

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Sequences of barrier islands and ebb-tidal deltas . . . . .	1
1.2	Focus of this thesis . . . . .	4
1.3	Georgia Bight . . . . .	5
1.3.1	Barrier Islands . . . . .	5
1.3.2	Ebb-tidal delta of Beaufort Inlet . . . . .	5
1.4	Wadden coast . . . . .	7
1.4.1	Barrier islands . . . . .	7
1.4.2	Ebb-tidal delta of Ameland Inlet . . . . .	8
1.5	Present-day knowledge . . . . .	8
1.6	Research questions . . . . .	12
1.7	Research approach . . . . .	12
<b>2</b>	<b>A potential mechanism for the initial formation of sequences of barrier islands</b>	<b>15</b>
2.1	Introduction . . . . .	16
2.2	Model formulation . . . . .	17
2.2.1	Hydrodynamics . . . . .	18
2.2.2	Volumetric sediment transport . . . . .	20
2.2.3	Evolution of the coastline . . . . .	21
2.3	Basic state and linear stability analysis . . . . .	22
2.3.1	Basic state . . . . .	22
2.3.2	Stability analysis . . . . .	24
2.3.3	Solution procedure . . . . .	25
2.3.4	Numerical implementation . . . . .	26
2.4	Results . . . . .	26
2.4.1	Reference case . . . . .	26
2.4.2	Sensitivity of results to tidal current amplitude . . . . .	29
2.4.3	Sensitivity of results to bathymetric parameters . . . . .	31
2.4.4	Influence of waves on the instability mechanism . . . . .	33
2.5	Comparison model results with observations . . . . .	33
2.6	Physical interpretation . . . . .	36
2.6.1	Growth and migration of perturbations . . . . .	36
2.6.2	Magnitude of growth rate for large wave numbers . . . . .	39
2.6.3	Sensitivity of model results to bathymetry . . . . .	41

2.6.4	Sensitivity of model results to forcing conditions . . . . .	41
2.6.5	Fastest growing mode when wave flux is included . . . . .	42
2.7	Discussion and conclusions . . . . .	42
	Appendix . . . . .	44
<b>3</b>	<b>Modeling of equilibrium tide-dominated ebb-tidal deltas</b>	<b>45</b>
3.1	Introduction . . . . .	46
3.2	Model . . . . .	48
3.2.1	Domain . . . . .	48
3.2.2	Hydrodynamics . . . . .	48
3.2.3	Sediment transport . . . . .	51
3.2.4	Sediment mass balance . . . . .	52
3.2.5	Morphodynamic equilibrium condition . . . . .	53
3.2.6	Reference equilibrium . . . . .	53
3.3	Methods . . . . .	53
3.3.1	Finding morphodynamic equilibria . . . . .	53
3.3.2	Numerical method to solve the hydrodynamic equations . . . . .	54
3.3.3	Method to solve the Poisson problem . . . . .	55
3.4	Results . . . . .	56
3.4.1	Default case . . . . .	56
3.4.2	Sensitivity to width of the inlet . . . . .	58
3.4.3	Influence of waves . . . . .	58
3.5	Comparison of model results with observations . . . . .	58
3.5.1	Beaufort Inlet . . . . .	58
3.5.2	Observed and modeled sand volumes . . . . .	61
3.6	Physical interpretation . . . . .	63
3.6.1	Hydrodynamics . . . . .	63
3.6.2	Equilibrium bathymetry . . . . .	64
3.6.3	Relation between ESV and TP . . . . .	66
3.7	Discussion and conclusions . . . . .	67
	Appendix . . . . .	69
<b>4</b>	<b>Physical processes causing asymmetry of tide-dominated ebb-tidal deltas</b>	<b>71</b>
4.1	Introduction . . . . .	72
4.2	Model description . . . . .	75
4.2.1	Domain . . . . .	75
4.2.2	Currents . . . . .	76
4.2.3	Sediment transport . . . . .	77
4.2.4	Sediment mass conservation and morphodynamic equilibrium . . . . .	77
4.3	Reference state and inlet state . . . . .	78
4.3.1	Reference state morphodynamic equilibrium . . . . .	78
4.3.2	Morphodynamic equilibrium due to presence of tidal inlet . . . . .	80
4.4	Methods . . . . .	82
4.4.1	Finding morphodynamic equilibria . . . . .	82
4.4.2	Method to solve hydrodynamic equations . . . . .	82

4.4.3	Numerical Method to Solve the Poisson Problem . . . . .	83
4.5	Results . . . . .	83
4.5.1	Coriolis force . . . . .	83
4.5.2	Shore-parallel currents . . . . .	85
4.5.3	Residual currents at sea . . . . .	90
4.6	Discussion and conclusions . . . . .	92
4.6.1	Coriolis force . . . . .	93
4.6.2	Shore-parallel tidal currents . . . . .	94
4.6.3	Residual currents at sea . . . . .	96
4.6.4	Suggestions for further research . . . . .	97
<b>5</b>	<b>Numerical modeling of ebb-tidal deltas</b>	<b>99</b>
5.1	Introduction . . . . .	100
5.2	Model formulation . . . . .	101
5.2.1	Domain . . . . .	102
5.2.2	Hydrodynamics . . . . .	102
5.2.3	Sediment transport . . . . .	106
5.2.4	Sediment mass balance . . . . .	107
5.2.5	Morphodynamic equilibrium . . . . .	108
5.3	Methods . . . . .	108
5.3.1	Domain . . . . .	108
5.3.2	Hydrodynamics . . . . .	108
5.3.3	Sediment transport . . . . .	109
5.3.4	Morphodynamic equilibria . . . . .	109
5.4	Results . . . . .	110
5.4.1	Set-up of the experiments . . . . .	110
5.4.2	Results for default case . . . . .	111
5.4.3	Sensitivity of model results to tidal velocity amplitude in the inlet .	115
5.4.4	Sensitivity of results to tidal asymmetry . . . . .	115
5.4.5	Sensitivity of results to quadratic bottom stress . . . . .	119
5.4.6	Sensitivity of results to waves . . . . .	119
5.5	Comparison of model results with observations and idealized model . . .	125
5.5.1	Comparison with field data . . . . .	125
5.5.2	Comparison with idealized model . . . . .	127
5.6	Discussion . . . . .	131
5.7	Conclusions . . . . .	135
<b>6</b>	<b>Discussion and conclusions</b>	<b>137</b>
6.1	Length scale of barrier islands . . . . .	137
6.2	Symmetric tide-dominated ebb-tidal deltas . . . . .	138
6.3	Asymmetric tide-dominated ebb-tidal deltas . . . . .	140
6.4	Suggestions for further research . . . . .	142
6.4.1	Modeling the dynamics of barrier coasts . . . . .	142
6.4.2	Modeling the dynamics of ebb-tidal deltas . . . . .	142

<b>Bibliography</b>	<b>145</b>
<b>Samenvatting</b>	<b>151</b>
<b>Dankwoord</b>	<b>157</b>
<b>Curriculum Vitae</b>	<b>159</b>