Environmental Aspects of Dredging Works in Practice

Stefan Aarninkhof
CEDA Seminar, Tallinn (Estonia)

Observations from the dredging industry

- Each project creates an impact to the environment
- The impact of the project is beyond control of the dredging industry
- The impact of the execution of the works is to be minimised by the dredging contractor
- Dredging industry performs a long year, systematic research into this subject
For every new project, questions:

- How standards have been set?
- How standards shall be adhered to?
- How compliance to standards can be monitored?
- What is cost/benefit ratio for ecology and for economy?

Discussed along project experiences

Øresund Fixed Link Project (1996)

- Peninsula for tunnel approach in Denmark
- Submerged tunnel, 3510 mtr. length
- Artificial Island, 4055 mtr. length
- Bridges, total length 7845 mtr.
Øresund Fixed Link Project
Effects of Dredging

- Impact on sea grass and mussel beds in the direct vicinity of the project area by sediment from the dredging.
- Effect of changing water and salt flow through the Sound and into and out of the Baltic Sea on fish species such as cod and other biological systems.

5% Spill Limit (overall)

“No effects” Compensation dredging

No previous practical experience so lack of certainty on effects

Øresund Fixed Link Project
Environmental standards

- Precious environment - high demand for control - high level of care - willing to pay for it
- Standards based on bio-assay - translated into physical parameters by Client
- Contractor responsible for compliance and monitoring
• Contractor was able to meet standards - against loss of production - with very high effort in monitoring
• Client confirmed criteria were met - follow-up evaluation did not show any impact
• Question: could the same have been achieved with less strict control?
Øresund Fixed Link Project
Considerations

• Successful in environmental and economical respect
  but
• not to be used as standard for the future as
• each project different in all aspects so
• do not copy / paste environmental requirements

Ruwais Port Extension
(UAE, 2000)

• Dredging of 1.5 km approach channel, turning basin and berth pocket
• Environmental concern: coral reef at ??? m
• Strict environmental requirements - very similar to Øresund
• Turbidity around dredger and effluent from disposal area
Ruwais Port Extension

Summary

• Construction and use of large retention basin
• Extensive monitoring - limits never reached
• Silt curtain supplied - never used
• So: All requirements were met
• Question: was this level of control really necessary?

Mejillones (Chile, 2002)

• Dredging for 3 terminals & turning basin
• Bay of Mejillones important for local fishery → environmentally sensitive area
• Environmental standards adopted from projects in Middle-East
• Restrictions on size of sediment plumes at dredging and disposal sites
Mejillones (Chile, 2002)

• First set-up:
  – limits set realistic, protecting aquaculture
  – monitoring extensive but no enforcement
  – negotiations for lowest price
• Second set-up:
  – confusion about scope / responsibilities
  – monitoring requirements exceed compliance level

• Monitoring should be integral part of project planning to avoid unforeseen delays / costs

Mejillones (Chile, 2002)

Summary

• Environmental standards adopted from earlier projects
• Monitoring at fixed locations and around dredging / disposal
  – up to 100 m depth
  – up to 11 km distance
• Measurements values only fraction of threshold
• Relevance of measurements can be questioned
• No flexibility to review monitoring procedures
Mejillones (Chile, 2002)
Contractor responsibility?

“Dredging should not disturb sea lions”

Safer Fairways to Port of Gothenburg (Sweden, 2003)

- Dredging for channel widening and deepening to ensure safety
- Sensitive habitats (eelgrass, mussels) and recreational demands
- Well engineered realistic monitoring & control requirements
- Absolute values for summer & winter
Gothenburg (2003)
Environmental monitoring

- Turbidity measured along lines parallel to channel
- Daily reporting of results

Summary

- Contractor responsible for reliability of monitoring
- Limited overflow adopted
- Good working relationship between Client and Contractor from start to end
- Outcome of monitoring
  - confirmed minimal impacts
  - enabled reduction of monitoring effort (24/7 → 12/7)
  - gave input for public hearings
- Stakeholder involvement & communication crucial for project success
Channel Deepening Project
Melbourne (Australia, 2005)

- Dredging for channel deepening
- Alliance contract between Port of Melbourne Corporation and Boskalis
- Major concerns on environmental impact
- Trial dredging (2005), project cont. in 2008
- Variety of monitoring, focus here on turbidity

Turbidity approach

1. Impact pathway – plume to consequence
2. Distribution & condition of plants
3. Plume extent, concentration & duration
4. Light climate–naturally & during dredging
5. Biological response of plant to reduced light
6. Estimate impact
7. Assess against project acceptability criteria
8. Mitigation & management options
9. Monitoring

Risk assessment & management process

Literature, field investigations, modelling
1. Impact Pathway

- Plume Dispersion
  - Increased Suspended Solids
  - Increased Light Attenuation Through Water Column
  - Decreased Light in Water Column and On Seabed

- Physical

- Biological
  - Reduced Photosynthesis
  - Physiological and Morphological Changes in Plants
  - Ecological Consequences

2. Distribution and condition of marine plants

3. Plume extent, concentration & duration

- Plume
- Plants in plume
- Concentration
- Duration
- Light Reduction
Environmental Limits

Light Requirement
15% Irradiance at 3m depth > 50% Time

Hydrodynamic Model

Dredging scenarios

TSS --- NTU

EWMA

Turbidity Control

TURBIDITY

Compliance
• 2 Buoys North
• 9 Buoys South

Additional
• 11 North+South
• Buoys,
  - GSM
  - Ad hoc maintenance
  - Weekly cleaning
  - Monthly verification

• EMP
  - Environmental limit

• Management
  - Response level 2
  - Response level 1

• Dashboard Display
  - EWMA
Melbourne (2005)

Summary

- Alliance contract with PoMC worked out well
- Turbidity limits soundly based on impacts sensitive receivers
- Ecological processes respond to prolonged impacts → justifies 6-hour avg + EWMA
- Time-averaging also needed for manageability of operational responses
- Concerns more realistically perceived

Khalifa Port and Industrial Zone (UAE, 2008)

- Dredging for construction of Khalifa Port
- Port located between world-class coral reef and power plant water intake
- Strong constraints on turbidity levels and other impacts - not well-founded
- Major operational demands (monitoring 24/7, 1-hour response time)
Khalifa Port
Sensitive receivers

Turbidity Measurements

Fixed monitoring stations
Khalifa data on-line
• Monitoring at fixed stations is only one component (amongst many others)

Khalifa (2008)

Summary

• Challenging project!
• Environmental standards were met so-far
• Rigid implementation & execution of environmental monitoring procedures
• Research monitoring provides data for validation of plume model
• Project benefits from open communication with Client
Monitoring of environmental parameters

• What is relevant?
• How to measure? Where? How often? At which depth?
• How to process data? How to interpret results?
• What are consequences if criteria are not met?

Monitoring of environmental parameters

• Anything possible, as long as clear and well to be adhered to
• Clear distinction between compliance and research
• Cost of monitoring in relation to project
Turbidity in a wider context

- Dredging-induced turbidity vs. other drivers

  - Mississippi River (USA)
  - Lake Michigan (USA)
  - Jiangsu, Yangtze River (China)

After: Van Houtam and Pauly (2007)
After: Vanderploeg (2007)
After: Walker (1997)

Turbidity Research

- Prediction of turbidity around hoppers: TASS program (funded by SSB)
- Ecodynamic Design: Building with Nature Program (Foundation EcoShape)
Observations from the dredging industry (2)

- Environmental requirements have become common
- Environmental limit values are getting more tight
- Tendency to relate limits to biological, chemical and/or physical processes
- Notification of background levels & exposure times is crucial
- Not all clients / consultants aware that imposing restrictions will increase costs

Conclusions

- Each project is unique
- Lessons from one project to be used for next, with great care (*lessons*, not *limits*)
- Formulation of limits needs better justification
- Environmental aspects should be integral part of the project
- Communication & stakeholder involvement prerequisite for successful project
Conclusions

- Research is carried out on
  - The establishment of environmental design specifications and operational requirements during execution
  - The development of equipment to meet these environmental demands

Dredging contractors do care for the environment