



Project part-financed by the European Union (European Regional Development Fund)



'Managing the 'Reiherstieg' sluice to improve oxygen conditions'

Measure analysis 12
in the framework of the Interreg IVB project TIDE

J. Knüppel ¹

¹ Hamburg Port Authority (HPA)

December 2012

Disclaimer

The authors are solely responsible for the content of this report. Material included herein does not represent the opinion of the European Community, and the European Community is not responsible for any use that might be made of it.



Johanna Knüppel
Hamburg Port Authority (HPA)

Citation:

Knüppel, J. (2012): 'Managing the 'Reiherstieg' sluice to improve oxygen conditions' (Elbe estuary). Measure analysis in the framework of the Interreg IVB project TIDE. Measure 12. 13 pages. Hamburg.



Project part-financed by the
European Union (European
Regional Development Fund)



Table of Contents

List of tables	4
List of figures	4
Part 1: Measure description	5
1.1 Introduction.....	5
1.2 Objectives	5
1.3 Background and side conditions	5
1.4 Measure.....	5
1.5 Expected effect.....	7
Part 2: Execution of the main effectiveness criteria	8
2.1 Effectiveness according to development targets of measure	8
2.2 Impact on ecosystem services	8
2.3 Degree of synergistic effects and conflicts according the uses	9
Part 3: Additional evaluation criteria in view of EU environmental law	10
3.1 Degree of synergistic effects and conflicts according WFD aims	10
3.2 Degree of synergistic effects and conflicts according NATURA 2000 aims	11
Part 4: Crux of the matter	12
Contact	13
References.....	13



List of tables

Table 1: Ecosystem services analysis for Managing the ‘Reiherstieg’ sluice to improve oxygen conditions: (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure.....	9
Table 2: Effect of the measure concerning the main pressures in the freshwater zone of the Elbe estuary	10
Table 3: Effect of the measure concerning the main conservation objectives in the operational area 2	11

List of figures

Figure 1: Bathymetry of the modeled area	6
Figure 2: Ecosystem services analysis for Managing the ‘Reiherstieg’ sluice to improve oxygen conditions: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation.....	8

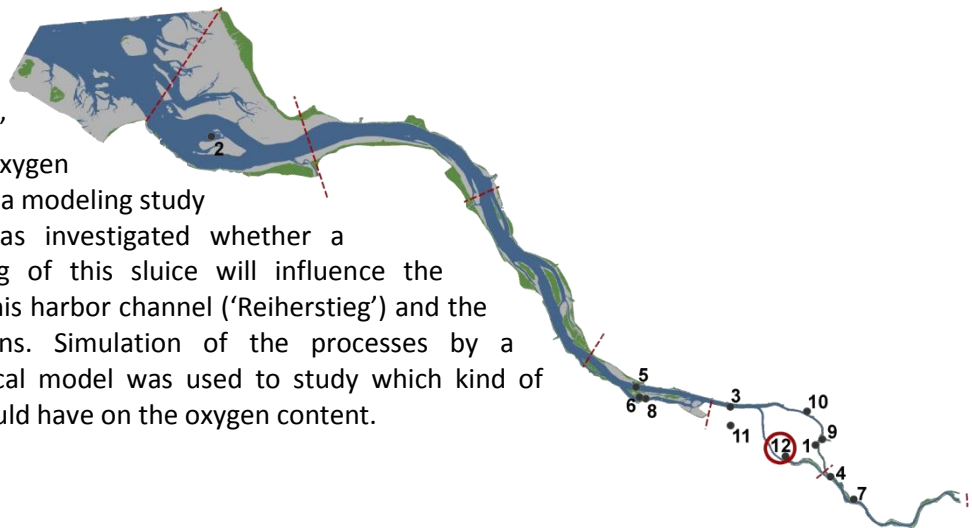


Part 1: Measure description

measure category	physical, chemical quality parameters
estuary	Elbe
salinity zone	freshwater
pressure	decrease of water and sediment chemical quality
status	feasibility study conducted
river km	616
country/location	Germany, Hamburg, Reiherstieg channel
responsible authority	Hamburg Port Authority

1.1 Introduction

In order to be able to implement the measure “Managing the ‘Reiherstieg’ sluice” leading to better oxygen conditions in this area, a modeling study was conducted. It was investigated whether a longer lasting opening of this sluice will influence the oxygen conditions in this harbor channel (‘Reiherstieg’) and the adjacent harbor basins. Simulation of the processes by a hydrodynamic numerical model was used to study which kind of effect the measure would have on the oxygen content.



1.2 Objectives

Particularly in summer, oxygen concentrations in the Elbe estuary and several harbor basins are very low. Therefore this study aims at simulating the whether and how the oxygen conditions of this harbor basin will be influenced by controlling the opening of the sluice during ebb flow. Changes in the opening schedule will be implemented in the case the study reveals positive results.

1.3 Background and side conditions

Hamburg Port Authority is planning a reconstruction of the sluice ‘Reiherstieg’. In this context it investigated in which way the opening times of the sluice will further affect the oxygen budget of the ‘Reiherstieg’ area.

There are several processes which affect the oxygen budget. High temperatures accelerate biological processes e.g. mineralization of organic compounds, and lead in combination with a low input of oxygen rich freshwater to low concentrations of oxygen. Furthermore the large water depth within the harbor basin and downstream of Hamburg harbor, results in a settlement of phytoplankton from



the sun lightened part of the water column into the dark zone of the water. The algae subsequently die and cannot produce oxygen anymore. In the contrary they serve as organic material ready to be broken down by bacteria under oxygen consumption.

1.4 Measure

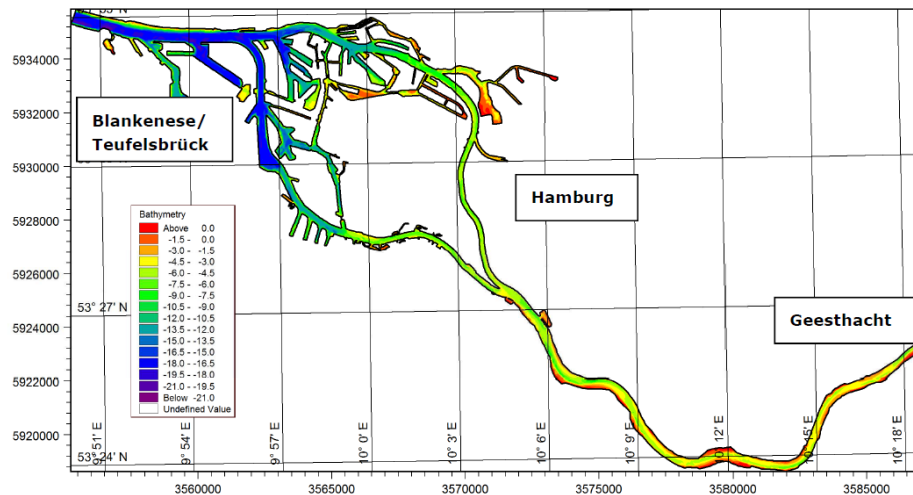


Figure 1 : Bathymetry of the modeled area

First calculations on determining the interference of the currents close to the sluice were carried out with a simple 1D model. A subsequent order was given for further profound investigations using a 2D hydrodynamic model of the Elbe estuary based on an existing model. The model area reached from the City of Geesthacht to Hamburg-Blankenese (Fig. 1). Tidal gauges at different places along the Elbe estuary were used for the calibration of the hydrodynamic model. An ecological process model was included into the hydrodynamic model in order to calculate the oxygen budget. In 2010 additional measurements of oxygen contents, current velocities and sediment parameters were carried out which should serve as basis for the calibration of the ecological model. It has to be mentioned that strong variations in the measured oxygen concentrations occurred due to different reasons (for instance sediment clouds due to ship maneuvers; surface runoff after rainfalls of organic polluted surface water). These can't be observed within the model in detail

Three questions were investigated:

- Is there an import of oxygen into the area by the fresh water discharge?
- What is the influence of suspended sediments, which are remobilized due to higher current velocities nearby the sluice?
- Can the chosen modified sluice management guarantee sufficient exchange of the water volume?

1.5 Expected effect

Before the model was set up it was expected that a longer lasting opening of the sluice could improve the oxygen conditions of the basin due to the water movement and fresh water discharge. However there is a risk of higher sediment circulation which could counteract the measure.

The model results showed that the opening of the sluice under the given conditions led to a slightly lower oxygen concentration with the exception of the southern part of the 'Reiherstieg'. Here longer lasting higher oxygen concentrations could be reached. However it should be noted that the model took unlimited sediment remobilization into account. That means that additional oxygen consumption as a result of the degradation of the organic compounds of the remobilized sediment occurs continuously.

A positive effect of the modeled management of the sluice will be the renewal of the water volume and that a modified operating of the sluice could be successful. However the model could not show whether the high oxygen consumption rate was rather related to the re-suspension of sediments.

In conclusion there has to be an interaction between the largest possible water exchange and the lowest rate of sediment re-suspension in order to adapt an operative management of the sluice aiming at improving the oxygen conditions in southern part of the 'Reiherstieg'.



Part 2: Execution of the main effectiveness criteria

2.1 Effectiveness according to development targets of measure

Definition of development targets:

- Influencing the oxygen conditions in the inner harbor by allowing the water exchange between the southern branch of the Elbe ('Süderelbe') and the adjacent channels ('Reiherstieg') and harbor basins during situations of low oxygen conditions.

Achievement of development targets

The hydrodynamic modeling study on managing the sluice showed that it is possible to affect the oxygen conditions inside the 'Reiherstieg' channel by a different opening scheme of the sluice.

2.2 Impact on ecosystem services

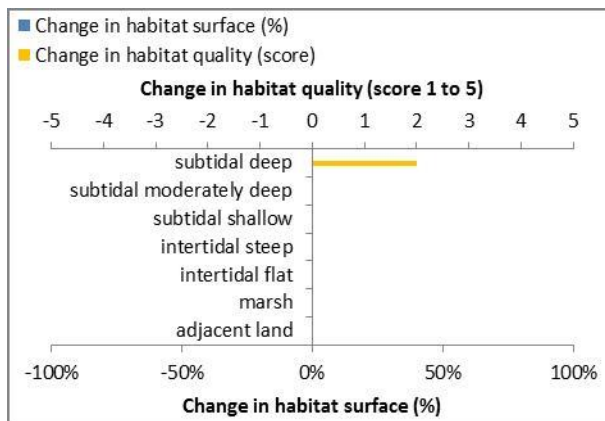


Figure 2: Ecosystem services analysis for Managing the 'Reiherstieg' sluice to improve oxygen conditions: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation.

- From the ES assessment it is concluded that this measure generates overall a slightly positive expected impact for several ES.
 - "biodiversity"
 - Cultural services
 - Some regulating services: Erosion and sedimentation regulation (by water bodies); Water quality regulation: transport of pollutants and excess nutrients
 - Some provisioning services: water for industrial use and water for navigation
- The expected impact on the development targets ("Water quality regulation: transport of pollutants and excess nutrients") is slightly positive.
- The expected impact for the different beneficiary groups is limited, with a slightly positive expected impact for indirect and future use and for local and region use.

Table 1: Ecosystem services analysis for Managing the 'Reiherstieg' sluice to improve oxygen conditions: (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure.

Managing the 'Reiherstieg' sluice to improve oxygen conditions		
Cat.	Ecosystem Service	Score
S	"Biodiversity"	1
R1	Erosion and sedimentation regulation by water bodies	1
R2	Water quality regulation: reduction of excess loads coming from the catchment	0
R3	Water quality regulation: transport of pollutants and excess nutrients	1
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	0
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	0
R8	Climate regulation: Carbon sequestration and burial	0
R9	Water quantity regulation: dissipation of tidal and river energy	0
R10	Regulation extreme events or disturbance: Wave reduction	0
R11	Regulation extreme events or disturbance: Water current reduction	0
R12	Regulation extreme events or disturbance: Flood water storage	0
P1	Water for industrial use	1
P2	Water for navigation	1
P3	Food: Animals	0
C1	Aesthetic information	1
C2	Inspiration for culture, art and design	1
C3	Information for cognitive development	1
C4	Opportunities for recreation & tourism	1

Beneficiaries:	
Direct users	0
Indirect users	1
Future users	1
Local users	1
Regional users	1
Global users	0

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

X Targeted ES

*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

The screening of the ecosystem services (ESS) that were effected by the measure 'Managing Reiherstieg sluice' showed the additional benefits that will be achieved with the implementation of this measure.

2.3 Degree of synergistic effects and conflicts according the uses

Improving oxygen conditions will improve the habitats of fish and will probably lead to positive effects for fishery.

The prolongation of the 'opening times' of the sluice during the ebb-phase in order to improve the oxygen supply will probably cause navigational problems inside the 'Reiherstieg' channel because of a potential change in current velocities. Additionally the sediment Import into the 'Reiherstieg' channel will increase.

Part 3: Additional evaluation criteria in view of EU environmental law

3.1 Degree of synergistic effects and conflicts according WFD aims

Table 2: Effect of the measure concerning the main pressures in the freshwater zone of the Elbe estuary

Indicator Group	Code	Main pressures freshwater zone Elbe	Effect?					Description: Aim of the study 'Reiherstieg Sluice'
			--	-	0	+	++	
S.I.	-	Habitat loss and degradation during the last about 100 years: Subtidal			0			
S.I.	1.1	Habitat loss and degradation during the last about 100 years: Intertidal			0			
S.I.	1.4/ 1.5	Gross change in morphology/hydrographic regime during the last about 100 years			0			
S.I.	3.1/3.2	Decrease of water and sediment chemical quality				+		
D.I.	2.3	Discharge of nutrients or harmful substances			0			
D.I.	1.3	Land claim during the last about 100 years			0			
D.I.	2.6	Capital dredging			0			

S.I. = state indicator; D.I. = driver indicator

The study 'Managing Reiherstieg sluice' is not assigned to the WFD nevertheless it covers one of the main pressures of the freshwater zone of the Elbe estuary. The study that was carried out shows the possibility of influencing the oxygen content in some parts of the port. Before implementation some unclear questions concerning flow velocities, navigation factors and sediment re-mobilization has to be pre checked and cleared up.

3.2 Degree of synergistic effects and conflicts according NATURA 2000 aims

Table 3: Effect of the measure concerning the main conservation objectives in the operational area 2

Operational area (zone)	Natura 2000 conservation objectives	Effect of Measure on conservation objectives			Description
		Positive	No effect	Negative	
2		Positive	No effect	Negative	
2	Prevention of further increase and/or reduction of tidal range (energy)		-		
2	Conservation and development of primarily floodplain/alluvial forest (*91E0)		-		
2	Conservation and improvement of alluvial meadows of river valleys (6440) and lowland and hay meadows (6510)		-		
2	Conservation of the primarily 'Elbe Water Dropwort' (<i>Oenanthe conioides</i>) with species specific dynamic, development of further habitats to improve the habitat network		-		
2	Conservation and development of spawn and growth habitats for asp, ensuring the habitat potential for the 'Twaite shad'	+			
2	Conservation and development of the transition functionality between the Middle Elbe and the Estuary downstream for migratory fish species of Annex II BHD	+			

Part 4: Crux of the matter

The studies on managing the 'Reiherstieg' sluice in order to influence the oxygen conditions showed different outcomes. On one hand the oxygen supply will raise rapidly inside the 'Reiherstieg' channel. On the other hand the remobilization of sediments caused by the occurrence of higher flow velocities and the subsequent rise in the biological oxygen demand (BOD) will affect the content of dissolved oxygen that entered the 'Reiherstieg' by the new operating scheme, too.

Additional studies on sediment consistency, amount, quality and time-varying remobilization have to be carried out to define the long-term effects the oxygen conditions in the investigation area.



Contact

Hamburg Port Authority
Nino Ohle
Neuer Wandrahm 4
20457 Hamburg

+49 (0)40 428 47-2409

References

DHI WASY (2010): Möglichkeiten zur Verbesserung des Sauerstoffgehaltes im Reiherstieg. i.A. der Hamburg Port Authority (HPA).

DHI WASY (2011): Möglichkeiten zur Verbesserung des Sauerstoffgehaltes im Reiherstieg. i.A. der Hamburg Port Authority (HPA).

