Ministerie van Verkeer en Waterstaat

Rijkswaterstaat

Management of weirs and hydro-electric power stations from an EU Water Framework Directive's perspective

Tom Buijse

Rijkswaterstaat – RIZA

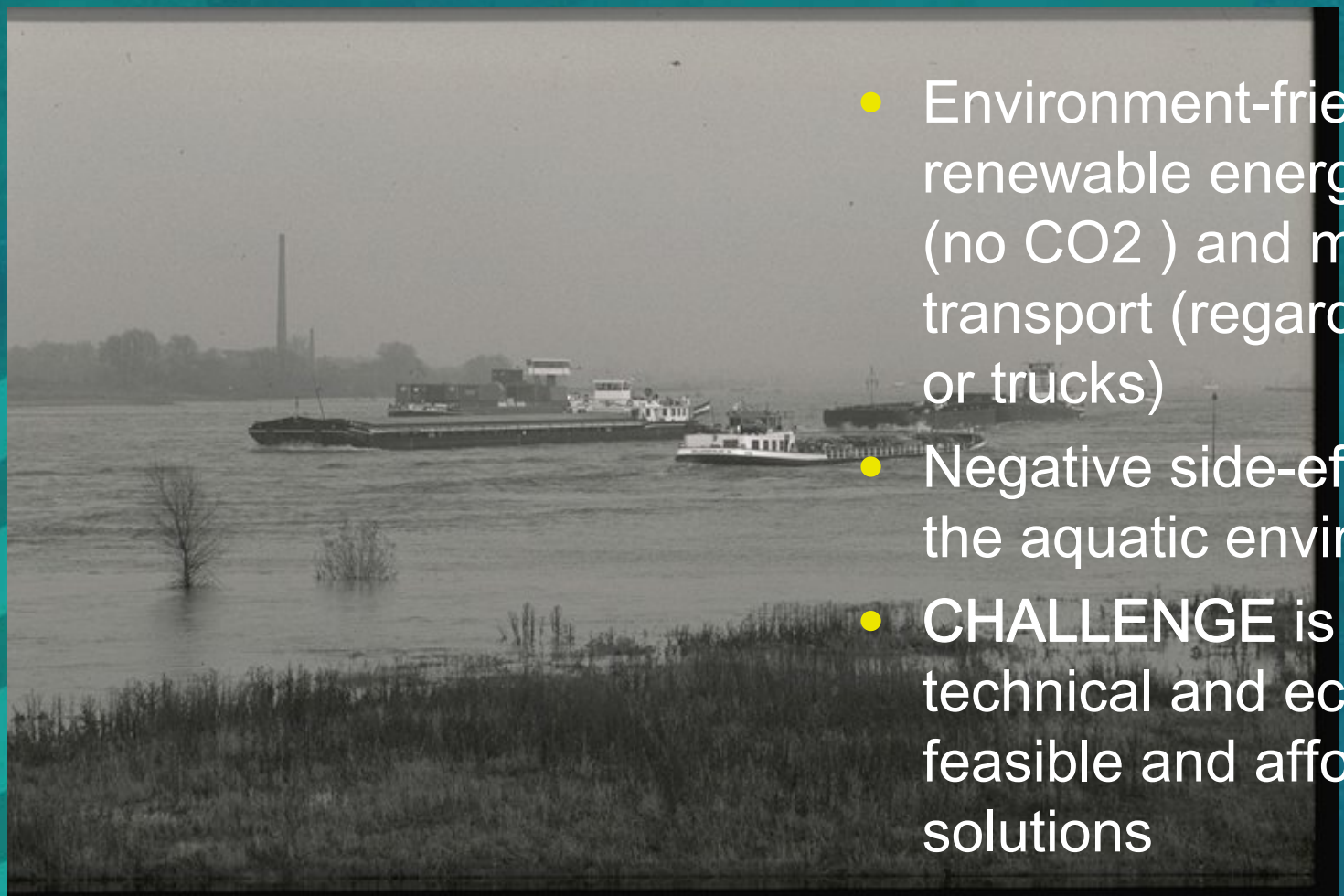
P.O. Box 17

8200 AA Lelystad, The Netherlands

a.d.buijse@riza.rws.minvenw.nl

5th International Rhine Symposium
Fish Migration: Up- and Downstream Fish Migration
Bonn, 2-4 November 2005

Hydro-electric power and Navigation



- Environment-friendly renewable energy source (no CO_2) and means of transport (regard to trains or trucks)
- Negative side-effects on the aquatic environment
- CHALLENGE is to find technical and economically feasible and affordable solutions

Examples from rivers Rhine and Meuse

Sources:

- International river basin district Meuse – analysis, cover report (www.cipm-icbm.be)
- International river basin district Rhine: features, assessment environmental effects of human activities and economic analysis of water use (www.iksr.org)
- CIS guidance on identification and designation of heavily modified and artificial water bodies (http://forum.europa.eu.int/Public/irc/env/wfd/library)
- Leitfaden für die Vergütung von Strom aus Wasserkraft
- CIS Workshop 'Water Framework Directive & Hydromorphology' (Prague, Oct 2005) (www.ecologic-events.de/hydromorphology)

Water Framework Directive - Hydromorfology

Hydrological regime

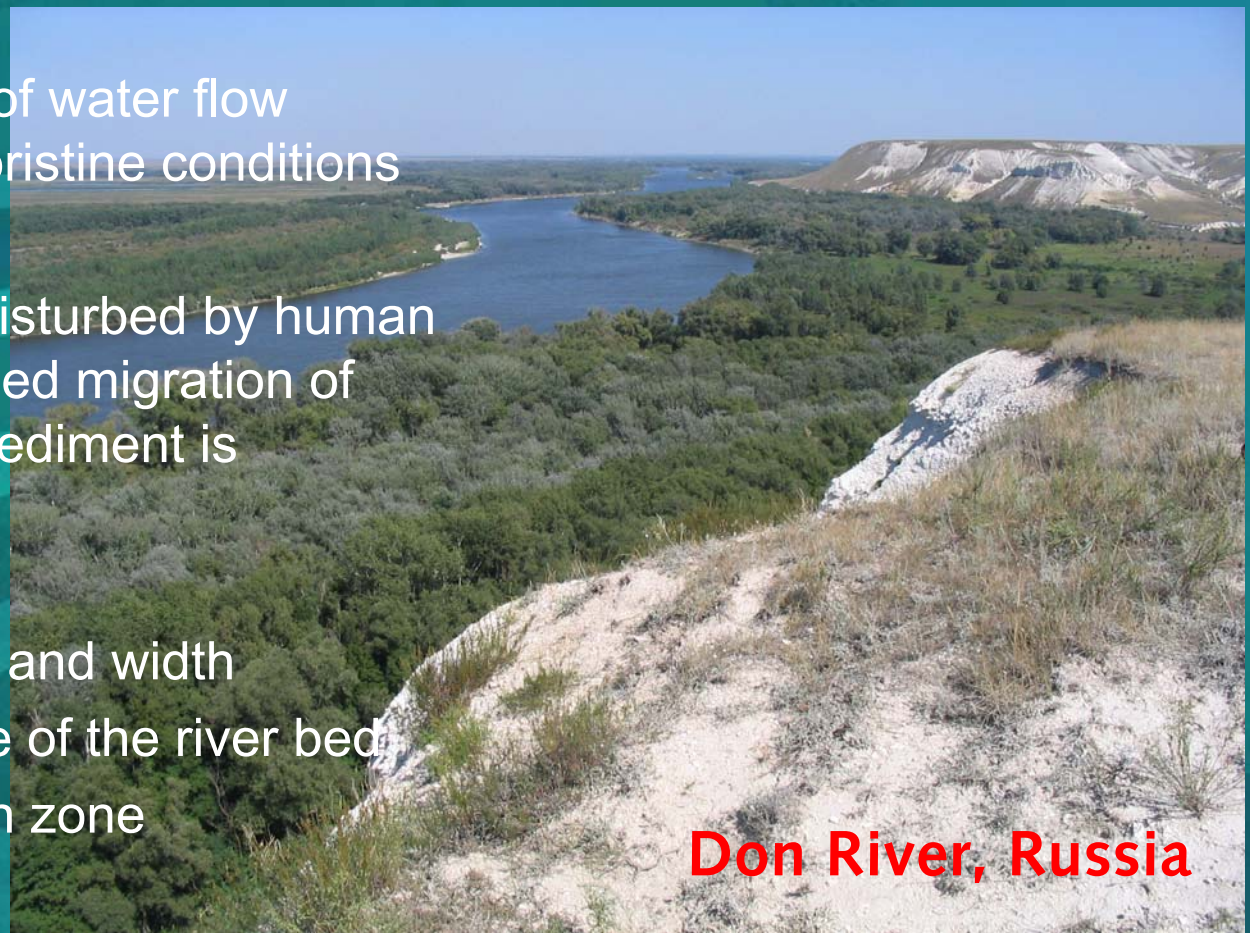
- Quantity and dynamic of water flow resemble an (almost) pristine conditions

River continuity

- The continuum is not disturbed by human activities and undisturbed migration of water organisms and sediment is possible

Morfological conditions

- Variatian in river depth and width
- Structure and substrate of the river bed
- Structure of the riparian zone



WFD – Fish community

Good Ecological State =

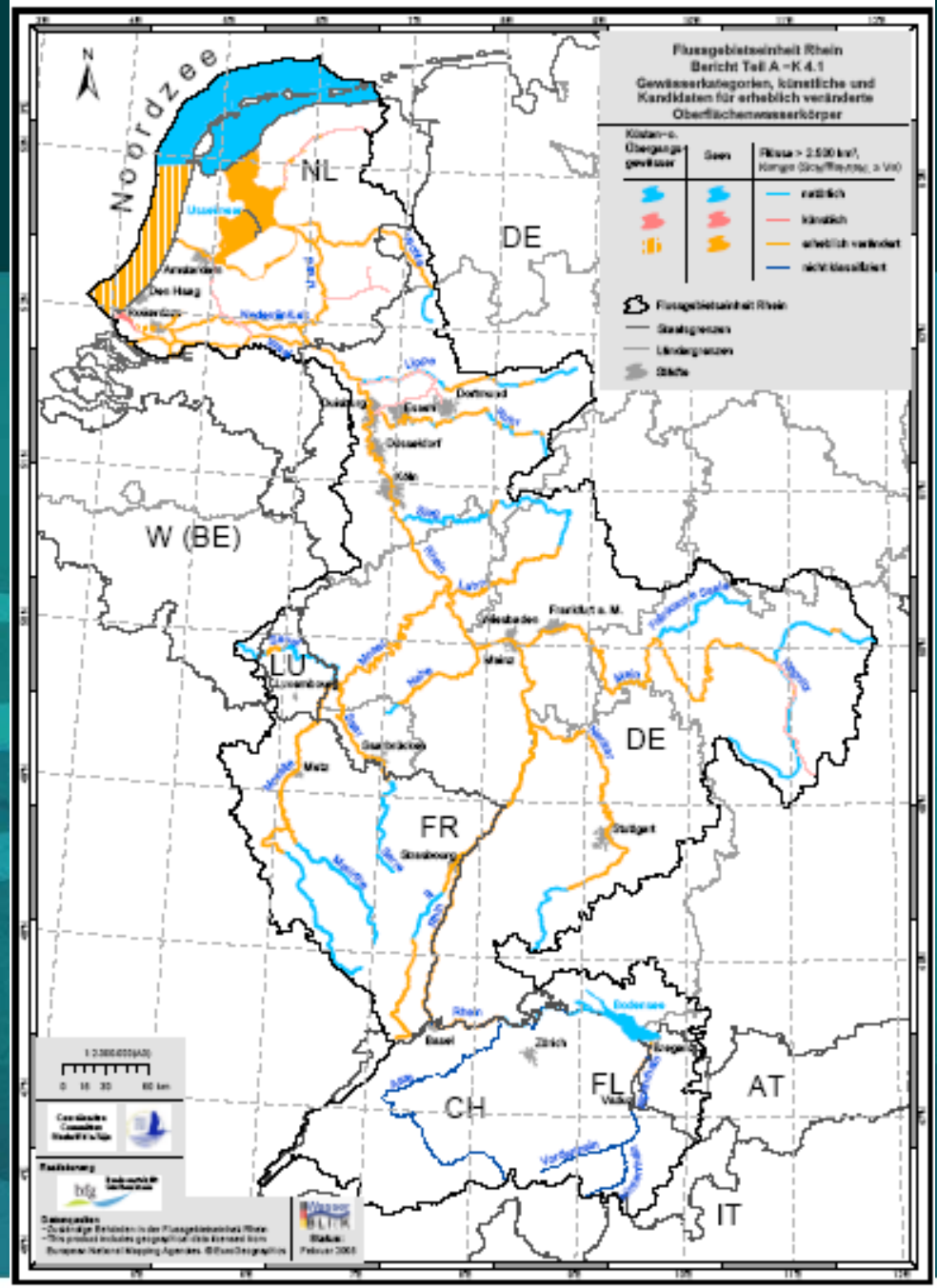
1. The composition and abundance of species with regard to type-specific communities is slightly modified
2. The age structure displays signs of disturbance and indicates in some cases to such a disturbance in reproduction or development of a specific species that certain age classes may be missing

- … as a result of anthropogenic influence on physical-chemical and hydromorphological quality elements.

WFD – heavily modified water bodies

- … by hydromorfological modifications as a result of present use
- Most common causes: flood defence, navigation, hydro-electric power, agriculture
- Hydromorfological changes: dams, embankments, weirs, sluices, canalisation, normalisation etc.

Rhine river basin district: preliminary designation of heavily modified water bodies



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WFD – heavily modified water bodies

Maximum Ecological Potential (MEP)

- … when all mitigation measures, which have no significant negative effects on a special function or the wider environment, are implemented

Good Ecological Potential (GEP)

- … = slight deviation from MEP
- In case achieving GEP is disproportional costly or technically impossible than targets may be postponed and lowered

Conclusion: WFD demands that we ecologically optimise our use use of rivers at acceptable costs

River Meuse

Weir near Lixhe (Belgium) with hydropower and fish passage

- The present discharge regime and morphology of the river bed are the main causes for the absence of natural rheophilic fish communities in the river Meuse
- Some weirs and hydro-electric power turbines hinder the free migration of organisms especially fish

Source: www.cipm-icbm.be

River Meuse

- A significant number of obstacles have to be removed before free migration of fish will be possible
- Some hydro-electric power stations have a substantial local negative effect on both aquatic and terrestrial faunal and floral communities

Source: www.cipm-icbm.be

River Rhine

- Water regulation in main channel and in major tributaries for navigation (maintenance of navigational depth)
- Also for hydro-electric power and flood defence the discharge of water is regulated
- The most notable hydraulic works are weirs (often combined with hydro-electric power stations) and sluices
- The main tributaries Neckar, Main, Lahn and Moselle have > 100 weirs and sluices

Source: www.iksr.org

River Rhine: hydro-electric power is intensively used for energy production

- High Rhine in Switzerland 11 HEPs; German-French Upper Rhine 10; Neckar 26; Main 33; Lahn 10; Mosel 22
- Many more in the numerous smaller tributaries: incomplete enumeration more than 2000 larger and smaller hydro-electric power stations

Source: www.iksr.org

River Rhine: side-effects of weirs and hydro-electric power stations

- Many weirs, which are only partially passable for migratory fish, obstruct the biological continuum substantially
- Downstream migration of fish: turbines can cause substantial fish mortality
- Impoundments lowers the water velocity in the vicinity of weirs
- Downstream of weirs the velocity increases
- Weirs and hydro-electric power stations cause artificial fluctuations in the discharge regime
- Hydropeaking to accommodate the demand for energy can have harmful side-effects

Source: www.iksr.org

Mitigation measures

- Upstream: fish passages, side channels
- Downstream: fish diversion, management of turbines and fish-friendly turbines to lower fish mortality rates
- Management of weir and hydro-electri power stations

River continuity: upstream

Fish passages

Example ‘River Meuse up to the Chiers tributary

- 47 weirs
- 18 functioning fish passages
- 22 malfunctioning fish passages

Conclusion: fish passages are a common and well-accepted mitigation measure, but the functionality varies significantly

The fish passages in the Neder-Rijn and Lek branch of the River Rhine (the Netherlands)

River continuity: downstream

Fish diversion systems

Example River Meuse up to the Chiers tributary

- 18 hydro-electric power stations (1 out of use)
- 16 without and 1 with fish diversion systems

Conclusion: fish diversion systems are to date hardly applied as a mitigation measure

River continuity: downstream

Management of HEP turbines to reduce fish injuries and mortality

- As little as possible operating turbines to maximise the discharge per turbine
- Shut turbine operation during peak periods of downstream fish migration

Modernise hydro-electric power stations

- Fish-friendliness has been an ignored issues in the design of turbines
- Turbines: higher efficiency and fish-friendly

Hydrologic regime: quantity and dynamics of water flow

Management of weirs and hydro-electric power stations WKC

- Minimum flow -> environmental flow
- Discharge = % total discharge with seasonal and yearly variation; fixed number of m3/s is undesired

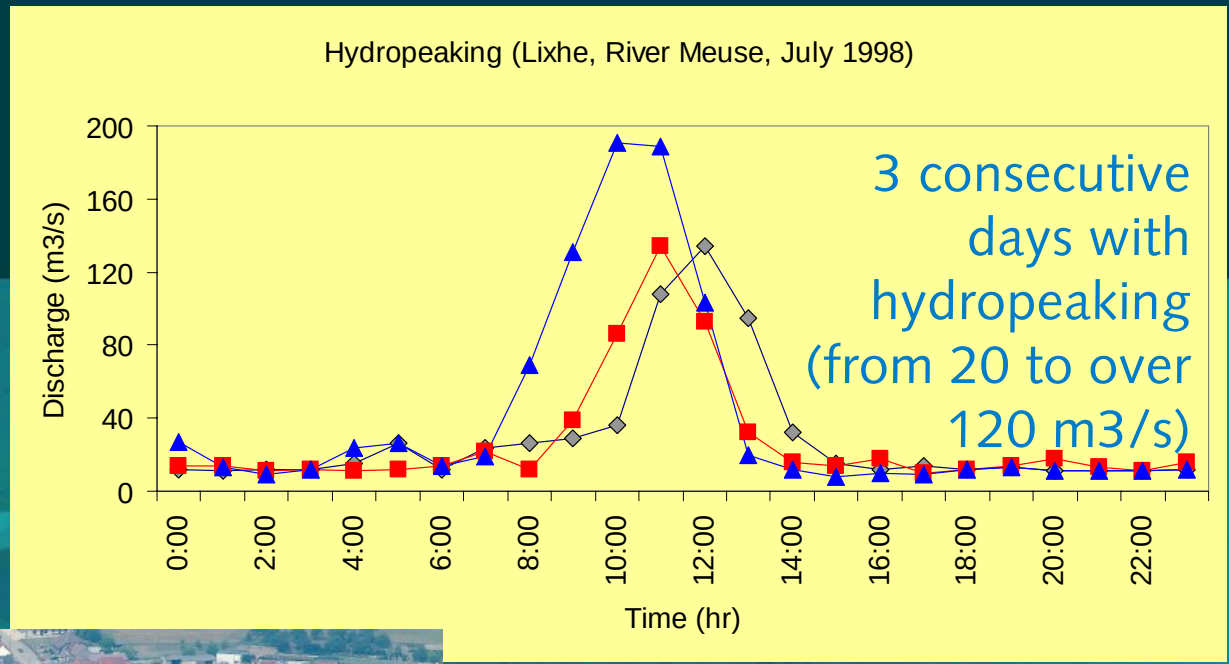
Hydropeaking:

- Preferably abandon or stop
- Intercept on river stretches with the least ecological consequences (analysis over multiple HEPS)

Example Rest-Rhein and downstream Iffezheim (free-flowing stretches) without hydropeaking

Example Meuse: spare the free-flowing Grensmaas -> Lixhe (Belgium) without hydropeaking

Hydropeaking as result of management of the hydro-electric power station near Lixhe (Belgium)



Widen the assessment of the impact of weirs and hydro-electric power stations to (sub)river basins

- Evaluate the consequences of hydro-electric power stations and weirs also mutual and cumulative
- Improve especially those with the highest ecological benefit
- Consider incidental to dismantle and remove weirs and hydro-electric power stations in case they have highly undesirable environmental side-effects or that their removal will result in a highly cost-effective and significant ecological improvement