

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
LIST OF TABLES	ii
LIST OF FIGURES	iv
INTRODUCTION	1
LITERATURE REVIEWS	5
MATERIALS AND METHODS	63
Materials	63
Methods	63
RESULTS AND DISCUSSION	114
CONCLUSION AND RECOMMENDATION	171
LITERATURE CITED	176
APPENDIX	180

LIST OF TABLES

Table	Page
1 Average monthly meteorological variables within last 30 years (between 1971 and 2000)	9
2 Average monthly and annual rainfall data located in Bung Boraphet catchment and nearby areas	11
3 Annual runoff data located in Bung Boraphet catchment and nearby areas	13
4 Average monthly runoff of three stations in the Nan River Basin nearby Bung Boraphet catchment	14
5 Land use patterns in Bung Boraphet catchment	15
6 Locations of 5 gauge height recording station	69
7 Collecting dates of the three Landsat5 images used in this study	83
8 Training area for supervised classification in Bung Boraphet and its surrounding area.	86
9 The coordinate and description of water quality observation locations	90
10 Details of water quality data collection for each time	91
11 Water quality parameters in Bung Boraphet and the Tributaries from the data collection	94
12 The observed daily discharges at 4 locations during the calibration period in October 2004	102
13 The observed daily water levels at the regulator during the calibration period in October 2004	102
14 The observed meteorological data during the calibration period in October 2004	103
15 The observed water velocities at 9 locations during the calibration period in October 2004	106
16 Observation time and SS concentration value at 4 locations to be used for model calibration	113

LIST OF TABLES (Continued)

Table	Page
17 Statistical parameters used to identify the goodness of fit of the lake water levels	122
18 Statistical values calculated from the comparisons between observed and calculated lake water levels and water storages	123
19 Annual summary of hydrological budget component of Bung Boarphet	127
20 Minimum water volumes and levels for different scenarios	129
21 Roughness coefficient and turbulence exchange coefficient at each Zone of the lake	158
22 The dispersion coefficient for each element types	162
23 The value of control parameter used for SS calibration	163
24 The property of sediment in Bung Boraphet	164
25 SS loading resulting from dredging operation for different scenarios	168
Appendix Table	
1 Water Quality data collected by PCD	181

LIST OF FIGURES

Figure	Page
1 Bung Boraphet Wetland in Nakhon Sawan Province, Thailand	6
2 Locations of rainfall stations in Bung Boraphet catchment and nearby areas	10
3 Location of runoff stations in nearby areas of Bung Boraphet catchment	12
4 Thiessen Polygon network	28
5 A rating curve	29
6 Remote sensing processes	30
7 The electromagnetic spectrum	31
8 Spectral reflectance curves for vegetation, soil, and water	33
9 Two dimensional element used with RMA2 model	41
10 Assumption of one dimensional element cross section	42
11 One dimensional element with different width at each corner node	42
12 Concept of transition element in RMA2	43
13 Concept of junction element in RMA2	44
14 Concept of control structure element in RMA2	44
15 The concept of Newton-Raphson scheme to obtain the solution in RMA2	45
16 Conceptual model of Bung Boraphet water budget	64
17 Conceptual model of Bung Boraphet water budget analysis	65
18 Volume-area-elevation curve of Bung Boraphet	66
19 Daily water levels of Bung Boraphet	68
20 Locations of 5 gauging stations, 5 rainfall stations, and 12 PVC tubes surrounding Bung Boraphet	69
21 Water levels data at 5 gauging locations between December 2002 and June 2006	70
22 Inflow rating curve at the outlet of Klong Bon	71

LIST OF FIGURES (Continued)

Figure	Page
23 Channel Inflow rating curve at the outlet location of Klong Tatako	71
24 Overbank inflow rating curve at the outlet location of Klong Tatako	72
25 Inflow rating curve at the outlet location of irrigation canal 1	72
26 Inflow rating curve at the outlet location of irrigation canal 2	73
27 Gravitational outflow rating curve at the outlet location of Klong Bon	74
28 Gravitational outflow rating curve at the outlet location of Klong Tatako	75
29 Gravitational outflow rating curve at the outlet location of irrigation canal 1	75
30 Gravitational outflow rating curve at the outlet location of irrigation canal 2	76
31 Regulated outflow rating curve at the outlet location of Klong Bon	76
32 Regulated outflow rating curve at the outlet location of Klong Tatako	77
33 Regulated outflow rating curve at the outlet location of irrigation canal 1	77
34 Regulated outflow rating curve at the outlet location of irrigation canal 2	78
35 Outflow rating curve at the weir	79
36 Outflow rating curve at the regulator	79
37 Locations of five rainfall stations used for direct rainfall estimation	80
38 Locations of 12 PVC tubes installing for lake seepage investigation	82
39 The ground control point used for geometric correction	84
40 Different image visualizations using different enhancement techniques	85
41 Areas before and after applying the clipping technique	86
42 An example assigning training area for PCI Geomatica software	87
43 The number of pixels and the percentage for each land cover	88
44 The water quality observation locations	89
45 The Schematic for the RMA2 Model and observed flow velocity locations	101
46 The finite element mesh within this boundary area	104

LIST OF FIGURES (Continued)

Figure	Page
47 The contour lines between the lowest and the highest elevations	104
48 The new finite element mesh of the RMA2 Model using for the RMA11 calibration	107
49 The contour lines within the elevation below +23.00 m (MSL)	108
50 Upstream boundary condition of RMA2 model application	108
51 The observed daily water levels at the regulator between 11 February 2003 and 11 July 2003	109
52 A schematic for the RMA11 Model and SS calibrated locations	110
53 Daily SS concentrations at the outlet of four tributaries	111
54 Comparisons between observed and calculated daily lake water levels between December 2003 and May 2006	121
55 Differences of observed and calculated daily lake water storages during inflow periods	123
56 Differences of observed and calculated daily lake water storages during outflow periods	124
57 Water budget scenarios in Bung Boraphet for different management Responses	126
58 Landsat imagery showing changes in the (a) Bung Boraphet, and (b) the surrounding area	131
59 Changes in land use and composition of (A) Bung Boraphet and (B) the surrounding area between 1993 and 2003, from analysis of Landsat images	132
60 Spatial variation of DO concentration in Bung Boraphet and its tributaries	133
61 Temporal variation of DO concentration in Bung Boraphet and its tributaries	134

LIST OF FIGURES (Continued)

Figure	Page
62 Spatial variation of BOD concentration in Bung Boraphet and its tributaries	136
63 Temporal variation of BOD concentration in Bung Boraphet and its tributaries	137
64 Spatial variation of TN concentration in Bung Boraphet and its tributaries	139
65 Temporal variation of TN concentration in Bung Boraphet and its Tributaries	140
66 Spatial variation of TKN concentration in Bung Boraphet and its tributaries	141
67 Temporal variation of TKN concentration in Bung Boraphet and its tributaries	142
68 Spatial variation of NO ₃ -N concentration in Bung Boraphet and its tributaries	144
69 Temporal variation of NO ₃ -N concentration in Bung Boraphet and its Tributaries	145
70 Spatial variation of TP concentration in Bung Boraphet and its tributaries	146
71 Temporal variation of TP concentration in Bung Boraphet and its Tributaries	147
72 Spatial variation of PO ₄ ³⁻ concentration in Bung Boraphet and its tributaries	148
73 Temporal variation of PO ₄ ³⁻ concentration in Bung Boraphet and its tributaries	150
74 Spatial variation of SS concentration in Bung Boraphet and its tributaries	151

LIST OF FIGURES (Continued)

Figure	Page
75 Temporal variation of SS concentration in Bung Boraphet and its Tributaries	153
76 Temporal variation of SS concentration along the profile of the lake	153
77 Relationships between SS concentration and turbidity	154
78 Relationships between 1/Secchi depth and SS concentration	155
79 Relationships between 1/Secchi depth and turbidity	156
80 The category of finite element for the RMA2 Model calibration	158
81 The comparison between the calculated and observed flow velocity	159
82 Flow velocity vectors resulting from RMA2 Model when the water level in Bung Boraphet was 23.39 m (MSL)	161
83 Flow velocity vectors resulting from RMA2 Model when the water level in Bung Boraphet was 22.21 m (MSL)	161
84 The category of finite element for the RMA11 Model calibration	163
85 The comparisons between observed and calculated SS at location 1	165
86 The comparisons between observed and calculated SS at location 8	165
87 The comparisons between observed and calculated SS at location 13	166
88 The comparisons between observed and calculated SS at location 15	166
89 The comparison between calculated and observed SS for RMA11 Calibration	167
90 The RMA11 scenarios for different SS loading	168