

Institut für Wasserbau und Wasserwirtschaft

Technische Universität Darmstadt



**Morphodynamic Response of Yangtze River Estuary
to Sea Level Rise and Human Interferences**

dem Fachbereich Bauingenieurwesen und Geodäsie
der Technischen Universität Darmstadt
zur Erlangung des akademischen Grades eines
Doktor-Ingenieurs (Dr.-Ing.)
vorgelegte

Dissertation

von
Xiaoyan Zhou
aus Yichang (China)

Darmstadt im Januar 2011

D 17

TABLE OF CONTENTS:

Abstract	i
Kurzfassung.....	iii
Table of Contents.....	v
List of Tables	vii
List of Figures.....	viii
List of Symbols.....	xii
List of Abbreviations	xiv
Chapter 1 Introduction.....	1
1.1 Research background.....	1
1.1.1 Natural factors affecting estuary morphology.....	1
1.1.2 Human interferences affecting estuary morphology.....	3
1.2 The study site - Yangtze Estuary (YE)	6
1.3 Existing situations and problems	9
1.4 Goal.....	14
1.5 Research approach.....	14
Chapter 2 Hydrodynamic conditions at Yangtze Estuary and its historical evolution on morphology	16
2.1 The field data	16
2.2 Hydrodynamic and sediment conditions	19
2.3 Field data statistics	24
2.3.1 Long-term trend	24
2.3.2 Variations in the estuary area.....	26
2.4 Morphological evolution analysis by field data	36
2.4.1 Near-River Estuary Reach (N-RER)	38
2.4.2 River Estuary Reach (RER)	39
2.5 Summary.....	42
Chapter 3 Analysis of morphological evolution at Yangtze Estuary by numerical model ..45	45
3.1 Morphodynamic models worldwide.....	45
3.2 Tide Morphodynamic model (TIMOR3).....	50
3.3 Model setup.....	56
3.3.1 Model area	57
3.3.2 Grid generation	57
3.3.3 Model input data	58
3.3.4 Boundary conditions	59
3.3.5 Model parameters	59
3.4 Calibration.....	61
3.5 Validation	65
3.6 Morphological simulation by TIMOR 3	75
3.6.1 Flow simulation.....	75

3.6.2 Sediment simulation	81
3.6.3 Morphological evolution.....	86
3.7 Summary.....	94
Chapter 4 Morphodynamic responses to human interferences at Yangtze River Estuary	96
4.1 Effect of human interferences on morphodynamics	96
4.1.1 Effect of dams and reservoirs.....	96
4.1.2 Effect of water diversion project.....	97
4.1.3 Effect of Water and Soil Conservation Project (WSCP).....	98
4.1.4 Effect of Reclamation.....	99
4.2 Regulation works in estuaries	99
4.2.1 Examples of worldwide projects	99
4.2.2 The Yangtze Deep Waterway Regulation Project (DWRP).....	106
4.3 Morphodynamic evolution induced by regulation work at Yangtze River Estuary.....	109
4.3.1 Morphological changes with and without the regulation works	110
4.3.2 Long-term morphological changes with regulation works.....	114
4.3.3 Analysis of dredging volume.....	122
4.4 Prediction of morphological changes under engineering measures	124
4.4.1 Bathymetry changes.....	125
4.4.2 Hydrodynamic changes	129
4.4.3 Dredging volume	131
4.5 Prediction of morphological changes under extreme hydrological conditions	131
4.5.1 Morphological changes under extreme high water discharge	132
4.5.2 Morphological changes under extreme low water discharge	134
4.6 Summary.....	136
Chapter 5 Morphodynamic response to the sea level rise at Yangtze River Estuary	138
5.1 The global climate change and sea level rise.....	138
5.2 Projection of sea level rise	140
5.3 Morphology under various projection of sea level rise.....	144
5.4 Joint effect of sea level rises and future discharges	152
5.4.1 Projection of water discharge	152
5.4.2 Morphology forecast	153
5.5 Summary.....	160
Chapter 6 Conclusions and recommendations	162
6.1 Conclusions	162
6.2 Recommendations	166
References	167