

CHAPTER 2

Theoretical Orientation

THE INDIAN MONSOON AND ITS VARIABILITY

The monsoon has been viewed as a gigantic land-sea breeze. It is shown in this paper that satellite and conventional observations support an alternative hypothesis, which considers the monsoon as a manifestation of seasonal migration of the inter tropical convergence zone (ITCZ). With the focus on the Indian monsoon, the mean seasonal pattern is described, and why it is difficult to simulate is discussed as well. Some facets of the intra seasonal variation, such as active-weak cycles; break monsoon; and a special feature of intra-seasonal variation over the region, namely, pole ward propagations of the ITCZ at intervals of 2–6 weeks, are considered. Vertical moist stability is shown to be a key parameter in the variation of monthly convection over ocean and land as well as pole wards propagations. Special features of the Bay of Bengal and the monsoon brought out by observations during a national observational experiment in 1999 are briefly described.

Monsoon pattern of West Bengal over last 100 years

The rainfall data of past 100 years suggests that, the overall rainfall amount of both south and north Bengal have been increased.

If we divide the 100 years time span into four cohorts (1901-1930, 1931-1960, 1961-1990 and 1990-2000), we will find that the mean rainfall amount of north Bengal region has declined (29. 3 mm.) during the time span of 1931-1960 over the mean rainfall of the time span of 1901-1930. The mean rainfall of the time span 1961-1990 and 1991-2000 has increased (3mm. and 120. 9 mm. respectively) over the time span 1901-1930.

As the south Bengal data suggest, the mean rainfall amount of the time span 1931-1960 has declined (7. 6 mm.) over the mean rainfall amount of the time span 1901-1930. While the mean rainfall of the time span 1961-1990 and 1990-2000 has been increased (53. 6mm. and 143. 4 mm. respectively) over the time span 1901-1930.

So, it is clear from the empirical data that the amount of rainfall is quiet satisfactory. The actual problem is scanty and uneven pattern of rainfall that causes plenty of unpredicted socio-economical and techno-managerial problems, which are sometimes beyond the mitigation capacity.

(Data curtsey-Prof. L Das, Department of Agricultural Meteorology and Physics, BCKV)

A. Monsoon: The Concept

The word "monsoon" is derived from the Arabic word for season and the distinguishing attribute of the monsoonal regions of the world is

considered to be the seasonal reversal in the direction of the wind. The monsoonal region delineated on the basis of significant change in the wind direction between winter and summer (with the direction of the prevailing wind within each season being reasonably steady) extends over a large part of the tropics, namely, $25\pm S$ to $35\pm N$, $30\pm W$ to $170\pm E$. Near the center of this monsoonal region is the Indian subcontinent and the ocean surrounding it, which experiences large seasonal variation in wind direction. In this paper, I focus on the monsoon over this region, specifically, the Indian monsoon; elucidate some facets of the mean seasonal patterns and the variability; endeavor to take stock of the present understanding of the underlying mechanisms; and identify the challenging problems that need to be addressed for further insight. The space-time variation of rainfall has such a large impact on the resources of the region that it has been said that the Indian economy is a gamble on the monsoon rains. Over a large part of the Indian region, most of the rainfall occurs in the months of June to September during the summer monsoon (or the so-called southwest monsoon, named after the direction of prevailing surface wind). The exception is the east coast of the southern peninsula, where most of the rainfall occurs during October–November. A useful index of the summer monsoon rainfall over the Indian region in any year is the all-India summer monsoon rainfall (ISMR), which is a weighted average

B. Monsoon—the basic system:

The primary cause of the monsoon was the differential heating between ocean and land. Thus, in this first-ever model proposed, the monsoon was considered to be a gigantic land-sea breeze. Differential heating of land and sea is still considered as the basic mechanism for the monsoon by several scientists. There is an alternative hypothesis in which the monsoon is considered as a manifestation of the seasonal migration of the inter tropical convergence zone or the equatorial trough in response to the seasonal variation of the latitude of maximum insolation. Whereas the first hypothesis associates the monsoon with a system special to the monsoonal region, in the second, the monsoonal regions differ only in the amplitude of the seasonal migration of the basic system (ITCZ/equatorial trough). The two hypotheses have very different implications for variability of the monsoon. For example, in the first case, we expect the intensity of the monsoon to be directly related to the land-ocean temperature contrast. It was pointed out that the latitudinal extent of the region characterized by low values of (OLR) is much larger over the Indian longitudes in the Northern Hemispheric summer than that characterizing the ITCZ over the Atlantic and Pacific and suggested that "the ITCZ over the Indian Ocean changes its existence drastically from winter to summer." The first study of the daily satellite imagery over the Indian longitudes showed that the cloud band over the Indian subcontinent on an active monsoon day is strikingly similar to that characterizing the ITCZ over other parts of

the tropics. Further, in 1980 it was showed that, dynamically, the system has all the important characteristics of the ITCZ, including low level convergence, intense cyclonic vorticity above the boundary layer, and organized deep convection showed that the large scale rainfall over the Indian monsoon zone is directly related to the meridional shear of the zonal wind just above the boundary layer. Clearly, the large latitudinal extent of the low OLR region noted by some climatologists does not arise from any difference in the basic system, but rather from the special nature of its intra seasonal fluctuations. These observations lend support to the second hypothesis considering the monsoon as a seasonal migration of the ITCZ. In the steady state, it is expected that the ITCZ over the oceans will be located over the latitude at which the sea surface temperature (SST) is maximum.

C. Intraseasonal variation:

The important role of the special nature of the variations of the TCZ (Tropical Convergence Zone) within the season in determining the nature of the seasonal pattern of OLR over Indian longitudes has been discussed above. In this section, I consider two features of the intra seasonal variation of the monsoon rainfall on the super synoptic scale, that is, the fluctuation between active and weak spells/breaks and northward propagations of the TCZ/rain belt at intervals of 2–6 weeks throughout the summer monsoon. Several important facets, such as the onset of the monsoon are not considered for want of space.

IMPACT OF MONSOON ON VARIOUS SECTORS

A. MONSOON AND AGRICULTURE

A study has been organised by the Observer Research Foundation (ORF) in New Delhi on August 1, 2012. The chief guest on this occasion was Mr. Harish Rawat, Hon'ble Member of Parliament and the then Union Minister of State for Agriculture and Parliamentary Affairs. Mr. Surendra Singh, Advisor ORF and former Cabinet Secretary to Government of India chaired the discussion. Select subject experts and scholars participated in the discussion, including Dr. L. S. Rathore of India Meteorological Department; Dr. Ravender Singh of Indian Agricultural Research Institute; Dr. V. U. M. Rao of Central Research Institute for Dry land Agriculture; Mr. Bharat Sharma of International Water Management Institute; and Ms. Sambita Ghosh of The Energy and Resources Institute. This publication offers a summary of views presented by the participants. It describes the impact of monsoon aberration on agriculture, and provides information on options available for managing agricultural droughts in India.

Importance of Monsoon

Monsoon is generally defined as the seasonal reversal of winds and the associated rainfall. In India, such changes in climatic conditions are experienced two times in a year. When moisture-laden winds flowing in the south-westerly direction from the Indian Ocean causes rainfall over the Indian subcontinent during June to September, the phenomenon is termed as South West (SW) Monsoon. Most parts of

the country receive rain from SW Monsoon. However, due to topographical barriers, certain areas over the Indian peninsula do not experience much rain, as the wind is diverted to other places due to the presence of Western Ghats.

Monsoon Variability and Agricultural

Drought Management in India

A striking reversal of winds from south-west to north-east direction is observed during mid-October which is followed by rainfall activity during October to December. Dry cold winds collect moisture from the Bay of Bengal and release it over south-east peninsular parts of India, including Tamil Nadu, coastal Andhra Pradesh, and Pondicherry which receive less rainfall from SW Monsoon. This is known as the North East (NE) or retreating Monsoon. The south-west monsoon brings about 80% of rains in the country. Its significance may be understood from the fact that more than 55% of farmers in India depend on adequate and well distributed timely rains from SW monsoon for raising good crops and growing feed for livestock. As 60% of agriculture in India is rain-fed and the produce supports 40% of the population, monsoon is often said to be the driver of Indian agriculture. It is realized that timely arrival, consistency, and sufficiency of monsoon rains is most essential. In this respect, it is noted that while India receives relatively high quantum of rainfall on its land compared to many other countries, the rains are uncertain and unevenly distributed in time and space. For example, in the same season, some States in

the country are reeling under floods and some other are facing drought. This happens every year and only the number of drought affected districts differs.

Furthermore, the onset of monsoon is sometimes delayed which affects the sowing of many rain-fed crops. On other occasions, the monsoon may begin on time, but many mid-season breaks occur leading to crop failures, and often farmers have to re-sow their crops. In such cases, the poor farmers face enormous losses as they not only lose their time, labour and inputs, but also have to invest again on seeds and inputs for the second time in the same season with no guarantee of success. The rain-fed farmers are generally poor and have little resources; they also do not get adequate credit from the financial institutions. The erratic nature of the monsoon, therefore, causes a lot of hardship to the farmers, the general population as well as livestock, and such conditions have an adverse impact on the economy. In the absence of sufficient rains, the flows in the rivers are poor, the reservoirs are not filled up, canals remain dry, and the farmers cannot transplant crops like paddy.

Monsoon Aberration and Impact on Agriculture

As mentioned above, monsoon occurrence varies. Sometimes, onset may be delayed or immediately after onset there is a long break. At times, onset and distribution may be very good, with almost one month dry belt in between. Furthermore, monsoon sometimes withdraws early in the first or second week of September.

Temporal data show that during the period 1877-2009, India experienced 24 major droughts and the severe drought years were 2009, 2002, 1987, 1972, 1918, 1899 and 1877. Insufficient and uneven rainfall leads to loss of certain crops. Some resistant varieties may sustain for 20 or 30 days, but some may not even for 10 days.

Monsoon Variability and Agricultural Drought Management in India

In 2002, rainfall deficit was 19% due to which 29% of country's total area was affected, and there was a loss of 24 million tonnes of food grain. The 2009 drought was the third worst since 1901, when a rainfall deficit of 23% was recorded and about 59% of the area was affected. But in 2009, the food grain loss was about 10-15 million tonnes, which is less than what was recorded in 2002. This happened due to variability in the occurrence of monsoon. Thus, while kharif crops suffered huge loss, good rain received during the rabi (winter) season compensated for the overall loss in food grain production. The effect of rainfall deficit on kharif crop production may be explained here. In 1972-73, 24% less rainfall was received which led to a 9.76% decline in rice production. In 1974-75, when rainfall deficit was only 12%, decline in rice production was 11.29%. Similarly, in 1979-80, with 19% less rainfall, a 27% decline in rice production was recorded. This may have been due to uneven distribution of rainfall. A State-level analysis reveals that in the drought-prone State of Andhra Pradesh, total decline in the yield of kharif food grains increased from 17% in 2002-03 to 25% in 2009-10. In the States of

Chhattisgarh, Gujarat, Madhya Pradesh and Rajasthan, a decline during the same period was not observed. But in 2012, many farmers were not able to sow the millets in Karnataka and in Gujarat due to less rainfall.

Drought Management Initiatives and Experiences

In India, the Ministry of Agriculture is the nodal agency for drought management. It prepares crisis management plans, which are updated every year depending on the likelihood of the weather pattern each year. Also, State governments have their own agencies to deal with problems created by monsoon deficiencies.

The Indian Council of Agricultural Research (ICAR) and Department of Agriculture and Co-operation(DAC) under the Ministry of Agriculture have taken several steps to help the farmers cope up with uncertain monsoons. These and other initiatives are described below.

Drought probability analysis has been carried out for the entire country, based on which moderate and severe drought-prone districts are identified. This helps the administration in taking advance action in case of deficient rainfall. Several crop varieties, which have a short duration and can tolerate drought, have been evolved, and are distributed to farmers through the Krishi Vigyan Kendras (KVK).

Availability of timely information about the occurrence of rains is most essential, and the India Meteorological Department (IMD) gives advance forecast on the pattern and behaviour of the monsoon.

However, it is realised that the prediction of the tropical Indian monsoon is quite difficult and many times it is not possible to predict the pattern well in advance.

In addition, the ICAR has undertaken a variety of steps for agricultural drought management, including preparation of crop contingency plans (CCP) at the State/regional level and weekly bulletins, conduct of awareness programmes for farmers, setting up of district level agro meteorological(agro-met) advisory services, and use of climate resilient technologies. With respect to the State/regional level CCPs, the experience has been that these plans do not provide sufficient details and thus it was thought appropriate to have such plans at the district level. So far, 320 district CCPs covering 14 States have been finalized by CRIDA, and work on 152 plans is in progress. Each plan presents the district agricultural profile (based on numerous parameters such as agro-climatic zone, rainfall, land use, soil, sown area, irrigation, crops, livestock, etc.), and explains strategies for weather-related contingencies. A weather forecast response and dissemination mechanism has been established through the integrated agro-met advisory service, which is operated by IMD in collaboration with ICAR and State agriculture universities. 130 agro-met field units have been set up in State agriculture universities to whom IMD supplies forecast information on a real time basis twice a week. At the unit level, weather forecast is translated into advisories suggesting farmers about the crop specific and animal specific management actions they are supposed

to take in view of the given rainfall or temperature scenario. A radio show time slot of four times a week, and print media columns are some of the initiatives for dissemination of information on weather forecast. During the Eleventh Plan period, when district level forecast-based agro-advisories were started, and IT based information dissemination system was put in place. There are now about 70 websites through which this information is being disseminated. Furthermore, about 3.3 million farmers are being reached through mobile phones. Short crunched SMS messages and one-minute voice messages are also being sent. The SMS message is repeated and voice message is given to about a million farmers. This work is being done with the help of various intermediaries like IFFCO Kisan Sanchar Limited, Thomson Reuters, and some companies. The companies have started selling their product to farmers for a price but now a proposal has been submitted to the government that the information should be provided free of cost. In the Twelfth Plan period, about 10 million farmers are being targeted to whom the information would be sent. To achieve this goal, other intermediaries including ITC, Nokia, who are willing to join hands, would be involved. Android-based applications wherein certain users can fetch the information from the source are also being developed. The government of India is also making seeds available of a variety of crops that can be planted late, and providing other inputs like fertilizers and machinery so that the farmers are able to plan short duration crops in case of further delay in monsoon. Besides this, the

empowered group of ministers has decided to enhance subsidy on seeds and give subsidy on diesel to the farmers of the drought affected areas. The group has also decided to extend help in the provision of drinking water and irrigation to the drought affected States. Even in the irrigated areas of Punjab and Haryana, farmers are being provided subsidy on diesel and extra power allocation for pumping groundwater to save their crops. In various parts of the country, there is evidence of different approaches being followed for drought management. Examples are conservation furrows and additional inter-culture in Ranga Reddy, sand application (after ploughing) to cultivated land for conserving moisture in Kurnool, application of sand mulch in Bijapur, in-situ moisture conservation leading to 25-40% yield benefit over farmers' traditional practice, rain water harvesting, trenching, agro-forestry and agri-horticulture for minimising impact of droughts, and crop diversification for higher profitability. Some factors are, however, responsible for poor drought management, such as poor recognition of drought, inaccuracy in monsoon prediction, delayed and inadequate action by administration, non availability of advisory information below district level, non-participative planning, poor implementation of drought relief measures, poor inter-departmental cooperation, etc. Moreover, there are numerous management problems with regard to contingency crop plans, availability of drinking water, employment and nutritional security, livestock management, and timely release of

relief funds. Two important areas of concern are described below in greater detail.

Forecasting of Monsoon

In India, it is possible to forecast weather for only up to 4 or 5 days, whereas in extra-tropical regions this can be done for up to 2 weeks. This is due to the intrinsic nature of atmospheric processes. As uncertainty is an integral part of weather and climate, the occurrence of monsoons has always been uncertain. To generate information about monsoon, data on various temporal ranges and special domains are needed on both real time bases, as well as in futuristic time and space. First, the initial condition (or the current status) needs to be defined through observing systems. In this task, difficulties are faced in generating data as there are vast gaps in observing systems around the globe. The oceans cover more than two-thirds of the earth's surface from where not much observation can be gathered. Data collection from mountain and desert regions is also hampered due to topographical constraints. Then, there are poor countries that cannot maintain the meteorological networks. Therefore, indirect methods of observing atmosphere such as satellite and radar based observing systems through remote sensing are used. Again, observing meteorological parameters through remote sensing techniques is not easy, and estimates of certain radioactive properties are derived and then translated into temperature, wind, etc. The current global model run at the IMD is of 30 km.

B. Monsoon and economy

Monsoon economy in India has got an undulating character. Economy that is struggling from the higher inflation now has to face the challenges of the drought. A year back, where the food production was at record level, this year will see agricultural output is plunging down to an alarming bottom. Food Inflation coupled with high energy cost will bring the growth to sub 6% level. In this kind of scenario, RBI has very little option and only hope is the Government proactive policy and initiatives.

IMD Declared Drought Monsoon below Normal: Cumulative rains during the first two months of India's crucial monsoon season (June - September) are 19 per cent below normal.

The country will end up with a deficient monsoon this year, the India Meteorological Department (IMD) confirmed on Thursday. Second half forecast is pointing to a deficient monsoon this year as a rainfall of anything less than 90% for the season is considered as deficient. Situation is expected be better than 2009, when the country faced one of the worst droughts in recent years with a rainfall deficiency of 22%. Average impact of last five droughts on growth of GDP: 2.10 Per cent Agriculture; GDP: 5 percent Industry; GDP: 4. 30 per cent services and, GDP: 5. 80 per cent India. India has already had five severe droughts in the past 40 years. The worst were in 1972 and 2009 , when the nationwide rainfall deficits were 24 per cent and 23 per cent respectively. Rainfall was 19% below normal during the droughts of 1979, 1987 and 2002. Average impact of last 5 droughts

on production, food Production 10.30 per cent, Kharif Production 13.40% rabi output 6.70 per cent. (deleted part)

Auto Sector: Two wheeler sales for July were badly hit with Bajaj Auto sales down 5% at 3.44 lakh units. Similarly Hero Moto saw a 1.4% dip in total sales while TVS Motor saw a 12% fall in domestic sales. Despite a lockout at its Manesar plant, Maruti saw sales rise by 9% at 82,234 units as compared to July 2011, due to the higher inventory it was carrying. Given the poor monsoon, purchasing power could go down especially in the rural areas, which could bring down sales.

Rural sales constitute almost 30% of total auto sales. The rural market(% of total passenger car sales) Maruti 28%Hyundai 30%Tata Motors – 45%M&M 30%The rural market(% of total 2wheelerssales) Hero Moto – 46%Bajaj Auto – 40%Honda 35%TextileThe rising trend in cotton prices is expected to continue in the September 2012March2013 cotton season, as a result of fall in acreage and delayed monsoon, rating agency Fitch said in its 2012 midyear outlook on Indian textiles. The Indian textiles are grappling with weak demand and thin margins, Fitch said. It also expects a prolonged demand slowdown to subdue capacity utilization levels and revenue growth prospects.

FMCGA weak monsoon is one such challenge. A poor monsoon impacts consumer companies in two ways, a demand squeeze, especially in rural areas, and high input cost inflation. The impact could be significant on these companies' financials, as well as stock

prices. Notably, the impact of poor monsoons is visible in the financials with a lag effect. Hence, while the full impact of a weak monsoon will be visible in the March 2013 quarter, the quarter ending December 2012.

Rural sales, which form 40-50 per cent of most FMCG companies' sales, could be hit due to the reduced purchasing power of customers. Analysts believe the volume growth in these areas could come down to eight to 10 per cent from the 11-13 per cent prevailing. A look at the historical data suggests FMCG stocks have largely under performed in years of poor monsoon. PSU Banks The Government has asked the public sector banks to gear up their branches to support farmers in the rain deficit areas. Bankers are already facing the heat on advances to the farm sector. Deteriorating asset quality and rising NPA will further worsen by the increase in lending the drought hit farm sector.

Action in due course by RBI & Policy makers RBI Reaction Policy rates to remain on hold in 2012 with 50bp rate cuts in 1H 2013. If food prices rise as they did in 2009, then we think the RBI would be forced to stay put throughout this fiscal year, as inflation shoots significantly above its target. Government Response Fiscal, administrative and trade policy tools are usually the first line of defense in tackling a drought like situation. Authorities may monitor local shortages more strictly and crack down on hoarding, since the gap between wholesale and retail prices remains very wide. The

government can also reduce import duties and ban exports, impose stock limits on commodity traders, and impose margins on, or ban, futures trading if prices rise too sharply. Most Indian crops require abundant, at least sufficient, supply of water. Where there are no irrigation works, the agriculturist gets his water supply entirely from the monsoon.

In South India, most of the rivers are rain-fed. Thus, the irrigation canals in Peninsular India get their water indirectly from the monsoons. Hence, the importance of the monsoons to India can easily be imagined. The crops grown in different regions of India and the methods of agriculture pursued are governed by the amount of rainfall secured by them respectively. Indian economy is largely determined not by the will of man but by the favors and frowns of Nature. This has introduced an element of uncertainty into the Indian economic life. If the monsoon fails over a wide area, then the result will be famine. The famine problem is largely the consequence of the vagaries of the monsoon.

As the incomes of the agriculturists fall, their capacity to buy the goods and services of other classes of people is diminished. Lawyers, doctors, and even teachers had their incomes reduced. Products of industry do not have a ready market. The supply of raw materials to industry also suffers. As many agricultural commodities are prominently in our export trade, a failure of the monsoon affects unfavourably the volume and the balance of India's foreign trade. Due to the fall in the national income, the revenues of the

Government undergo a sharp decline and the Government may, in addition, be faced with extraordinary expenditure because of famine relief. Hence, so great is the dependence of Government revenues on the monsoons. The excessive dependence on India on the caprices of the monsoons may be mitigated by the construction of modern irrigation canals, flood control, afforestation, and diversification of Indian industries.

C. Impact of monsoon in livelihood

India's monsoon hit the Southern Indian state of Kerala on Friday, June 5, four days later than expected. With monsoon rains comes relief from India's strong heat wave, which began in May.

The Indian Institute of Tropical Meteorology predicts that the monsoon will spread across most of India by the end of June. Rains are expected to reach the country's West coast by June 17 and central India by June 25.

The India Meteorological Department predicts that the monsoon will be weaker than usual, bringing less than 90 per cent of typical monsoon rain fall. It is estimated that crop planting in India has gone down by 9% since last year. This is due to weak monsoon rains, which not only lead to low crop production, but to high food prices. The crops most affected are grain and cotton. In response, the Indian government has taken several steps to boost agricultural production. The India Meteorological Department has begun to send mobile weather alerts to farmers, and public officials have been promoting the cultivation of more drought-resistant crops. Minister of

Agriculture explained, "Growing vegetables and fruits would be our priority. This will give farmers something for daily survival, without too much investment, along with the main crops ahead of the kharif season. "

The agricultural sector employs more Indian citizens than any other sector of the economy. This means that a below-average monsoon could have a significant effect on the Indian economy, as a whole. The ICICI Bank of India estimates that weak rains will cause a drop in India's GDP growth for this fiscal year, from the originally estimated growth rate of 7.8% to 7.3%. But even during a relatively dry year, monsoon rains have the potential to negatively impact other sectors of the Indian economy, as well. Heavy rains put crucial infrastructure at risk throughout India, and are particularly threatening to burgeoning industrial cities such as Bangalore, home to 30% of India's start-up companies. With heavy rains come blackouts and losses in internet connectivity. While larger corporations can afford more reliable internet connections, smaller companies often depend on unreliable nationwide internet service providers or local cable networks. Weakened infrastructure has also led to sanitation problems in many parts of India, particularly in poorer parts of the country's largest cities. Although overall water contamination levels have gone down in the past decade, contamination usually rises significantly during monsoon season.

Rising underground water levels during the monsoon season affect outdated underground sewages systems and leaking pipes,

leading to abnormally high levels of E-Coli and other bacteria. These bacteria cause diarrheal disease and various water-borne illnesses.

Vector-borne diseases such as malaria and dengue are also particularly prominent during monsoon season. To avoid exposure to contaminants, Indians are encouraged by health to take precautionary measures such as boiling all drinking water and only eating foods stored inside.

Monsoon has a very strong and certain effect on Indian livelihood. Effects of monsoon are in various phases of life, that are-

- ***Flood and drought.*** Flood and drought are natural calamities, these create a very devastating effect on the overall livelihood of the people. Because regions with a monsoon climate have distinctly wet and dry seasons, they are prone to floods and droughts, both of which are hazardous to health. During summer monsoons, heavy rainfall can cause flooding. Powerful floodwaters can drown victims and damage buildings, leaving people without homes and vulnerable to the elements. During the 2014 summer monsoon in Pakistan and India, nearly 300 people lost their lives during landslides and home collapses.
- ***Deadly diseases:*** The main health hazards during summer monsoon season are diseases like cholera, dengue, chikungunya and malaria, as well as stomach and eye infections. Each year, as the summer monsoon season

approaches, Indian hospitals prepare for high numbers of patients with these illnesses.

- **Threats of famine:** A long term dry spell can create acute shortage of water for agriculture and this may sometimes lead to shortage of food grains and ultimately leads to famine.
- **Impact on people particularly on women:** A latest study says climate change induced disasters had left negative impacts on psychology and behaviour of people, in particular women, who bore the major brunt of various disasters that struck Sindh in recent years. "There is evidence that shows inter linkages between climate change, health and sexual and reproductive health and rights (SRHR)," says the study titled 'Understanding climate change, impact on women's reproductive health: Post disaster interventions in Sindh'. The study was carried out by the Sindh Community Foundation and Asian-Pacific Resource and Research Centre for Women (ARROW).

Farmers in monsoon regions rely on the wet summer months to grow crops. However the summer monsoon does not always bring the same amount of rainfall, and variations in rain have implications for agriculture and the economy. For example, in 2009 very little rain fell during the summer monsoon in India. In some areas rainfall was half of what is typical during the wet season and farmers could not plant their crops. Farm animals starved; many were sold for a fraction of what they would have normally been worth because farmers were

desperate. From wheat and rice to vegetables, cotton, and tea, Indian farmers grow a wide range of crops and the country uses more land for crops than any other country in the world (215 million acres). Crops depend on rain and, in India, more than three quarters of the annual rainfall occurs during the four months of the summer monsoon season. But during years when there is less rainfall than usual, crops die in the fields or cannot be planted at all. Take a look at the graphs to the left to see how the amount of grain crops produced by farmers in India (including wheat, rice, and barley) relates to the amount of rainfall. Over half of India's population works in agriculture, and monsoon rains directly affect their incomes and livelihood. Agriculture adds up to more than 15% of India's Gross Domestic Product (GDP), which means that when crops fail because of too little rain, the economy suffers. While too little rainfall during the summer monsoon can cause dire conditions for farmers on land, too much rainfall and overly strong winds can make coastal waters unsafe, preventing fishermen throughout South Asia from heading to sea to catch the fish they depend on for income. Monsoon rains can be harnessed as hydropower, a valuable energy resource. Hydropower currently provides 25% of India's electricity. Reservoirs are filled during the summer monsoon rains and then the water is gradually released through dams, turning turbines to create electricity year-round. During years when there is little monsoon rainfall, the reservoirs are not replenished, limiting the amount of hydroelectric power produced in the year.

Monsoons and health:**Deleted part.....**

During summer monsoons, heavy rainfall can cause flooding. Powerful flood waters can drown victims and damage buildings, leaving people without homes and vulnerable to the elements. During the 2014 summer monsoon in Pakistan and India, nearly 300 people lost their lives during landslides and home collapses.

Australia's 2011 monsoon flooding caused about \$4.5 billion in damage. Yet the main health hazards during summer monsoon season are diseases like cholera, dengue, chikungunya, and malaria, as well as stomach and eye infections. Each year, as the summer monsoon season approaches, Indian hospitals prepare for high numbers of patients with these illnesses. When floods cause water purification systems to become compromised, diseases like cholera can spread through unclean drinking water. Also, mosquitoes that carry disease breed in open containers that fill with rainwater – from large water barrels and ponds to small coconut shells. Mosquitoes that spread malaria, dengue, and chikungunya are common in the tropics. Because mosquitoes have more places to breed during the summer monsoon rains, there are more mosquitoes. That leads to more mosquito bites that spread disease. During the winter, clouds rarely provide shade and the dry land surface can't cool off by evaporation, so heat waves are common. At least 2500 people died in a major heat wave that swept across India in 2015, and over 1000 died about a month later from a heat wave in Pakistan. Temperatures

in New Delhi were near 120°F(almost 50°C). Water is scarce at this time of year, which causes water-washed diseases to become common; these diseases spread when there is too little water for proper hygiene. Meningitis, which kills one in ten victims, spreads during the dry season in sub-Saharan Africa when desert dust becomes airborne and is inhaled. Typically the number of cases drops with the first monsoon rains. The number of people affected by both the wet and dry monsoon seasons depends on the population of the affected region. For example, Mali in West Africa has a fast-growing population and researchers are investigating how people will cope with the same limited water resources during the dry season as the country's population grows.

D. Impact of monsoon on Indian culture:

The Harappans may be the most advanced ancient civilization that most Westerners have never heard of. They flourished in the Indus River basin on the Indian subcontinent around the same time the Egyptians were building the pyramids along the Nile and the Mesopotamians were digging irrigation channels fed by the Tigris and the Euphrates.

Till now monsoon has a great impact on the overall cultural lives of the communities. It is a common belief in rural people that if the first rain of the monsoon season well wet the crops, then the years' production would be good. After the monsoon comes Autumn. The clean blue sky with clouds like fuzzy cotton brings a happy and

rejoicing feeling to the people and they make themselves ready for festivals (viz. Durgapuja, Navaratri, Dewali etc.).

India is the land of festivals, every next day there will be festival somewhere across the country. As the monsoon arrives in India in June, it's a best month to enjoy the wet weather and monsoon festival in India. Generally the monsoon festivals fall during the holy month of Shravan, during this there are plenty of fairs and festivals that celebrated with dancing, singing and feasting welcome the rains. India's festivals celebrate not only gods and goddesses but also wind, rain, fire, trees and animals known as holy animals. There are numerous traditional fast and festivals celebrated during the wet season, some of them are Ganga Dussehra, RathYatras, Kanwarias, Janmashtami, Barsha Mongol Ramadan and Splash fairs are one of the most important part of all monsoon festivals.

Teej: The HaritalikaTeej is a fasting festival for Hindu married women, celebrated during the monsoon. This festival is dedicated to the Goddess Parvati, commemorating her reunion with Lord Shiva. The most important festival of monsoon is most widely celebrated across various parts of India, traditional songs and dancing are the unique features of Teej celebrations. Teej is a very popular festival of India and all women in India celebrate this festival with great enthusiasm and joy.

Ten major festivals of monsoon

Nag Panchami: The festival of snakes, celebrated on the fifth day of the moonlit-fortnight in the month of Shravan. It very important

Hindu festival, people worship the snake and offer milk to honor the snakes " The Indian Cobra". The sacred Hindu festival dedicated to snake god to protect them from all evils. People worship the snake idols and in some extreme form of worship people feed milk to live cobras as well.

Onam: Onam is the largest festival in the "God's Own Country" of Kerala, celebrated with fun and fervor by Malayalees across India. The harvest festival of Onam is celebrated with ten days of feasting, snake boat races, song, dance and merriment. The 10 days are part of the traditional Onam celebrations and each day has its own importance in various rituals and traditions. During the foremost cultural festival of the Kerala, flower arrangement and amazing designs are one of major attentions.



Source- Internet

Raksha Bandhan: The most famous Indian festival, Raksha Bandhan is celebrated in the month of Sravan. The day symbolizes love, affection and a feeling of brothers and sisters, The significance

of Rakhi is the bond of protection or promise of protection. Sisters apply tilak to the forehead of their brothers, tie the Rakhi to the wrist and do arati and pray for their good health & long life.

Nariyal Purnima: The Coconut Day festival or Narali Purnima is celebrated mostly by the fishing community in Maharashtra and other coastal areas. The festivals shows the true culture and traditions of Maharashtra and fishermen called as Koli. It is celebrated on the same day of RakshaBandhan festival in western state at the end of monsoon season.

Adiperukku: The great and unique festival of Tamil which is known as Adi Perukku celebrated during mid july-August by women. The festival pays tribute to water's life-sustaining properties, celebrated near river basins, water tanks, lakes and wells. The monsoon festival of south India falls on the 18th day of tamil month of Aadi and celebrated in a grand manner.



source-Internet

Hemis Festival: The hemis festival is celebrated in the famous monastery of Ladakh in the state of Jammu and Kashmir. The five day Hemis Festival is held every year in the Hemis Monastery, the biggest Buddhist monastery of Ladakh. The festival and fair offers a colorful and wide variety of exquisite works of art, culture and a spectacular view of snow-clad Himalayan beauty.



Source -Internet

Hareli: The tribal states of India, Chhattisgarh celebrate Hareli festival to pray for a good harvest. This is an important harvest festival celebrated in Chhattisgarh and some part of Madhya Pradesh during the holy month of sawan. In this festival farmers worship cow, bullocks and farm equipments, bull race at some part attracts a major crowd. Raja Parva is also a monsoon festival celebrated by women in the state of Orissa.



Source- Internet

Behdienkhlam: The annual Behdienkhlam is one of the prime festival of Meghalaya, celebrated during the monsoon season in the month of July at Jaintia Hills. This is the festival of tribal Pnar people, Young men make a symbolic gesture of driving away of the evil spirit and dancing in the muddy pool of water is main attraction. There are other monsoon festivals also celebrated at north east India such as Nongkrem Dance, Reh Festival, Cheiraoba festival.



Source-Internet



Source-Internet

Effect of monsoon on income and employment:

Monsoon rain is considered as life blood of Indian agriculture. It is like a both side serrated knife, if the monsoon comes timely and occurs in a sufficient amount then the farms would flourish, but if the

rainfall is erratic or either so high or so low than the normal, then it is very bad for the farms and for the concern farmers. Untimely or abnormal amount of rainfall creates a very devastating impact on the income of the rural community. If they can't harvest adequate profit then it is very hard for them to fulfill their family needs or to repay the loan that they have taken to carry on the farming activities.

Monsoon not only affects farm income, but also has a huge impact on the employment of the landless laborers. If the overall farming activity is at a standstill then there will be no need of agricultural laborers. Subsequently the persons who are engaged with jobs like food processing, food storing or warehousing, would also lose their source of income.

EFFECTS OF MONSOON ON OCCUPATIONAL MIGRATION

Occupational migration is a very alarming problem of today. The rural landless poor people, who earn their wages by working in other people's field, are become temporarily jobless in off-seasons or in flood or drought conditions. This large number of mass then move into the nearby cities or towns for earning, This creates an extra pressure in the city- life when it has to accommodate a large number of people. So, there comes the road resident problem. Without having a suitable occupation, many of them engaged in begging, stealing or with some other immoral and unsocial activities. The over populated cities or towns then fail to give it's residents an appropriate environment in which they can live a happy and secure life.