

CONTENTS

CHAPTER	PAGE
Title Page	i
Approval of the viva-voce board	ii
Certificate	iii
Acknowledgements	iv
Declaration	v
List of Symbols and Abbreviations	vi
Abstract	viii
Contents	ix
Chapter 1 Introduction	1-4
Chapter 2 Review of Literature	5-30
2.1 Hydrologic Models	5
2.1.1 Model classification	6
2.1.2 Distributed physically based hydrological modeling	7
2.1.3 SWAT model application in watershed hydrology	8
2.2 Identification of Critical Areas and Prioritization of Watershed	9
2.2.1 Prioritization of watersheds using SWAT model	10
2.3 Reservoir Sedimentation	11
2.3.1 SWAT model application for reservoir sedimentation estimation	12
2.4 Land Use/Land Cover and Hydrological Modeling	13
2.4.1 LULC change modeling	13
2.4.2 Spatial pattern of LULC and hydrological modeling	15
2.4.3 SWAT model application for LULC change impact studies	17
2.5 Climate Change Impact Studies on Water Resources	17
2.5.1 Climate change	18
2.5.2 Global circulation models	18
2.5.3 Emissions scenarios	19
2.5.4 Climate change impact on watershed hydrology	20
2.5.5 Climate change impact studies on water resources in India	22
2.5.6 SWAT model application for climate change impact studies	23

CHAPTER	PAGE	
2.6	Watershed Management	24
	2.6.1 Best management practices (BMPs)	25
	2.6.2 Structure based management	26
	2.6.3 Best management practices using SWAT model	27
2.7	Critique	29
Chapter 3	Model Description	31-48
3.1	SWAT: Soil and Water Assessment Tool	31
	3.1.1 Watershed components	32
	3.1.1.1 Hydrology	32
	3.1.1.2 Weather	37
	3.1.1.3 Soil erosion and sediment yield	37
	3.1.2 Routing components	39
	3.1.2.1 Channel flow routing	39
	3.1.2.2 Channel sediment routing	41
	3.1.3 Impoundment water and sediment routing	43
	3.1.3.1 Impoundment water routing	43
	3.1.3.2 Impoundment sediment in water bodies	46
Chapter 4	Materials and Methods	49-72
4.1	Description of Study Area	49
4.2	Data Used	51
	4.2.1 Topography	51
	4.2.2 Land use/land cover	52
	4.2.3 Soil	53
	4.2.4 Hydro-meteorology data	54
	4.2.5 Reservoir data and reservoir characteristics	55
	4.2.6 Damodar catchment watershed boundary map	56
	4.2.7 Future climate data and scenario	56
4.3	Preparation of LULC Map	57
4.4	Trend Analysis of Historical Meteorology Data	58
4.5	Hydrological Modeling	60
	4.5.1 SWAT model setup	60
	4.5.2 SWAT model sensitivity analysis	61
	4.5.3 Model calibration, up-scaling of calibrated parameter and validation	61
4.6	Evaluation Criteria for the Model Performance	62
	4.6.1 Coefficient of determination (R^2)	63
	4.6.2 Nash-Sutcliffe efficiency (NSE)	63
	4.6.3 Root mean square error (RMSE)	64

CHAPTER	PAGE	
4.6.4	Percent bias (PBIAS)	64
4.6.5	Kappa coefficient (K_{hat})	64
4.7	Identification and Prioritization of Critical Watersheds	65
4.8	Reservoir Sedimentation Rate and Reservoir Life Estimation	66
4.9	Impact of LULC Change and Climate Variability in Damodar Catchment	67
4.10	Impact of Future Climate Change on Damodar Catchment Hydrology	68
4.11	Effective Management of Critical Watersheds	68
Chapter 5	Results and Discussion	73-150
5.1	Land use/Land Cover Classification	73
5.2	ArcSWAT Model Setup	76
5.2.1	Sensitivity analysis	77
5.2.2	Model calibration	79
5.2.2.1	Model calibration for runoff	80
5.2.2.2	Model calibration for sediment yield	83
5.2.2.3	Model calibration for reservoir inflow	86
5.2.3	Model validation	88
5.2.3.1	Model validation for runoff	88
5.2.3.2	Model validation for sediment yield	92
5.2.3.3	Model validation for reservoir inflow	94
5.2.4	Identification and prioritization of critical watersheds	97
5.2.5	Reservoir sedimentation rate and reservoir life estimation	100
5.3	Catchment Response to LULC Change and Climate Variability	101
5.3.1	Climate variability: trend analysis of temporal variability	101
5.3.2	Historical changes in water availability: reservoir inflow	106
5.3.3	Historical changes in reservoir sediment inflow	108
5.4	Climate Change and Catchment Response	109
5.4.1	Projected change in rainfall and temperature by RCMs	109
5.4.2	Impact of climate change on reservoirs	115
5.4.2.1	Impact of climate change on reservoir inflow	116
5.4.2.2	Impact of climate change on reservoir sediment inflow	123

CHAPTER	PAGE
5.4.2.3 Impact of climate change on reservoir sedimentation rate	130
5.5 Identification of Critical Watersheds under Future Climate Projections	132
5.5.1 Impact of climate change on erosion classes of watersheds	132
5.6 Evaluation of Best Management Practices under Future Climate Change	140
5.6.1 Impact of BMPs on reservoir inflow	140
5.6.2 Impact of BMPs on reservoir sediment inflow	142
5.6.3 Impact of BMPs on reservoir sedimentation rate	145
5.6.4 Impact of BMPs on soil erosion classes of watersheds	147
Chapter 6 Summary and Conclusions	<i>151-162</i>
References	<i>163-185</i>
Brief Curriculum Vitae	<i>187</i>