

## LIST OF FIGURES

## PAGES

Figure 3.1:	Location of the study area	32
Figure 3.2:	Geological sub-division of the Himalaya	34
Figure 3.3:	Physiographic division of the Himalaya	36
Figure 3.4:	Major streams of the Subansiri basin in India	39
Figure 3.5:	Drainage network of the Alaknanda river basin	39
Figure 3.6:	Isohyetal map of average annual rainfall (in cm) in the Subansiri basin	43
Figure 3.7:	Annual Rainfall (mm) in major towns of the Alaknanda basin in 2008	45
Figure 3.8:	Geological map of the Subansiri basin	49
Figure 3.9:	Geological map of the Alakanda basin	49
Figure 3.10:	Soil map of the Subansiri basin in India	51
Figure 3.11:	Soil map of the Alaknanda basin	51
Figure 3.12:	Suspended sediment load (ha.m) at Chauldhoaghat in the Subansiri basin	54
Figure 3.13:	Sediment load (a) and Suspended sediment concentration (b) in the Alaknanda basin for the year 2004 – 05	55
Figure 4.1:	Monthly total rainfall (mm) at (a) Chauldhoaghat and (b) North- Lakhimpur from 1992 to 1996	64
Figure 4.2:	Monthly total rainfall (mm) at (a) Rudraprayag and (b) Joshimath from 2004 to 2007	65
Figure 4.3(a):	Annual rainfall (mm) in the districts of the Subansiri basin	66
Figure 4.3(b):	Annual rainfall (mm) in the districts of the Alaknanda basin from 1980 to 2002	66
Figure 4.4:	Monthly total rainfall (mm) at North-Lakhimpur from 2007 to 2009	67
Figure 4.5:	Mean Monthly maximum temperature and minimum temperature (°C) at North -Lakhimpur from 1992 to 1996	67
Figure 4.6:	Mean Monthly temperature (°C) at (a) Rudraprayag and (b) Joshimath from 2004 to 2007	68
Figure 4.7:	Hydrographs at Chauldhoaghat and Dam site	69
Figure 4.8:	Comparison of flow with rainfall at Chauldhoaghat in 1996	70

Figure 4.9:	Mean Annual, Maximum Annual and Minimum Annual flow (m <sup>3</sup> /s) at (a) Rudraprayag and (b) Joshimath from 1971 to 2003	71
Figure 4.10:	Environmental Flow components of the Subansiri river at (a) Chauldhoaghat and (b) Dam site	72
Figure 4.11:	Annual flow duration curves of Subansiri river at Chauldhoaghat and Dam site from 1992 to 1996	73
Figure 4.12:	pH of the Subansiri and Alaknanda rivers at selected locations	83
Figure 4.13:	Electrical Conductivity of the Subansiri and the Alaknanda rivers at selected Locations	84
Figure 4.14:	Turbidity of the Subansiri and the Alaknanda rivers at selected locations	84
Figure 4.15:	Total Solid (in gram) of the Subansiri and the Alaknanda rivers at selected locations	85
Figure 4.16:	Total Dissolved Solid (in gram) of the Subansiri and the Alaknanda rivers at selected locations	86
Figure 4.17:	Total Hardness of the Subansiri and the Alaknanda rivers at selected locations	87
Figure 4.18:	Ca <sup>++</sup> (mg/l) of the Subansiri and the Alaknanda rivers at selected locations	87
Figure 4.19:	Mg <sup>++</sup> (mg/l) of the Subansiri and the Alaknanda rivers at selected locations	88
Figure 4.20:	K <sup>+</sup> of the Subansiri and the Alaknanda rivers at selected locations	88
Figure 4.21:	Na <sup>+</sup> of the Subansiri and the Alaknanda rivers at selected locations	89
Figure 4.22:	Cl <sup>-</sup> (mg/l) of the Subansiri and the Alaknanda rivers at selected locations	89
Figure 4.23:	SO <sub>4</sub> <sup>-</sup> of the Subansiri and the Alaknanda rivers at selected locations	90

Figure 4.24:	PO <sub>4</sub> <sup>3-</sup> of the Subansiri and the Alaknanda rivers at selected locations	91
Figure 4.25:	NO <sub>3</sub> <sup>-</sup> (ppm) of the Subansiri and the Alaknanda rivers at selected locations	91
Figure 4.26:	The study area of the case study 1	94
Figure 4.27:	Relief Map of the Subansiri river basin	96
Figure 4.28:	Relief Map of the Alaknanda river basin	96
Figure 4.29:	Graphical presentation of relief characteristics of the Subansiri and Alaknanda river basins	97
Figure 4.30:	Slope Map of the Subansiri river basin	98
Figure 4.31:	Slope Map of the Alaknanda river basin	99
Figure 4.32:	Graphical presentation of different slope categories in the Subansiri and the Alaknanda river basins	100
Figure 4.33:	Aspect Map of the Subansiri river basin	101
Figure 4.34:	Aspect Map of the Alaknanda river basin	101
Figure 4.35:	Location of the study basins: a <sub>1</sub> and a <sub>2</sub> show the Kyar Gad and Bhardari Gad subbasins of the Alaknanda basin (a) while b <sub>1</sub> and b <sub>2</sub> represent Sipu and Gayung subbasins of the Subansiri basin (b)	104
Figure 4.36:	Drainage network of (a) Gayung subbasin of Subansiri basin and (b) Bhardari Gad subbasins of Alaknanda basin	105
Figure 4.37:	Drainage network of (c) Sipu subbasin of Subansiri basin and (d) Kyar Gad subbasin of Alaknanda basin	105
Figure 4.38:	Relief maps of Gayung and Bhardari Gad subbasins	116
Figure 4.39:	Relief maps of Sipu and Kyar Gad subbasins	116
Figure 4.40:	Slope maps of Gayung and Bhardari Gad subbasins	117
Figure 4.41:	Slope maps of Sipu and Kyar Gad subbasins	117
Figure 4.42:	Aspect maps of Gayung and Bhardari Gad subbasins	118
Figure 4.43:	Aspect maps of Sipu and Bhardari Gad subbasins	118
Figure 4.44:	Satellite view (LANDSAT) of the Subansiri basin, 2000	122
Figure 4.45:	Satellite view (LANDSAT) of the Subansiri basin, 2014	122
Figure 4.46:	LU/LC map of the Subansiri basin, 2000	123

Figure 4.47:	Graphical presentation of LU/LC pattern of the Subansiri basin, 2000	123
Figure 4.48:	LU/LC map of the Subansiri basin, 2014	124
Figure 4.49:	Graphical presentation of LU/LC pattern of the Subansiri basin, 2014	124
Figure 4.50:	Satellite view (LANDSAT) of the Alaknanda basin, 2000	126
Figure 4.51:	Satellite view (LANDSAT) of the Alaknanda basin, 2013	126
Figure 4.52:	LU/LC map of the Alaknanda basin, 2000	127
Figure 4.53:	Graphical presentation of LU/LC pattern of the Alaknanda basin, 2000	127
Figure 4.54:	LU/LC map of the Alaknanda basin, 2013	128
Figure 4.55:	Graphical presentation of LU/LC pattern of the Alaknanda basin, 2013	128
Figure 4.56:	Graphical presentation of LU/LC categories of Subansiri and the Alaknanda basins, 2000 - 2014	130
Figure 4.57:	Graphical presentation of LU/LC change detection of the Subansiri and the Alaknanda basins	131
Figure 4.58:	NDVI map of the Alaknanda basin, 2000	133
Figure 4.59:	NDVI map of the Subansiri basin, 2000	133
Figure 5.1:	Human settlements in the villages of the Subansiri basin	138
Figure 5.2:	Total number of households in the districts of Subansiri basin	139
Figure 5.3:	Uses of tap water from the treated source in the Subansiri basin	140
Figure 5.4:	Uses of tap water from the untreated sources in the Subansiri basin	140
Figure 5.5:	Uses of river/canal water by the rural people of Subansiri basin	141
Figure 5.6:	Population in the Subansiri and the Alaknanda basins in 2001 and 2011	146
Figure 5.7:	Number of rural and urban Population in the Subansiri and the Alaknanda basins, 2001	147
Figure 5.8:	Number of male and female Population in the Subansiri and the Alaknanda basins in 2001	147
Figure 5.9:	Type of house (% of households) in the Subansiri and the	

	Alaknanda basins in 2001	148
Figure 5.10:	Scheduled Caste Population in the Subansiri and the Alaknanda basins, 2001	148
Figure 5.11:	Scheduled Tribe Population in the Subansiri and the Alaknanda basins, 2001	149
Figure 5.12:	Number of villages having drinking water facilities in the Subansiri and the Alaknanda basins, 2001	150
Figure 5.13:	Number of villages having primary school in the Subansiri and the Alaknanda basins, 2001	150
Figure 5.14:	Number of villages having middle school in the Subansiri and the Alaknanda basins, 2001	151
Figure 5.15:	Number of villages having secondary/sr. secondary school in the Subansiri and the Alaknanda basins, 2001	151
Figure 5.16:	Literacy rate in the Subansiri and the Alaknanda basins in 2001 and 2011	152
Figure 5.17:	Total workers in the Subansiri and the Alaknanda basins in 2001	152
Figure 5.18:	Number of villages having bus services in the Subansiri and the Alaknanda basins in 2001	153
Figure 5.19:	Number of villages having medical facilities in the Subansiri and the Alaknanda basins in 2001	153
Figure 5.20:	Number of villages having electricity (power supply) in the Subansiri and the Alaknanda basins in 2001	154
Figure 5.21:	Number of villages having post, telephone and telegraph facilities in the Subansiri and the Alaknanda basins in 2001	154
Figure 5.22:	Number of villages having paved approach road in the Subansiri and the Alaknanda basins in 2001	155
Figure 6.1:	Morpho-tectonic active map of the Alaknanda basin	171