CONTENTS

CHAPTER	TITLE	PAGE
	ABSTRACT	i
	ACKNOWLEDGEMENT	ii
	CONTENTS	iii
	LIST OF TABLES	v
	LIST OF FIGURES	vi
1	INTRODUCTION	
	1.1. Rational/Problem Statement	1
	1.2 Objective	4
	1.3 Scope of study	4
2	THEORIES AND LITERATURE REVIEWS	
	2.1 Carbon cycle and Earth's climate	5
	2.2 Roles of forest soil respiration on global carbon cycle	8
	2.3 Relationship between nutrients cycling and soil respiration in tropical ecosystem	10
	2.4 Components of ecosystem respiration and their relationship with environmental factors	15
	2.5 Dipterocarp forest; importance, distribution in the world and Thailand	21
	2.6 Studies of carbon cycle in dipterocarp forest	24
3	METHODOLOGY	
	3.1 Site description	27
	3.2 Preparation of microbial and root respiration study plot	28
	3.3 *In Situ* gases flux measurements and instrument setup	30
	3.4 *In Situ* gases concentration measurements and instrument setup on soil profiles	34

CONTENTS (Cont')

CHAPTER	TITLE	PAGE
3.5	Biotic factors observation	36
3.6	Abiotic factors observation	48
3.7	Statistical analysis	49
4	RESULTS	
4.1	Meteorology data	50
4.2	Vegetation data	58
4.3	Temporal variation of soil respiration and it components	71
4.4	Variations of soil concentrations along soil profile	83
4.5	Seasonal variation of soil respiration (R_s) and ecosystem respiration (R_e)	86
5	DISCUSSION AND CONCLUSION	
5.1	Comparison of annual CO_2 emissions through soil respiration in dry dipterocarp forest with other forest ecosystems	88
5.2	Temporal variation of soil respiration in dry dipterocarp forest	90
5.3	Relationships between forest activity and soil respiration	103
5.4	Soil respiration and physical factors	113
5.5	Environmental factors controlling forest activity	119
5.6	Relationship between soil respiration and ecosystem respiration	124
5.7	Conclusion	125
	REFERENCES	127

LIST OF TABLES

TABLES	TITLE	PAGE
2.1	Carbon stocks in tropical and temperate zone	12
2.2	Soil respiration rate in different vegetation types in the tropical regions	19
2.3	Values of aboveground and stem wood biomass and carbon content of dry biomass by various forest types	22
3.1	Summary of chamber operating and CO_2 measurement system	32
3.2	Diameter, height and dry weight of stem, branches, leaf and root of 6 dominant species at dry dipterocarp forest, Ratchaburi province	38
4.1	General characteristics of soil samples in dry dipterocarp forest	57
4.2	Means diameter and height of trees growth in dry dipterocarp forest during February 2009 to February 2012	59
4.3	Measurement results of biomass stock in W_{s+b}, W_L, and W_R (kg/tree) during May, 2009 to February, 2012.	60
4.4	Decomposition rate constant (k) of four species of leaf and branch litter	67
5.1	The mean, S.D., and coefficient of variations (CV) of soil respiration and its component at different time scales	92

LIST OF FIGURES

TABLES	TITLE	PAGE
2.1	The global carbon cycle. Pools in Pg (= 10^{15}g) C and fluxes in PgC yr^{-1} are indicated by arrows	9
2.2	Schematic diagrams of ecosystem carbon processes in forests	10
2.3	Location of study sites in East Asia plotted on a land classification map	14
2.4	Monthly R_e observed at the 11 sites listed in Table 2.2. The site code, year(s) of ecosystem respiration (Re) evaluation, and ecosystem type are indicated in each figure	14
2.5	Relationships between soil respiration rate and soil temperature and moisture in Dinghushan Nature Reserve forests, Southern China	17
2.6	Relationships between soil respiration rate with soil moisture in Brazil, and soil temperature in China	18
2.7	Distribution of DDF plant species in the world	23
3.1	Soil respiration and related parameters that are included in the current dissertation study	26
3.2	Location of the study site at KMUTT Ratchaburi Campus, Rang Bour Subdistric, Chom Bueng Distric, Ratchaburi province in western of Thailand	27
3.3	Ratchaburi flux observation site in dry dipterocarp forest ecosystem	28
3.4	Trenching areas for measuring CO_2 flux from microbial respiration	30
3.5	Schematic diagram of CO_2 flux measurement setting and picture of automated-chamber used in this study	31
3.6	Schematic diagram of CO_2 flux measurement setting	32
3.7	The suitcase-size box to determination of CO_2	33
3.8	Installation of CO_2 profile measurements	35
3.9	The collection of soil respiration in soil profiles by using static chamber method	35

LIST OF FIGURES (Cont')

FIGURE	TITLE	PAGE
3.10	Example of chromatogram of gas sample analysis. Each peak identifies component of gas sample and magnitude of peak is proportional to the concentration of CO_2	36
3.11	The processing estimated carbon stock of all biomass in a dry dipterocarp forest. Backhoe engine dig soil for (a) cutting the tree and (b-c) separated composition of the plant	38
3.12	Allometric relationships for tree components dry weight of 6 dominant species	39
3.13	Measurement of circumference (calculate diameter at breast height: DBH) and height of 26 trees in every 3 month	41
3.14	Estimating root biomass by using taking soil core and separates According to the sizes of roots	42
3.15	Illustration of belowground instrument setup for root monitoring and soil environmental property at different soil depths	44
3.16	Litter trap in dry dipterocarp forest at Ratchaburi Province	45
3.17	Microbial biomass measured by using fumigation-extraction method	46
3.18	The litter bag from litter decomposed study	47
4.1	Variation of soil temperature on trenching and non-trenching plots at 0.05 m soil depth during 2008 – 2011	51
4.2	Long-term time series of measured soil temperature in soil profiles in dry dipterocarp forest during August 2011 – July 2012	52
4.3	Mean diurnal patterns of soil temperature at five depths of 0.05, 0.25, 0.75, 1.5, and 2.5 m during 14 – 20 March 2012	52
4.4	Seasonal variation of soil moisture in trenching and non-trenching at 0.05 m soil depth	54
4.5	Long-term time series of measured soil moisture in five soil layers in dry dipterocarp forest during August 2011 – July 2012	55
4.6	Mean diurnal patterns of soil temperature at five depths of 0.05, 0.25, 0.75, 1.5, and 2.5 cm during 14 – 20 March 2012	55

LIST OF FIGURES (Cont')

FIGURE	TITLE	PAGE
4.7	Seasonal variation of precipitation in dry dipterocarp forest	56
4.8	Root biomass for three different soil layers during September 2010 – August 2011. The bar refers to standard deviations (*N*=3).	61
4.9	Seasonal variation of fine root growth of different soil layers during January – December 2011. The bar refers to standard deviations (*N*=2)	63
4.10	Seasonal variation of fine root senescence of different soil layers during January – December 2011. The bar refers to standard deviations (*N*=2)	63
4.11	Relationship between fine root length and weight	64
4.12	Monthly changes in root biomass growth and senescence from January to December. The bar refers to standard deviations (*N*=2)	64
4.13	(a) Rate of fine root growth and senescence, and (b) the amount of fine roots throughout the soil profile. The bar refers to standard deviations	65
4.14	Monthly litterfall measured in DDF during June 2009-May 2012	66
4.15	Litterfall components in DDF from June, 2009 to May, 2012	66
4.16	Monthly weight loss in dry dipterocarp biomass from litter bags placed on forest floor (0 cm).The bar refers to standard deviations	68
4.17	Monthly weight loss of dry dipterocarp biomass from litter bags placed on forest floor (10 cm). The bar refers to standard deviations	69
4.18	Microbial biomass for three different soil layers during September, 2010 – August, 2011. The bar refers to standard deviations (*N*=3). Different letters indicate significant differences in total microbial biomass among the months	70

LIST OF FIGURES (Cont')

FIGURE	TITLE	PAGE
4.19	Monthly mean diurnal variations of soil respiration and its components, soil temperature and moisture during the dry (a, c, e, g) and the wet seasons (b, d, f, h). For soil respiration, the solid line is the monthly average values and the symbols show value ranges at specific time of the day. Soil respiration, microbial respiration and root respiration are shown separately for dry season (November-April) (a, c, e) and wet season (May-October) (b, d, f). Soil temperature (^{O}C) and soil moisture (%WFPS) with errors bar representing S.D. for each month are also shown (g, h)	72
4.20	Monthly changes of: (a) mean soil respiration (mg CO_2 m^{-2} h^{-1}) and precipitation (mm), (b) mean microbial respiration and soil moisture (%WFPS) at 5 cm soil depth, (c) mean root respiration and soil temperature (^{o}C) at 5 cm soil depth for 2008-2011 in dry dipterocarp forest	74
4.21	Daily mean soil respiration at DDF by using automated-chamber method from 2008-2011	76
4.22	Daily mean microbial respiration at DDF by using automated-chamber method from 2008-2011	77
4.23	Daily mean root respiration at DDF by using automated-chamber method from 2008-2011	78
4.24	Yearly variations of soil respiration, microbial respiration and root respiration during 2008-2011	79
4.25	Temporal variations of R_m/R_s and R_b/R_s during 2008-2011. Error bars indicate S.D. of daily values averaged over 2008-2011	81
4.26	Gradients of mean soil CO_2 concentrations during the wet and dry seasons during January to December 2011	83
4.27	Soil CO_2 concentrations versus depth and month to show seasonal shifts between wet and dry seasons in dry dipterocarp forests	83
4.28	Monthly variations of mean soil CO_2 concentrations versus soil depth during January to December 2011	84

LIST OF FIGURES (Cont')

FIGURE	TITLE	PAGE
4.29	Monthly variations of increasing CO_2 concentrations in each profile ($\Delta C/\Delta T$) between dry and wet seasons in 2011	84
4.30	The ratios of R_s/R_e during wet and dry seasons in DDF	85
4.31	Seasonal variations of mean soil respiration and ecosystem respiration observed during 2009 – 2010	86
5.1	Relationships between R_s, R_b, R_m and mean GPP for 2011. Only R_b is significantly related with GPP ($Y= 0.1317x - 162.27$, $R^2 = 0.7546$)	95
5.2	Seasonal variations in fine roots (< 2 mm) and 2-10 mm root biomass during September 2010–August 2011 at 0 to 0.6 m depth. Bar refers to standard deviation (*N*=3). Different letters or asterisks indicate significant difference in fine root biomass, or root with diameter 2-10 mm	95
5.3	Relationships of cumulative CO_2 emissions as R_s, R_m, R_b with (a) mean soil temperature, and (b) mean soil moisture during 2008-2011	98
5.4	Relationship of CO_2 concentration versus soil temperature and soil moisture at 15, 75, 150, and 250 cm soil depths	102
5.5	Mean biomass increasing rate of leaf (W_L), stem and branches (B_{S+B}), and root (B_R) estimated by automated-close chamber and allometric equation method during May 2009 – February 2012. WS refers to wet season and DS refers to dry season	104
5.6	Relationships of linear correlation between soil respiration and plant growth every three months in the dry dipterocarp forest	104
5.7	Monthly litterfall produced in the dry dipterocarp forest and means soil respiration during June 2009-May 2012	106
5.8	Relationships between (a) soil respiration and weigh loss of litter, and between (b) microbial respiration and weigh loss of litter at ground floor	109
5.9	Seasonal variation of mean root respiration, fine root growth and senescence (< 2 mm of diameter) during September 2010-August 2011	111

LIST OF FIGURES (Cont')

FIGURE	TITLE	PAGE
5.10	Relationships between R_b and find root growth and senescence during September 2010-August 2011	111
5.11	Seasonal variations of monthly mean microbial respiration and microbial biomass during January to December	112
5.12	The correlations between daily CO_2 effluxes of R_s, R_m, R_b and soil temperature were positive at 0.05 m when soil temperature at < 26°C and negative when soil temperature was > 26°C	116
5.13	(a) The correlation between soil CO_2 efflux and water fill pore space (%WFPS) at 0.05 m were positive when %WFPS was < 20% (except R_b<16 %). (b) shows the overall pattern of relationship between daily CO_2 effluxes and soil moisture	117
5.14	Correlation between soil temperature and soil moisture of (a) mean soil respiration, (b) microbial respiration, and (c) root respiration of dry dipterocarp forest during February 2008 - December 2011.	118
5.15	The relationship between plant growth and environmental factors as soil temperature (a) and soil moisture (b)	120
5.16	The relationships between litterfall and environmental factors such as (a) soil temperature and (b) soil moisture (n = 31; *p-value*< 0.01)	121
5.17	The relationship between litter mass loss and environmental factors such as (a) soil temperature and (b) soil moisture	122
5.18	Monthly change in microbial biomass in the dry dipterocarp forest and mean soil temperature and soil moisture during January - December 2011 temperature (a) and soil moisture (b) (n =52; *p-value*< 0.01)	123
5.19	The relationship between microbial biomass and environmental factors such as (a) soil temperature and (b) soil moisture (n =65; *p-value*< 0.01).	124