1.1. Climate Change

The global warming-cooling is a slowly varying low-frequency mode phenomenon, so it is relative and gradual rather than absolute and abrupt. This requires description of period and tendency of recent trend and the period and tendency of immediate preceding trend. Further, short period of rising trend intricately woven in the long epoch of falling or other way round can often be seen in the climatic time series. In the past 600 million years average temperature of the globe fluctuated between ~12°C and ~22°C, and the CO₂ concentration between ~200ppm and 7000ppm. The last glacial period ended around 11,000 years before present (B.P.). From 11,000 to 9000 years B.P. the surface air temperature of the northern hemisphere rose from 11°C to 15°C. Since then temperature of the NH fluctuated around 15°C (±1°C). The CO₂ concentration and the atmospheric temperature are not really correlated on geological time scale, and they are weakly correlated during industrial era (~200 years). In any secular climatic trend of ~100,000 years few millennia can be seen with warmer climate and few cooler, in each millennium few centuries warmer and few cooler, in each century few decades warmer and few cooler, in each decade few years warmer and few cooler, in each year few seasons warmer and few cooler and each season with large intra-seasonal variability (highly variable sequence of wet-dry and/or warm/cool spells. Hence, understanding temporal resolution of climate variability is a complex issue. In the northern hemisphere (NH) surface air temperature fluctuations over the past 10,000 years (late quaternary or Holocene period), six warm epochs and five cold epochs can be identified. Short period of rising trend intricately woven in the long epoch of falling or other way round can often be seen in the climatic time series. Understanding climatic changes of the Holocene Period (past 11,000 years) is crucial to assess impact of global warming on Indian environment. A brief account of climatic fluctuations measured on the basis of surface air temperature of the northern hemisphere, their consequent influence on the Indian summer monsoon rainfall, and their effects on human civilization and culture from mythological period to recent is as follows (Archibald, 2007; Dansgaard et. al. 1969; Singh et. al. 1974; Figure 1).
• Before 11,000 B.P. - cold and dry
• 11,000 to 8,000 B.P. - equable climate (Vedic period; snow-melt fed Saraswati River existed)
• 8,000 to 7,000 B.P. - warm-moist with dominant seasonality (Ramayana period in the Indo-Ganga Plains)
• 7,000 to 6,000 B.P. - hot-humid with frequent floods (Mahabharata period; rain fed perennial Saraswati River existed)
• 6,000 to 5,000 B.P. - cool and dry with frequent droughts
• 5,000 to 4,000 B.P. - warm-moist with seasonal floods (Indus Civilization; rain fed ephemeral Saraswati River existed)
• 4,000 to 3,500 B.P. - cool-dry with frequent droughts (start of Jainism)
• 3,500 to 2,600 B.P - warm-moist with dominant seasonality (Epic period)
• 2,600 to 2,000 B.P. - cool-dry with frequent droughts (Buddha-Ashoka period)
• 2,000 to 1,400 B.P - warm-moist with dominant seasonality
• 1,400 to 1,100 B.P. - cool-dry with frequent droughts
• 1,100 to 750 B.P. - medieval warm period (foreign aggression started)
• 750 to 150 B.P. - Little Ice Age (mixing of Asian, European and African cultures on the Indian soil)
• 150 to Present - warm-moist with seasonal extremes

1.2 Vedic Period

During last glacial period (110,000-11,000 years Before Present or BP) it appears that even Lower Himalaya was covered with ice and snow. The glacial period ended around 11,000 BP and in the following 1,000 years the surface air temperature of the northern hemisphere (NH) rose from 11°C to 15°C. From glacier/ice/snow melts, rivers flowed through northwest India- one of them being the Saraswati. Originating near Shimla (Himachal Pradesh State) the Saraswati flowed through present day Punjab, Rajasthan and Gujarat States (parallel to India and Pakistan border) and debouched on to the Arabian Sea. The monsoon current was very weak, sometimes absent, but the moderate climate, plain land, fertile soil and ample good quality water provided amicable environment for
the Vedic Civilization to flourish on the bank of the Saraswati. With Yamuna, Satluj, Beas, Ravi and Chenab as its tributaries, the Saraswati was a perennial river. People living on its bank practiced agriculture and rearing domestic animals (cow, buffalo, horse etc.), spoke Sanskrit and knew critical details of nature from the atom to the universe. They knew clearly the importance of living elements (fire, air, water and soil), space, and gravity, vegetation, animate and inanimate for the human existence on the planet earth. Observing nature critically, describing its importance and usage in lucid shlokas, memorizing them and transferring the generated and accumulated knowledge orally to the next generation were important components of education in the Guru-Protege lineage (Rigveda, 1993). This culture of Vedic Civilization in the Saraswati Valley existed for more than 1,000 years.

Flowing water in the Saraswati River was the main determinant of the people of the Vedic Period. Sixteen shlokas in the Rig Veda provide description of large fluctuations in the behavior of the Vedic Saraswati: heavy floods, low flow to no flow and even changes in its course are documented. Due to persisting temperatures of about 15° C the ice/snow cover was exhausted in the lower and middle Himalaya and the Saraswati turned into a dry channel around 8,000 BP. People migrated towards the east along the banks of River Ganga and towards south - in due course the Vedic Civilization ended that existed for more than 1,000 years waned to an end.

1.3 Ramayana Period

The River Ganges rose to prominence after the collapse of the Vedic Civilization. The temperatures now ranged between 15° C and 15.5° C - the monsoon circulation and the rainfall being almost similar to the present day. Except northwestern parts, the entire Indian subcontinent was inhabited including Sri Lanka. It appears landscape and drainage pattern of northern India started developing through pluvial (rainfall) processes during this period. Archeological evidences suggest that rice was an important crop in the Gangetic Plains. In feudal system, the society was divided in three tiers: the mighty king and his administrators and army living in cities and towns at the topmost; the gurus and the proteges associated with gurukul system of education living in hermitages in the forest at second rung; and farmers, traders, artisans and laborers living in rural areas at the third. Sanskrit was the language of rulers and the elite while workers and laborers spoke varied numerous dialects. Besides teaching Vedic knowledge, the hermitages were also training warriors. The Ramayana Culture flourished in the Indo-Gangetic Plains for ~1,000 years.
Around 7,000 BP the temperature started rising above 15.5°C. Intense monsoon rainfall activities shifted westward due to westward shift in two important components of the summer monsoon circulation i.e. surface ‘heat low’ and the Tibetan Anticyclone in the upper troposphere. The area between Delhi and Kandahar (Afghanistan) experienced much greater rainfall compared to present day and the Gangetic Plains frequent droughts. Narration in Ramayana indicates occurrence of intense drought during last phase of the period. King Janaka performed a ritual to get rains, he ploughed agricultural land using golden implement which collided with a golden pitcher from which Sita was born. People from Gangetic belt started migrating towards west and the Ramayana Culture started waning.

1.4 Mahabharata Period

During 7,000-6,000 BP the temperatures were greater than 16°C. The atmosphere was hottest compared to other parts of the Holocene period and the monsoon was quite intense due to heating of the Afro-Eurasian dry province and the Tibetan-Himalayan highlands. The northwestern Indian subcontinent experienced a much wetter monsoon compared to present day with perennial rivers and thick vegetation proliferating in the region. Two narrations in the saga of Mahabharata talk about heavy rains in the area. The first one is when Krishna was born, and the other is when the people of Gokul denied worship to Lord Indra, who in a fit of anger started pouring rain; Krishna intervened to save the rain ravaged people by lifting Govardhan Hill and sheltering them underneath it. There was re-emergence of the Saraswati River - but this time it was a rain fed river. The Mahabharata Culture flourished – spreading over Delhi and Kandahar. A pilgrimage by Balarama (the elder brother of Krishna) from Dwarka to Mathura is mentioned in the texts – along the rivers Saraswati and Yamuna, providing the last description of the Saraswati available in mythological scriptures. The river might have changed its course westward and eastward due to west-east fluctuations of the monsoon rainfall associated with rise and fall of the northern hemisphere temperatures, and the effect of climatic changes on the river flows might have altered the drainage pattern of the Vedic Saraswati.

Sanskrit was still the language of the upper classes and commoners spoke dialects. The society was prosperous and the gurukul education expanded to train warriors on a much larger scale. In the Great Mahabharata War, which broke out around 6,000 BP nearly 2 million soldiers were killed in merely 18 days. Around the same time the temperature started falling sharply and was below 15°C. Frequent monsoon failures and
droughts escalated the miseries of the war torn people. The Saraswati became a dry channel. This condition prevailed for about 1,000 years, and people started migrating eastward and southward with the Mahabharata culture coming to an end. The Great Mahabharata coupled with dry climatic conditions shattered the human society and it took nearly 2,000 years for the society to resume normalcy around 3,500 BP.

1.5 Indus Valley Civilization

During cool and dry epoch of 1,000 years (6,000-5,000 BP) there was large migration of people from Middle East and central Asia in search of food and water into the Indus Valley. Around 4,500 BP the northern hemisphere temperatures rose to around 16°C and northwestern Indian subcontinent started experiencing ample monsoon rainfall. The Saraswati started flowing a third time but as an ephemeral (seasonal) river. This emergence might have altered the drainage pattern of the Saraswati River during the Mahabharata Period. Hence, the LANDSAT imageries can only decipher the drainage pattern of the Saraswati River of the Indus Valley Period but not of the Mahabharata and the Vedic Periods. People lived in the Indus Valley during 5,000-4,000 BP, and exalted in education, agriculture, art, architecture, trade, commerce and urban planning. Around 4,000 BP the temperatures decreased to less than 15°C and monsoon rains started failing frequently. Northwest India became a dry province and a large majority of the Indus Valley population lost their lives to hunger and epidemics, and the rest migrated to the east and south.

It may be noted that historians document the occurrence of Vedic, Ramayana, Mahabharata, Indus Valley and Epic periods (compilation of Vedic and other mythological scriptures) over a very short period of time (Fagan, 2009; Frawley and Rajaram, 2005, Radhakrishna, 1999 a & b and many others). In the history of India available in the literature, important epochs such as Vedic, Ramayana, Mahabharata and Epic periods are described in an overlapping and mingled manner, and generally confining them in the period between 1500 B.C. and 3500 B.C. perhaps this is due to lack of knowledge about the relationship between global temperature and Indian summer monsoon circulation and associated rainfall.

1.6 Period of Social Transformation through Religion

Jainism (Dawn of Religion and Dry Period Social Transformation) - In the post-Indus Valley Period (4,000-3,500 BP) a group of people started strictly practicing some moral,
ethical and social values to propagate the philosophy of mercy, compassion and non-violence in order to overcome atrocities in the society. This practice to keep human society in order (civilized and disciplined) came to be known as Jainism or Jain Religion. This religion had great impact on society.

1.7 Epic Period

Hinduism (Culture/Religion of the subcontinent east of the Indus River) – After seeing the effect of Jainism the large population got consolidated as much bigger cultural/religious group under the banner of the Hinduism. There are four components of every religion—place of worship, the holy book, mythology and rituals. For their religious activities the Hindus derived these components from Gods and Goddesses, wisdom, spirituality, philosophy and rituals of the Vedic through the Ramayana and the Mahabharata Periods. One of the religious activities of the Hindus was to compile the vast knowledge available in oral form. By the end of 10th century BC Hinduism became the religion of large masses of the Indian subcontinent. The community enjoyed some material prosperity during 1,400 BC to 600 BC with warmer atmosphere and wetter monsoon.

Important to remember is that the scriptures were compiled much later than the events actually occurred, later the events were described in nakas and were kept in oral form for a very long time. It is believed that at the time of compilation some texts were modified depending upon the prevailing circumstances. There is no material evidence to corroborate most of the descriptions provided in the scriptures, but, by any assessment one will come out with the understanding that the human society of those days must have taken a few thousand years to realize the following:

- Generation of the Vedic Knowledge
- Development of Sanskrit Literature
- Episodes of Ramayana and Mahabharata to happen
- Climatic conditions required for snow-fed perennial river Saraswati to flow in northwest India
- Dawn of social transformation through religion (Jainism)
- Consolidation of huge human population spread over the land mass east of the Indus River under the banner of Hindu culture/religion.
1.8 Buddha-Ashoka Period

During 2,600 to 2,300 BP the northern hemisphere was cooler (~14°C) and the Indian monsoon drier and frequent and severe droughts occurred over the Gangetic Plains. The longest drought of 100 years (in the recorded history) occurred around 400 BC. The first rainguage was invented by Chanakya during this period. Kautilya’s ‘Arthashatra’ provides an elaborate description of rainfall distribution across the country, particularly over forests of Bihar, west coast and Himalayan region and over Ujjain and Maharashtra. Due to frequent droughts, rainfall was somewhat lesser compared to present day. This period was the witness to the rise and fall of five outstanding historical personalities – Gautama Buddha, Alexander the Great, Chandragupta Maurya, Vishnugupta Chanakya ‘Kautilya’ and Ashoka the Great, Buddhism emerged one of the greatest religions. This was the second dry period social transformation after the end of the Indus Valley Civilization.

1.9 Post- Buddha-Ashoka Period

Around 2,000 BP the temperature was greater than 15.5°C. The monsoon was wetter over the Indian subcontinent. Some of the most important historical events took place during this period such as rise and fall of the mighty Roman Empire and the origin of the Christianity. Around 1,600 BP the northern hemisphere temperature was below 15°C. During this period Prophet Mohammad propounded Islam. During AD 800-1300 the temperature rose beyond 15°C. The period is widely known as medieval warm period. India experienced a wetter monsoon and a wealthy society. Mohammad Bin Kassim invaded India during this period to acquire more wealth. Mohammad Gazanavi attacked India 17 times during 1001-1026 AD.

1.10 The Little Ice Age (LIA)

The LIA started around 1250 AD. The NH temperature during this period was about 14°C, and the country frequently suffered from droughts due to weaker monsoon. India was invaded by Portuguese, French, Mongols, Turks, Arabs, Afghans and British and was ruled by foreign rulers for more than 700 years. India witnessed a mixing of a large number of European, African and Asian cultures and a new culture of Hindustan emerged with a different clothing, language, religious beliefs, food habits, agricultural practices and water resource utilization. The foreigners introduced large number of new
cereals, pulses, fruits, vegetables, fodder crops, fiber crops, medicinal plants, oil seeds, root and tuber crops, palms and beverages.

The indigenous plants of India are (Randhawa, 1980): Cereals- chawal, kodon, kutki, raishan and gurlu; Pulses- arhar, kulthi, ured and moong; Root crops- boromon kachu, arvi, khamalu, yam and adrak; Oil seeds- sarson and rai; Fruits- kathal, tari, jamun, kapitha (wood-apple), am, kela, amla, khajur, imli and ber; Vegetables- khira, baingan, karela, sengri, newari multi, ghia, kaddu, jhinga, kali torai, chachinda and poi; Spices- haldi, kali mirch, peter, pippal, choti ilachi; Sugarcane- ganna; Fibre crops- jute, pat, san, kapas, patsan, patwa and lalambari; and Medicinal plants- bhang and ganja.

The plants introduced into the country from western Asia: Cereals- jau and gehun; Vegetables- pyaz, lehsun, chukandar, shalgam, bandh gobi, gazar, muli and methi; Spices- dhania, zira and sauf; Fodder crops- hol and vilaiti gawuth; Fibre crops- alsi and Medicinal plants- anvur shefa, mulhatti, afim and kala isabgol.

The plants introduced from Africa: Cereals- ragi, bajra and jowar; Pulses- lobia and chowli; Vegetables- bhindi; Spices- dhania, zira and sauf; Fodder crops- gini-ghas and elephant-grass; Oilseeds- arind and til; and Beverages- kafi.

The plants introduced from China: Cereals- chin, marha, and kangni; Pulses- bhat, ramkurthi; Oilseeds- tung-oil, pippal yam and vilaiti shisham; Fruits- lokat, akhrut, lichi, khumbani and aru; and Beverages- cha.

The plants introduced from Southeast Asia and Pacific Islands: Root & tuber crops- khamalu and chuprialu (greater yam); Fruits- bilambi, kamrakh, karmal, nimbu, khatta, ckakotara, baraminbu (lemon), grape fruit, musambi, malta and mangustan; Palms- suger-palm, niriya and, sago (sago-palm); Chewing- supari; and Toilet- mehandi (henna).

Portuguese introduced grafting techniques to develop high yielding hybrid varieties of plants which produced excellent results on the Indian soil. In the last 100 years motivated efforts of the Agriculture Ministry of the Central and State Governments, Indian Council Agricultural Research (ICAR), Agricultural Universities, and programs like ‘Green Revolution’, All-India Coordinated Research Project for different crops, ‘Oil Seeds Mission’, Integrated Past Management etc. the country became food-grains surplus state from a deficit state.
(Dry Period Social Transformation, DPST-III) - Guru Nanak Dev Sahib started the Sikh Religion founded on Vedic knowledge, spirituality of Sufism and manual labor. This was the third dry period social transformation (DPST-III) after the collapse of the Indus Valley Civilization. After Sanskrit and Tamil the third literary language Urdu was born from a mixture of Sanskrit, Persian, Arabic, Turkish and number of dialects spoken by the people in and around Delhi. Literary development of Bengali language started with arrival of British during 16-17th centuries. The development of Malayalam, Telugu, Kannada, Marathi, Gujarati, Odia, Assamese, Punjabi and Kashmiri took place during 17-19th centuries. Development of Hindi as a literature started with the literature started with the fall of Mughal Empire and the ascension of British supremacy to assume full administrative control of India in the middle of 19th century.

India started becoming wealthier state with good rainfall activities associated with rising trend in the northern hemisphere temperature since 1850. Instrumental rainfall data for India is available for the period 1813-2009 (Figure 2).

1813-1869 (dry): India experienced frequent droughts and famines due to the failure of monsoon caused by the little ice age. Routine instrumental meteorological observations started at Chennai (Madras). The most important event of this period was the start of railways in response to the demand to transport food grains from one part of the country to another.

1870-1894 (wet): Control of all the meteorological observations across the country was taken over by the central government and India meteorological Department (IMD) started functioning from 1875 onwards for all weather and climate related purposes. Attempts were made for the first time to foreshadow the performance of the summer monsoon to predict rainfall. Movement for popularizing Hindi as a national language started.

1895-1941 (dry): The country experienced frequent droughts and expansion of the Thar Desert towards east and southeast was reported. A large number of palaces, forts, monuments were built under food for work programme. Large scale western style education started in the country. Operational long-range forecast of summer monsoon rainfall was started by the IMD under the leadership of Sir G.T. Walker.

1942-1964 (wet): Construction of large reservoirs, dams and canal network started in the country. India’s population grew at a faster rate during this period.

1965-1994 (fluctuating): Numerous measures were adopted by the federal government under the banner of ‘Green Revolution’ to meet the food grains demand of the growing
population. Agricultural production increased sharply due to management of water resources and adoption of advanced technology for agricultural purposes. Effective systems were developed for large scale storage of the food grains.

1995-2009 (dry): Despite the rising temperature of the northern hemisphere the performance of summer monsoon rainfall remained weaker. It is a paradoxical situation as the Asian summer monsoon is a thermally driven circulation system. Investigations reveal that from 1965 onwards temperature of the lower troposphere (surface-4 km) is rising (+2.2°C/100-year), 4-6 km is thermally stable but above 6 km the atmosphere is cooling (-2.2°C/100-year). During warmer upper troposphere and lower stratosphere (6-16 km layer) the Tibetan anticyclone, one of the important components of the Asian summer monsoon circulation, lies over western Tibet-Afghanistan-Iran sector (40°N latitude). But due to recent cooling of the upper atmosphere the Tibetan anticyclone is weaker and frequently located south of its normal position; roughly over northwest India-Pakistan-Afghanistan sector (30°N latitude).

The northern hemisphere temperature of 15°C is critical for the Indian summer monsoon- temperature less than that would lead to drier conditions over the Indo-Gangetic Plains (IGPs). Temperature between 15°C and 15.5°C would result in a wetter monsoon (similar to the present day) over the IGPs. Temperature greater than 15.5°C would induce a westward shift in monsoon rainfall activities with relatively drier condition prevailing over the Gangetic Plains. This relationship occurs on centuries and millennia scales rather annual and decadal scales. During cooler atmospheric and drier monsoon - spirituality, religion, philosophy and literature dominated the psyche of the Indian masses while materialism, power, wealth, politics, economics, trade and commerce dominated during warmer atmosphere and thus wetter monsoon. From *Vedic Period* 10,000 BP to Indus Valley Period (4,000 BP) the warmer and cooler epochs were of longer duration. However, the epochs were of shorter duration with less intensity in the later period. This suggests that the recent rising trend in atmospheric temperature is not likely to continue for a longer period.

During British Raj and other foreign rules, the indigenous Indian people were divided in three categories: (a) those interested in power, position, politics, property and popularity; (b) entertainers; and (c) farmers, workers, labourers and artisans. Frequent droughts during LIA were one of the major causes of the fall of dynasty and foreign rules and British Raj, and democracy was opted as an alternate form of state governance. After
independence the people from second and third strata played pivotal role in the political activities of the nation and occupied powerful positions in large number. Today wealth determines the class and worth of a person.

India's progress and prosperity is dependent on adoption of sustained agriculture and efficient utilization of water resources. Rainfall is the key factor for agriculture and water resources. Recently Sontakke et. al. 2008 have studied rainfall variation over 15 physiographic divisions and 48 subdivisions/provinces using longest instrumental rainfall data (1813-2006). Percentage area of the country under different recent rainfall trends is as: annual- 68% decrease, 22% increase and 10% stationary; winter (JF)- 47% decrease, 37% increase and 16% stationary; summer (MAM)- 73% increase, 17% decrease, 10% stationary; monsoon (JJAS): 75% decrease, 22% increase and 1% stationary; Post- monsoon (OND): 54% increase, 38% decrease and 8% stationary; June: 55% increase, 41% decrease and 4% stationary; July: 85% decrease, 9% increase and 6% stationary; August: 58% decrease, 38% increase and 4% stationary; and September: 69% decrease, 23% increase and 8% stationary (Figure 1.3).

- Compared to 1931-1964, during 1965-2006 mean annual rainfall over the country has decreased by 4.23%; winter rainfall has decreased by 11.48%, monsoon by 4.72% and post-monsoon 3.14%, while summer rainfall has increased by 1.01%.
- Compared to 1931-1964, during 1995-2006 mean annual rainfall over the country has decreased by 3.08%, winter rainfall has decreased by 3.91% and monsoon by 5.90%, while summer has increased by 12.31% and post-monsoon 5.10%.
- Annual rainfall over the Rajasthan Desert (physiographic subdivision/province Marusthali) is increasing at the rate of 35 mm/100-year since 1899.

The researches done in this program are reported in six technical chapters, chapters II to VII. In chapter II, an objective criterion has been used for identification of a hydrological wet season (HWS), and variability of parameters of the HWS over the river basins of the country are described utilizing the longest available instrumental monthly rainfall data (1813-2006) of well spread 316 rainguage stations. The summer monsoon is a crucial component of the climate of India. The different features (onset, withdrawal, duration and rainfall activities) of the summer monsoon show large temporal and spatial variations. In chapter III, an objective criterion has been developed for the determination of onset and withdrawal of the monsoon season over 19 subregions across the country. Rainfall occurs in spells. Characteristics of 40 parameters of regional
wet and dry spells and their extremes using 1-degree square grid (1-DSG) daily rainfall data of the period 1951-2007 are described in chapter IV. To understand relationship between rainfall occurrences and the circulation features, on daily basis, large scale wet and dry spell have been identified over the country by developing an objective criterion. Climatology and fluctuation of extreme and spatiotemporal extreme rainfall events concerning rainfall intensity, rainfall areal extent and rainwater for 1- to 25-day durations and 1-DSG spatiotemporal rainfall extremes for 1- to 150-day durations are described in chapter V. In the past three decades, numerous studies have demonstrated the adverse effect of contemporary El Niño and La Niña on the Indian summer monsoon rainfall starting from Sikka (1980). In chapter VI, the effect of the El Niño-La Niña on the parameters of the rainy/wet season and wet and dry spells are studied. In the era of rising global temperature availability of quantum of water for human consumption is of serious concern. Using actual field capacity (F.C.) of ~1400 locations, 1-DSG daily maximum and minimum temperature and 0.5-DSG daily rainfall data of the period 1972-2005 water balance studies have been carried out using soil moisture accounting method of Thronthwaite and Matter. Chief features of rainy/wet season and wet and dry spells over the river basins of the country are summarized in the summary and conclusion chapter VIII. A future outlook for 50 to 200 years concerning surplus rainwater potential for the country as a whole is also given in this chapter.
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Figure 1.1 Variation of surface-air temperature of the northern hemisphere during the Holocene Period (past 11,000 years) and evolution of culture of Indian subcontinent.
SUMMER MONSOON RAINFALL VARIATION OVER INDIA: 1813-2009

Figure 1.2 Summer monsoon rainfall (June through September total) variation over India during 1813-2009.
Figure 1.3 Percentage area of the country under different recent rainfall trends (after Sontakke et. al. 2008)