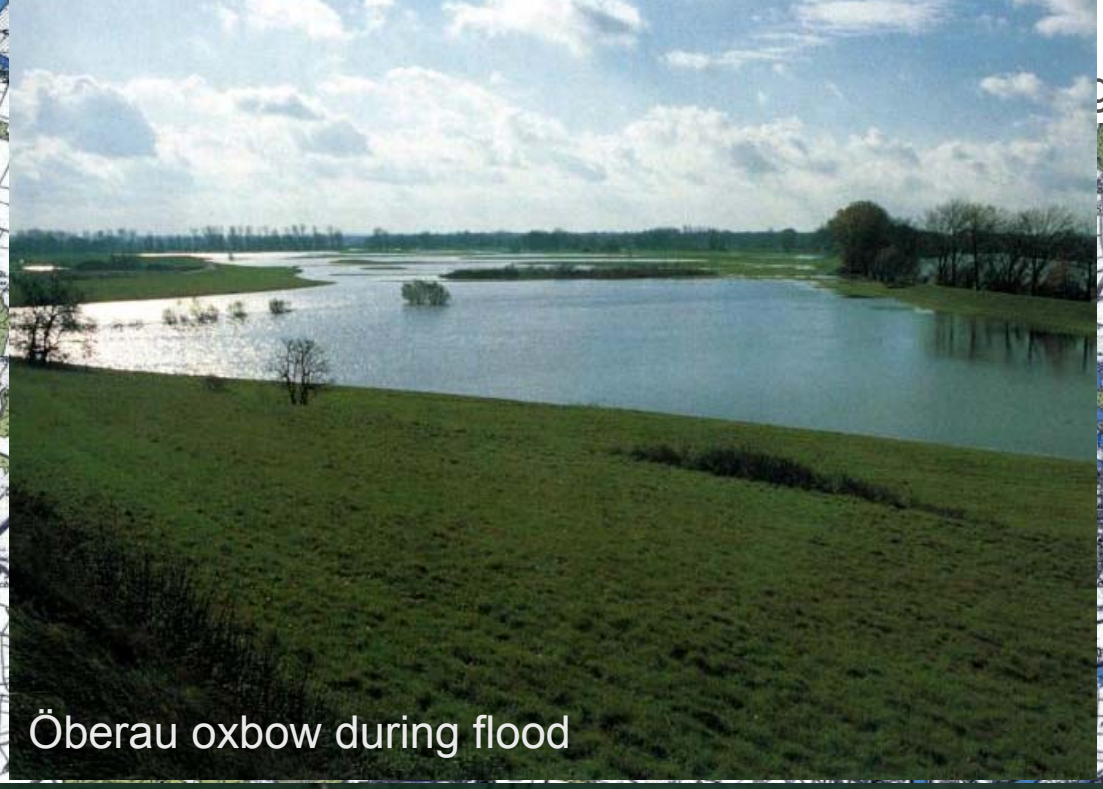



Rhine near Karlsruhe 1819

Erosion, Upper Rhine

ge

# eting



Öberau oxbow during flood

odies for navigational use

ng width, stabilization of banks,

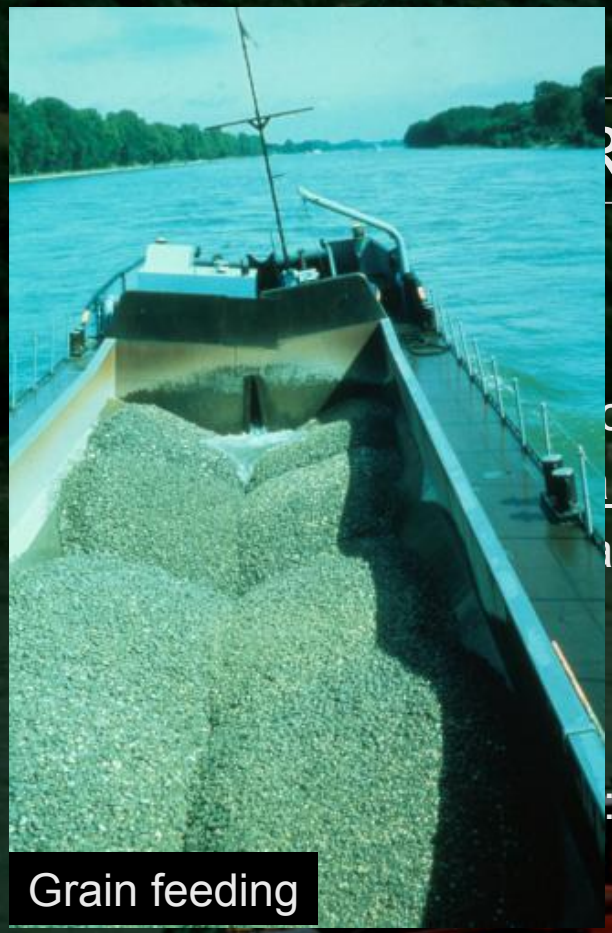
s or parallel dykes ...

elocities, sediment transport: erosion

q, coarsening bed sediments ...

- Erecting barrages: reduced slopes, velocity, sed. transport: sedimentation <u>water level rise</u>, need to erect side dams, cutting oxbows from main stream ...

# Results of the 1st meeting


Grain feeding

onsidered?

l effects of preparing water bodies for navigational use

asures: cutting banks, narrowing width, stabilization of banks, regulation with groynes or parallel dykes ...
⇒ increased slopes, velocities, sediment transport: erosion
⇒ water level lowering, coarsening bed sediments ...

: reduced slopes, velocity, sed. transport: sedimentation
water level rise, need to erect side dams, cutting oxbows from main stream ...

- Channel maintenance: dredging, artificial grain feeding, artificial coarsening of bed sediments

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  ⇒ water level lowering, coarsening bed sediments ...
- Erecting barrages: reduced slopes, velocity, sed. transport: sedimentation water level rise, need to erect side dams, cutting oxbows from main stream ...
- Channel maintenance: dredging, artificial grain feeding, artificial coarsening of bed sediments

What **should** be considered?

**Direct impacts** of ships (less important than indirect impacts!) in comparison to natural effects (e.g. wind waves)

# InCom WG27 - Results of the 1st meeting

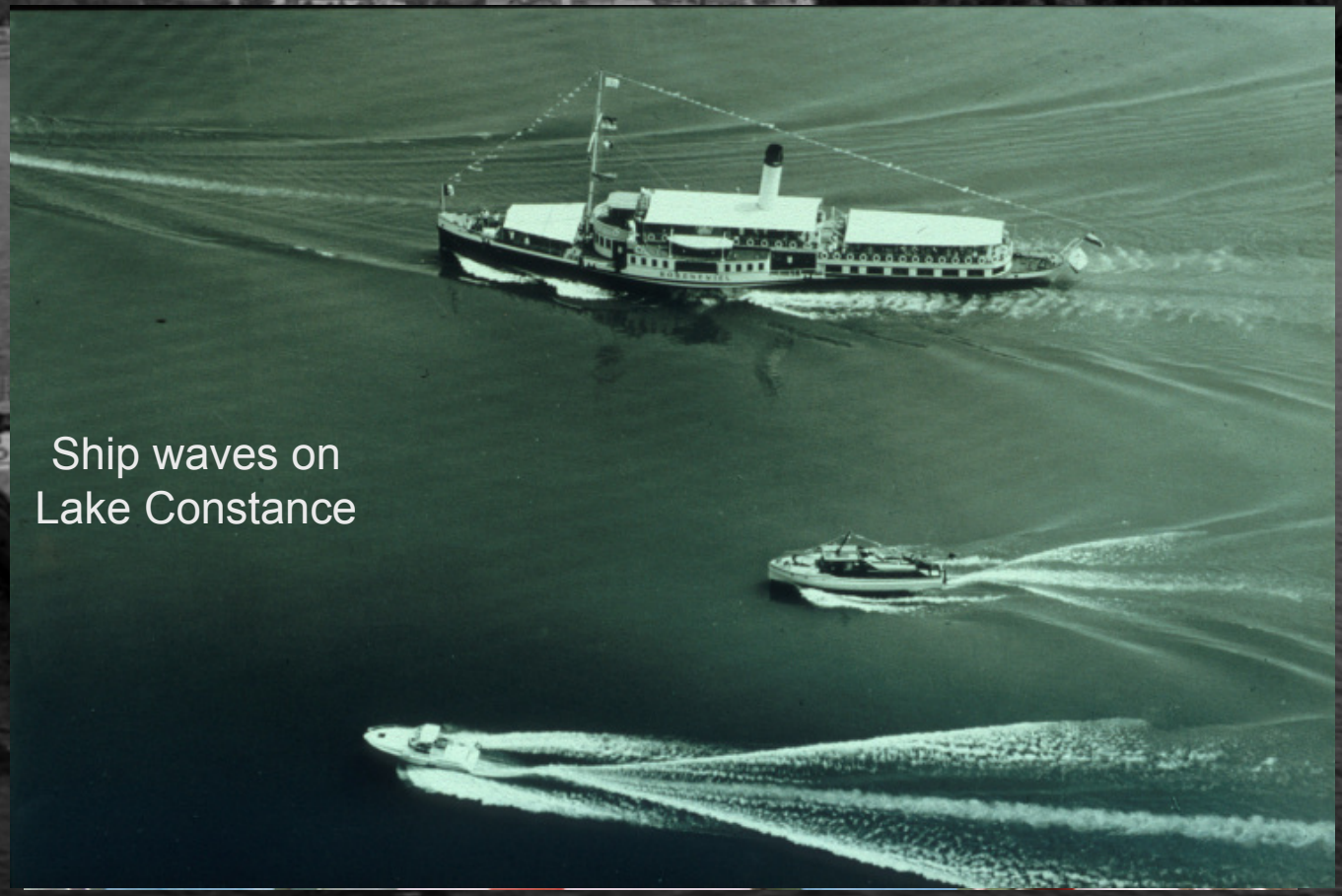
**“Hit list” of important subjects**

ship types and propulsion

large motor vessels / push tow units US,GER

recreational boats FR,UK,FIN

new ships and propulsion systems IT



# InCom WG27 - Results of the 1st meeting

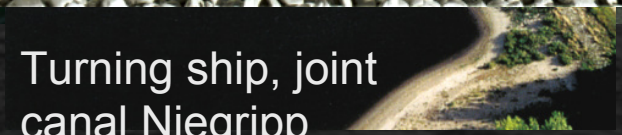
"Hit list" of important impacts

| water bodies |
| --- |
| large rivers US,GER |
| backwater and marsh areas US |
| aquatic areas near banks US,GER |
| lakes FIN,GER |
| lagoons (very shallow water) IT |
| canals GER,UK |

# InCom WG27 - Results of the 1st meeting

P ng ustream,

Breisach site investigations, Rhine River



Turning ship, joint canal Niegripp

**hydraulic impacts**

drawdown GER,US

secondary waves GER

propeller stroke and pressure gradient US

propeller jet IT

scouring FIN,IT

# InCom WG27 - Results of the 1st meeting

"Hit list" of important impacts

| ship types and propulsion | water bodies | hydraulic impacts | environmental effects |
|---|---|---|---|
| large water vessels / push tow units US,GER | large rivers US,GER<br>backwater and marsh areas US<br>aquatic areas near banks US,GER | drawdown GER,US<br>secondary waves GER<br>propeller stroke and pressure gradient US<br>propeller jet IT<br>scouring FIN,IT | fish larvae mortality US<br>impacts on benthic habitats GER |
| recreational boats FR,UK,FIN<br>new ships and propulsion systems IT | lakes FIN,GER<br>lagoons (very shallow water) IT<br>canals GER,UK | | resuspension of polluted sediments FIN,US<br>turbidity UK,IT<br>ballast water pollution UK,FIN<br>aliens FIN |

# InCom WG27 - Results of the 1st meeting

Table of Contents (planned PIANC-Report)

1 Introduction (TOR, findings 1st meeting, aims ...)

2 Principle effects (in general phenomenologically, simple formulae
(impact types) to check importance of the impact)

2.1 Impact qualification

- strength
- area
- duration
- frequency

# InCom WG27 - Results of the 1st meeting

Table of Contents (planned PIANC-Report)

1 Introduction (TOR, findings 1st meeting, aims ...)

2 Principle effects (in general phenomenologically, simple formulae

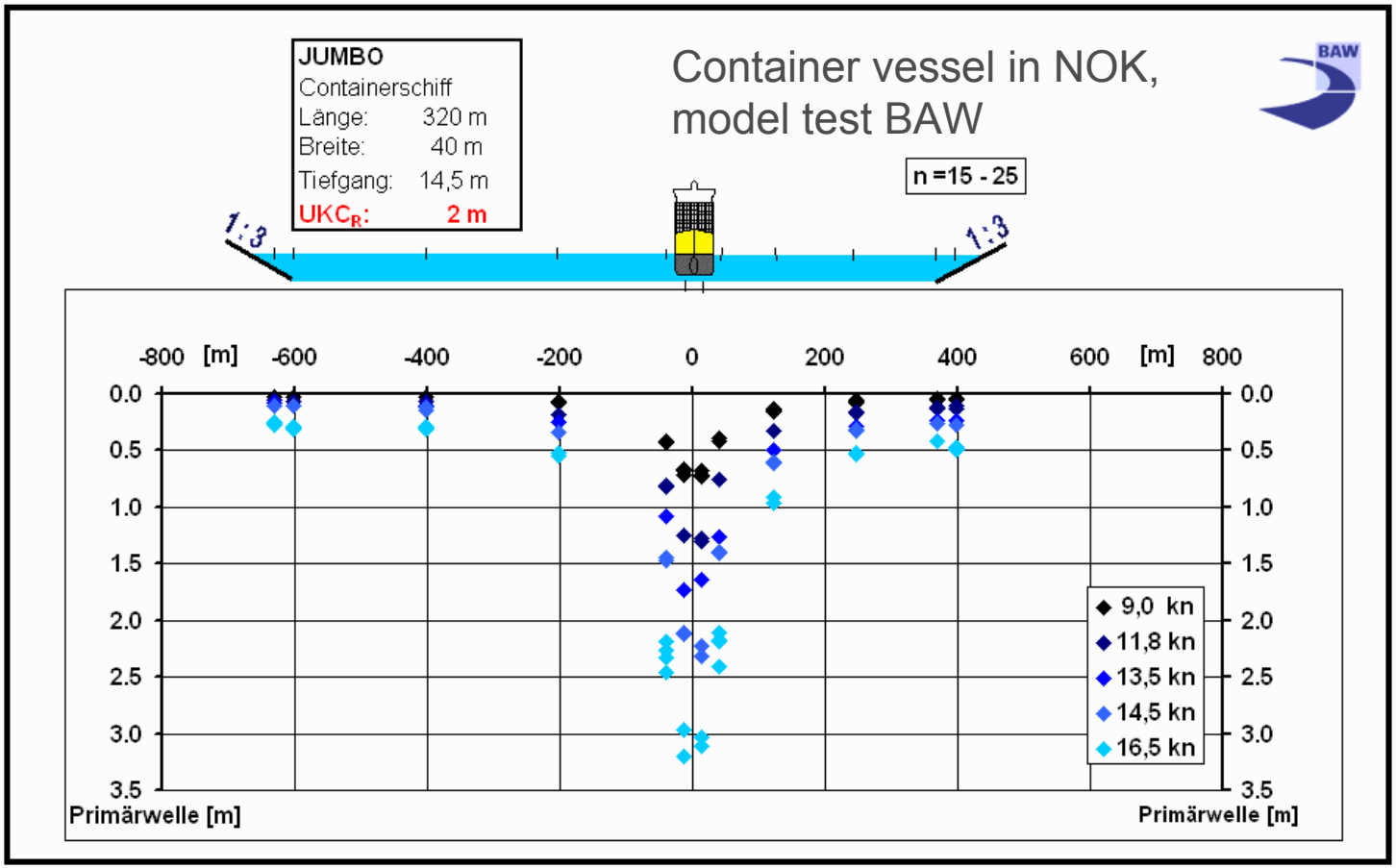
| impact components, | | ship going upstream | | | | downstream |
|---|---|---|---|---|---|---|
| | | return current | propeller jet | wake | sucking in of stones | wake |
| intensity | | increased | strong | strong | high | strong |
| duration | | long | short | average | very short | average |
| width | | ship´s length | propeller diameter | beam | vortex diameter | beam |
| influence on bed load | gravel bed | large | average | average | small | average |
| | coarse gravel | average | large | large | average | large |

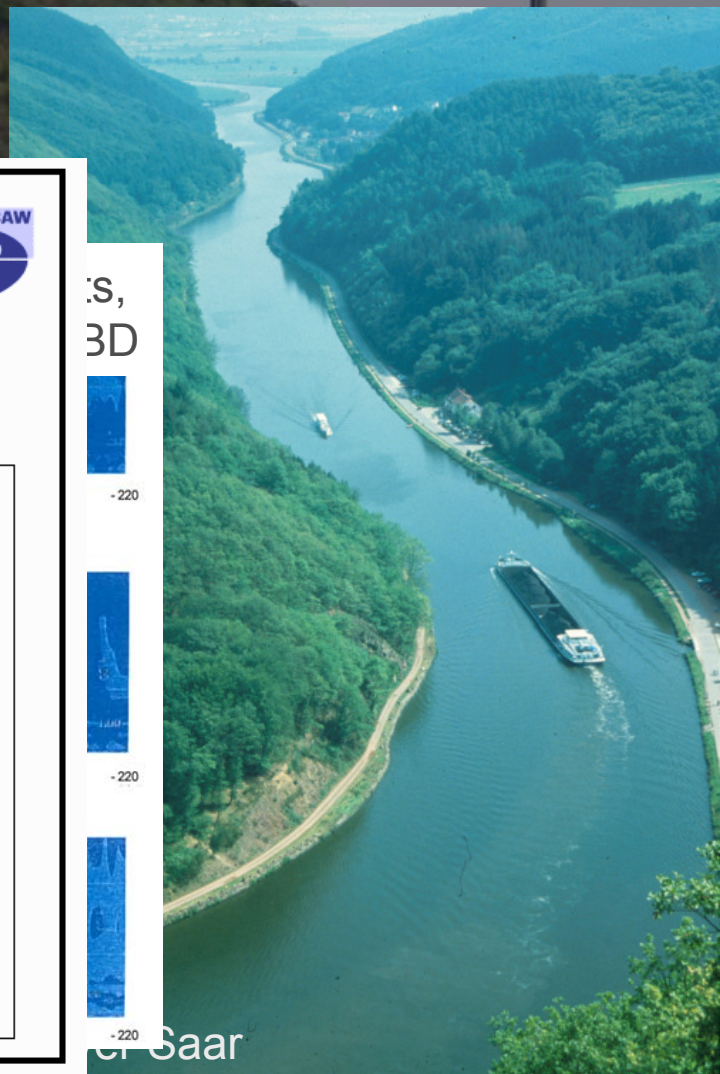
# InCom WG27 - Results of the 1st meeting

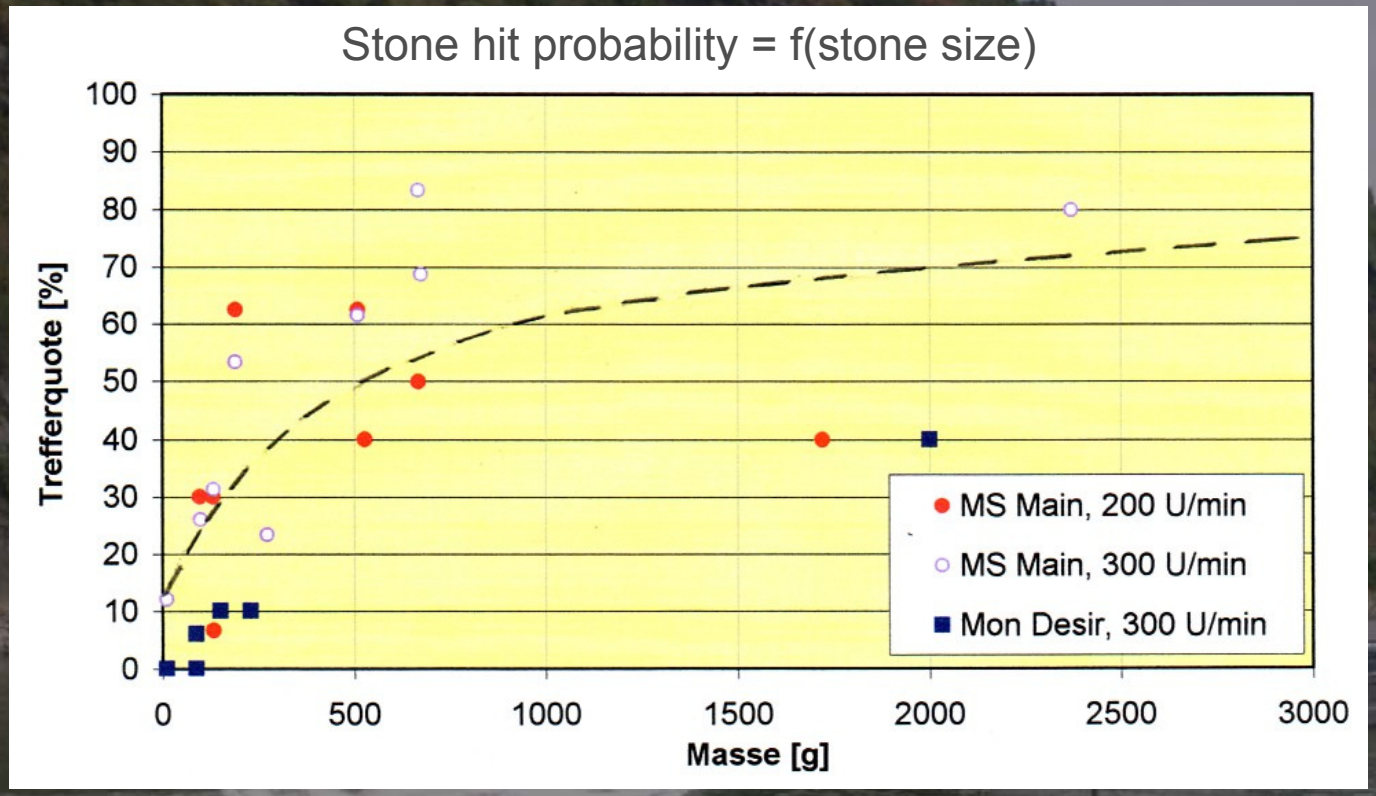
## 2.2 Impact types

<u>large impact area / duration</u>

- drawdown ⊕ order of magnitude O(1 m)






<u>small impact area / duration</u>

- propeller hits on adult fish ⊖ O(25 m/s)

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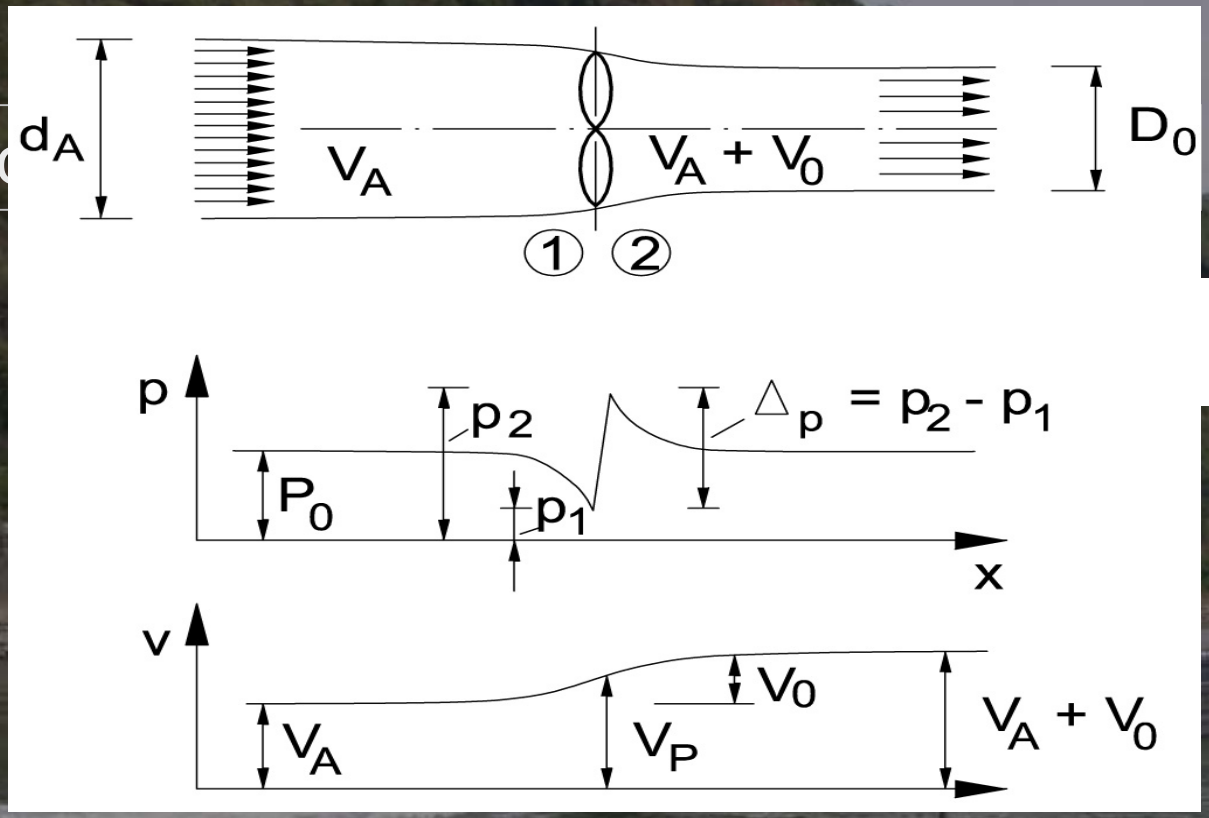



Pressure increase, 1D propeller theory

<u>small impact area / duration</u>

- propeller hits on adult fish ⊖ O(25 m/s)
- propeller pressure increase ⊕ O(5 m pressure height in 0.15 s)

# InCom WG27 - Results of the 1st meeting

## 2.2 Impact types

<u>large impact area / duration</u>

- drawdown ⊕ order of magnitude O(1 m)
- return currents ⊕ O(1 m/s)

<u>average impact area / duration</u>

- wave behind ship stern ⊕⊖ O(3 m/s)
- secondary waves ⊕ O(0.5 m)

<u>small impact area / duration</u>

- propeller hits on adult fish ⊖ O(25 m/s)
- propeller pressure increase ⊕ O(5 m press
- propeller jet on river bed ⊕⊖ O(2 m/s)
- propeller scour ⊕⊖ O(0.5 m)

Marseille (Peiker 1975)

# InCom WG27 - Results of the 1st meeting

## 2.2 Impact types

<u>large impact area / duration</u>

- drawdown ⊕ order of magnitude O(1 m)
- return currents ⊕ O(1 m/s)

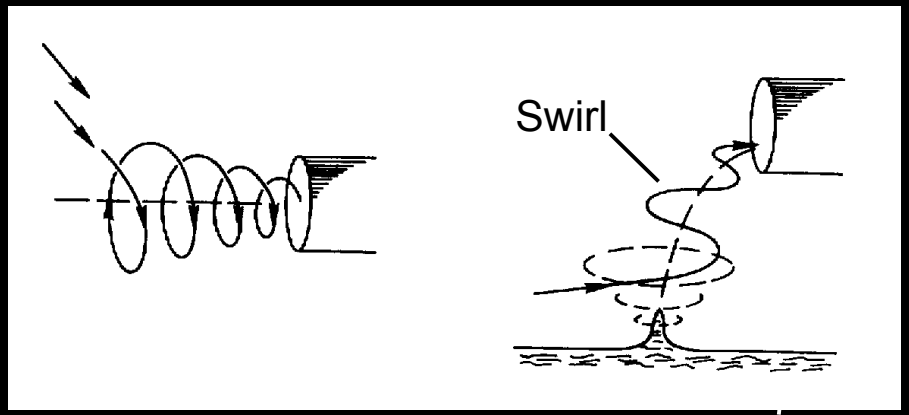
<u>average impact area / duration</u>

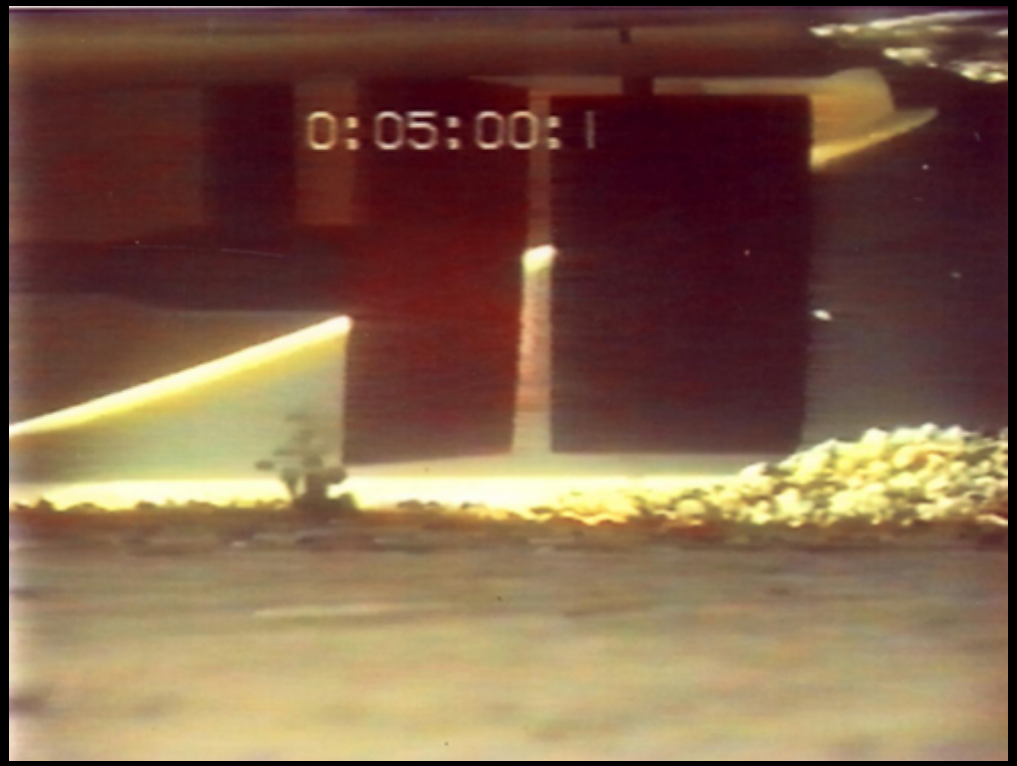
- wave behind ship stern ⊕⊖ O(3 m/s)
- secondary waves ⊕ O(0.5 m)

<u>small impact area / duration</u>

- propeller hits on adult fish ⊖ O(25 m/s)
- propeller pressure increase ⊕ O(5 m pressure height in 0.15 s)
- propeller jet on river bed ⊕⊖ O(2 m/s)
- propeller scour ⊕⊖ O(0.5 m)
- propeller sucking in stones ⊕⊖ O(5 m/s inside “tornado”)

# Origin of stone hits on the propeller

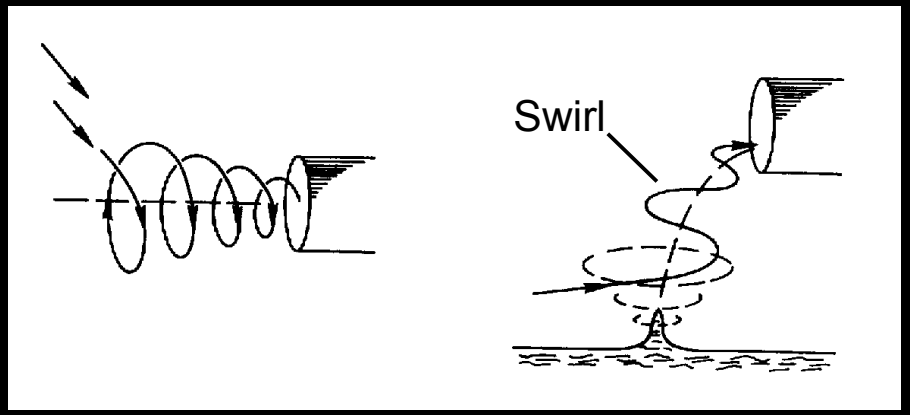



experimental setup to produce a waterspout after Blanchette

model tests, Ybbs 1992, large motor vessel, f = 0,3m, n = 120 RPM ,
V = 1,5 m/s, d = 75 - 100 mm

# Origin of stone hits on the propeller → possible suction of adult fish



# InCom WG27 - Results of the 1st meeting

3 Ecological effects

- drying former wetted areas drained by drawdown ⊕
- shear stress from return currents and propeller wash ⊕
- return current induced bed load transport ⊕⊖
- suspended load and turbidity, caused by return currents, wave behind stern, propeller wash ⊖
- bed fluidization by quick drawdown ⊕⊖
- ship waves influencing bank- ⊕⊖ and plant-stability ⊖
- direct propeller action on adult fish (cutting, pressure increase) ⊕⊖
- seasonal effects ⊖
- comparison to natural effects (wind waves, sed. transport, water level fluctuations) ⊕

# InCom WG27 - Results of the 1st meeting

4 Mitigation measures

<u>engineering measures</u>

- distance fairway - banks
- minimizing channel width
- wave breakers

<u>restrictions / rules to navigation</u>

- allowed ship speeds
- permitted ship types / propulsion systems
- timing of allowed impacts
- creating protected habitats

5 Monitoring

6 Further researches needed

7 Summary

8 Nomenclature