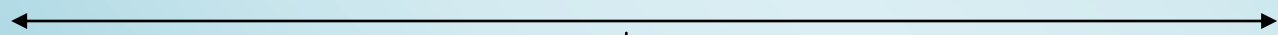


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## IMPACT OF CLIMATE CHANGE ON RURAL DEVELOPMENT OF INDIA

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### **ABSTRACT:**

*Climate change is a very important, extensive and intensive global environmental problem. It has the number of evil consequences on the economic development along with the different productive sectors and economic development activities in the economy. The note worthy feature is that it is being a global problem all the countries of the World have to bear with the evil consequences and negative impacts on their economic and development, irrespective of their contribution to the climate change. This poses the urgent need for studying the economic impact of the climate change. Besides this, the developing economies are dominated by the rural economy in general and agriculture economic activity in particular. Hence the studying of impact of climate change on rural economy coupled with agriculture is of pivotal importance. India is a very well known country in the world on various grounds. There is misunderstanding in the world that India is like that of China is also a prominent contributor to the problem of climate change. It is being a developing country, which is dominated by the rural economy and agriculture. Hence it is of very much importance to study the impact of the climate change on rural development of India along with its agriculture. It is against this overall background, the present paper intends to examine the impact of the climate change on the rural development of India, in which rural development is of crucial significance. No more such studies found with reference to India in general and its rural development in particular. Hence it is of crucial importance to take up a study on the impact of climate change on the rural development of India. The present study endeavours to examine the impact of climate change on the rural development of India for the latest study period from 2006 to 2013. The prime objective of the present study is assessing the impact of climate change on the rural development of India within the framework of indicators given by the IPCC. Besides this, the study has an objective of analysing the present state of climate change with emphasis on India, and to examine the prominent contributor to the global warming and consequently climate change. The present study concludes that even though India is not a dominant contributor to the global warming and climate change, it is significant sufferer of the climate change especially in the form of rural development and consequently the overall development of the economy as a whole, because it is the development of agriculture in particular and rural area in general is the overall and all round development of the Indian economy, which requires country as well as global level efforts.*

**Key Words:** Green House Gases, Carbon dioxide, Global Warming, Climate Change, Rural Development, Agriculture, Agricultural Productivity, Employment, Water Stress.

**JEL Classification:** Q1, Q2, Q4, Q54,

## I) INTRODUCTION:

Climate change is a very important, extensive and intensive global environmental problem. It has the number of evil consequences on the economic development along with the different productive sectors and economic development activities in the economy. The note worthy feature is that it is being a global problem all the countries of the World have to bear with the evil consequences and negative impacts on their economic and development, irrespective of their contribution to the climate change. This poses the urgent need for studying the economic impact of the climate change. Besides this, the developing economies are dominated by the rural economy in general and agriculture economic activity in particular. Hence the studying of impact of climate change on rural economy coupled with agriculture is of pivotal importance. India is a very well known country in the world on various grounds. There is misunderstanding in the world that India is like that of China is also a prominent contributor to the problem of climate change. It is being a developing country, which is dominated by the rural economy and agriculture. Hence it is of very much importance to study the impact of the climate change on rural development of India along with its agriculture. It is against this overall background, the present paper intends to examine the impact of the climate change on the rural development of India, in which rural development is of crucial significance.

## II) REVIEW OF RESEARCH STUDIES:

Some of the important research studies relating to the present topic of the research are reviewed as follows. Kim Chang (2010) in his study says, according to the fourth report of UN IPCC (2007) on climate change, it is indisputable that global warming has serious impacts on the earth and it is very likely that the increase in greenhouse gas emission by anthropogenic activities has caused global warming since the mid-20th century. According to the author, it is necessary to understand that the countermeasures for the agricultural sector against climate change are to minimize the risks of climate change and utilize it as an opportunity. For this, proper education and training programs for agriculture workers, public officials and the personnel from the related agencies should be developed and put into practice so that they can properly cope with climate change. Dubey and Phiri (2013) in their study argue that the reality of climate change is now a well-accepted reality and there is emerging evidence that climate change poses a massive threat for development especially in poor countries. The findings of the study were that the effects of climate change on livelihoods in the study area are alarming. Climate change has altered the physical geography of the area leading to a disappearance of flora and fauna and other natural habitat that constituted the livelihoods of the local people. Declining precipitation and rising temperatures are making farming increasingly more difficult, and thus aggravating food insecurity in the area. Urgent climate change programming steps must be taken to prevent a livelihoods catastrophe in semi arid regions in sub-Saharan Africa. Sadashivam, T (2010) in his study views that climate change is a global and regional environmental problem faced by humanity with strong implications for rural populations. For developing countries like India, the aim of achieving 9% or double digit G.D.P growth, will not take place without achieving 4% growth in agriculture on a sustainable basis over the medium term. For that, we need to take into account the effect of climate change on rural areas, particularly on agriculture, which can promote inclusive growth, enhancing rural income and sustain food security. Also, it is our moral responsibility to our children and future generation to

provide them with a world which is clean and safe to live in. Now the time has come to follow the values and lessons provided by our long tradition and teach the world community about ecologically sustainable development. Kumar and Sharma (2013) analyze the impact of climate change on agricultural productivity in quantity terms, value of production in monetary terms and food security in India. Climate variation affects food grain and non-food grain productivity and both these factors along with other socioeconomic and government policy variables affect food security. Regression results for models proposed in this study show that for most of the food grain crops, non-food grain crops in quantity produced per unit of land and in terms of value of production climate variation cause negative impact. The adverse impact of climate change on the value of agricultural production and food grains indicates food security threat to small and marginal farming households. Dev Mahendra S. (2011) in his study says climate change is a major challenge for agriculture, food security and rural livelihoods for billions of people including the poor in the Asia-Pacific region. Agriculture is the sector most vulnerable to climate change due to its high dependence on climate and weather and because people involved in agriculture tend to be poorer compared with urban residents. More than 60 per cent of the population is directly or indirectly relying on agriculture as a source of livelihood in this region. The climate change is already making adverse impact on the lives of the population particularly the poor. The study examines the impact of climate change on rural livelihoods, agriculture, and food security. It discusses the options for adaptation and mitigation and requirements for implementation at local, national and international level of these measures.

The foregoing review of the research studies concerning the present topic of the paper reveals that no doubt, there are some studies relating to the economic impact of climate change in general, and impact on agriculture in particular. No more such studies found with reference to India in general and its rural development in particular. Hence it is of crucial importance to take up a study on the impact of climate change on the rural development of India.

### III) RESEARCH METHODOLOGY:

The present study endeavours to examine the impact of climate change on the rural development of India for the latest study period from 2006 to 2013. The prime objective of the present study is assessing the impact of climate change on the rural development of India within the framework of indicators given by the IPCC. Besides this, the study has an objective of analysing the present state of climate change with emphasis on India, and to examine the prominent contributor to the global warming and consequently climate change. The study exclusively relies on the secondary data, which has been collected from the sources such as Government of India Economic Survey, Inter Governmental Panel on Climate Change (IPCC) (2014). Fifth Assessment Report (AR5), Chapter IX; Rural Areas — Government of India (2014). Annual Climate Summary, Ministry of Earth Sciences, National Climate Centre, India Metrological Department, Pune, UNICEF (2013). Water in India: Situation and Prospects, UNICEF, India Country Office 73 Lodi Estate New Delhi 110 003 India, etc. For the supporting the results and analysis the help of the previous research studies is taken. The collected secondary data has been classified and tabulated in the light of objectives and parameters or indicators of the study and has been analysed by employing suitable statistical tools like Compound Growth Rate (CGR), Change over the period, percentage share, and others. The graphical presentation of the trends in some of the important variables taken into consideration is also

given. The important indicators which this study uses for assessing the impact of climate change on rural development on India are; trends in agricultural production and productivity, livestock, forestry, fishing, trends in employment nature and growth in rural areas, water accessibility and stress in the context of rural economy of India.

#### IV) PRESENT STATUS OF CLIMATE CHANGE:

Before examining the impact of climate change on the rural development of India, it is crucial to get familiar with the present status of climate change. The Intergovernmental Panel on Climate Change (IPCC) reviews and assesses the most recent scientific, technical, and socio-economic information produced worldwide relevant to climate change. The IPCC in its recent report— Fifth Assessment Report (AR5)—published in 2014 has observed that there has been an increasing trend in the anthropogenic emissions of greenhouse gases (GHG) since the advent of the industrial revolution, with about half of the anthropogenic CO<sub>2</sub> emissions during this period occurring in the last forty years. The period 1983- 2012 is likely to have been the warmest thirty year period of the last 1400 years. CO<sub>2</sub> emissions from fossil fuel combustion and industrial processes have contributed a major portion of total GHG emissions during the period 1970 - 2010. The change in the climate system is likely to have adverse impact on the economy, livelihoods, cropping pattern, and food security. According to the various projections by the IPCC, extreme heat events are likely to be longer and more intense in addition to changes in precipitation patterns. The change in climate could affect the production of wheat, rice, and maize in the tropical and temperate zones; have negative impact on health by exacerbating health problems that already exist especially in developing countries; and adversely impact productive activities like growing food and working outdoors (Govt. of India, 2014-15, p120).

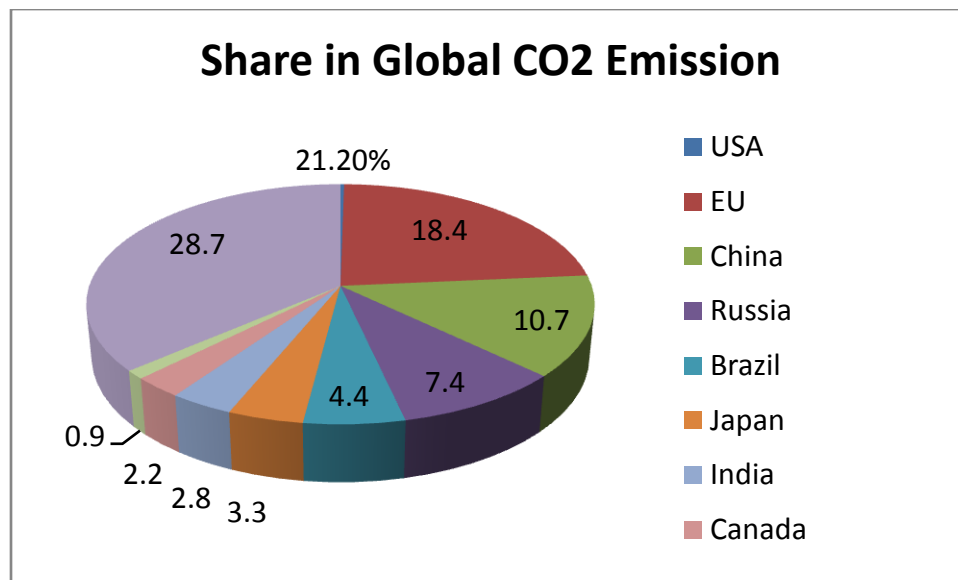
The ecological overshoot problem, i.e. the ecological footprint being larger than the bio capacity of the population, is an important issue in the global climate discourse. The ‘overshoot’ can also be understood in terms of the carbon budget. The risk of climate change is largely a function of total cumulative GHGs in the atmosphere. IPCC AR5 has estimated that for temperature increase to remain below 2°C of pre-industrial levels the world can emit only about 2,900 Giga tonnes (Gt) of CO<sub>2</sub> from all sources from the industrial revolution till 2100. Till 2011, the world has emitted 1,900 Gt of CO<sub>2</sub>, thus already consuming around two-thirds of this budget. This means that out of the budget of 2,900 Gt, only 1,000 Gt remains to be used between now and 2100. The World Resources Institute estimates that if emissions continue unabated, the remaining budget will last only 30 more years (Govt. of India, 2014-15, p121).

It is a well known fact that global warming is a global environmental problem and climate change is its effect. Hence it is of crucial importance to study the major contributors to the problem of global warming and consequently climate change. It is the green house gases, which are responsible for the global warming, but the prominent is carbon dioxide exclusively. The contributions of different countries to the global carbon dioxide are presented below.

**Table 1: Contribution of Different Countries to Global CO2 Emission**

Sr. No.	Country	Share in Global CO2 Emission
1	USA	21.2%
2	EU	18.4
3	China	10.7
4	Russia	7.4
5	Brazil	4.4
6	Japan	3.3
7	India	2.8
8	Canada	2.2
9	South Africa	0.9
10	Rest of the World	28.7

*Source:* Centre for Science and Environment and IPCC AR5.



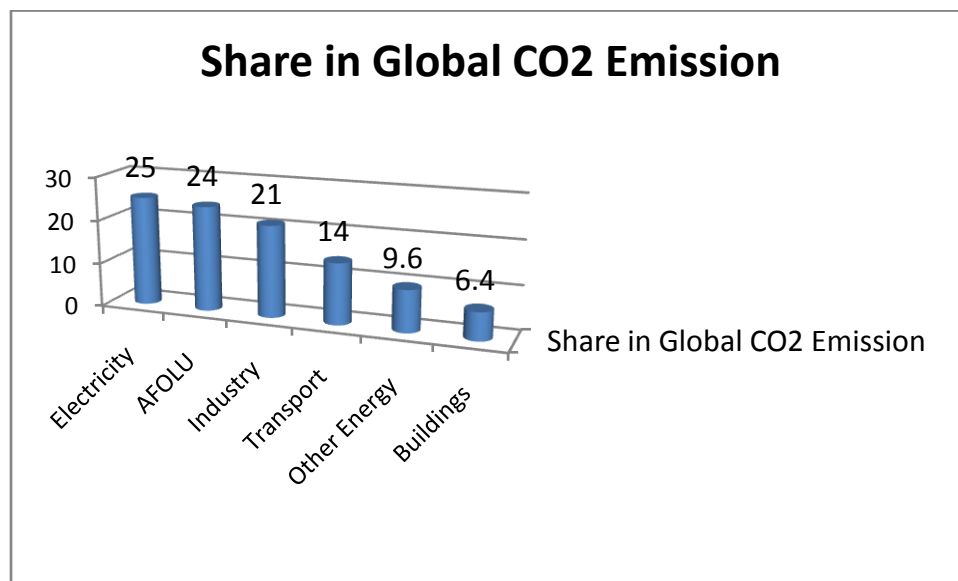
It is adequately clear that the USA is a major contributor to the global carbon dioxide emission in the World, which is followed by the countries like China, Russia, Brazil, etc. The share of India in the global carbon dioxide emission is marginal only, which stood at just 2.8% after Japan. The noteworthy thing is the contribution of the China to the global carbon dioxide is , no doubt, significant one, but as usual the USA is ahead in the World.

The desire of the countries of the World especially the developed countries to achieve the rapid and all round economic development through the development of the economic development activities and productive sectors is responsible for the emissions of the carbon dioxide in the World. Hence it is of crucial significance to study the sectoral distribution of the global co2 emissions.

**Table 2 : Sectoral Distribution of Global CO2 Emission (2010) (%)**

Sr. No.	Productive Sector	Share in Global CO2 Emission
1	Electricity & Heat Production	25
2	AFOLU	24
3	Industry	21
4	Transport	14
5	Other Energy	9.6
6	Buildings	6.4

Source: IPCC, AR5.



It is very much clear that, there a few economic development activities that are responsible for more emissions of carbon dioxide in the World economy. The prominent is electricity and heat production, which is followed by AFOLU, Industry and transport. Thus it is the energy sector a very dominant productive sector responsible for global warming and consequently climate change.

**PRESENT STATE OF CLIMATE IN INDIA:**

**Temperature:** Spatial pattern of annual mean, maximum and minimum temperature anomalies for 2014 reveals that anomaly in the maximum, minimum and mean temperature over most parts of the country was generally 0 in range of +1.0 C. However, parts of Himachal Pradesh, Jammu & Kashmir, Nagaland, Mizoram, Manipur & Tripura and Andaman & Nicobar Islands were warmer than the normal by more than 1 C. The annual mean temperature for the country as a whole during 2014 was +0.53 C above the 1961-1990 average, thus making



the year 2014 as the fifth warmest year on record since 1901. The other 9 warmest years on record in order are: 2009 (0.77), 2010 (0.75), 2003(0.61), 2002(0.59), 1998(0.49), 2012(0.48), 2006(0.43), 2007(0.41) and 1987(0.40). It may be mentioned that 7 out of the 10 warmest years in India were during the recent past decade (2001-2010) making it the warmest decade on record with decadal mean temperature anomaly of 0.49 C. Time series and trend in mean temperature shows the mean temperature for the monsoon season (with anomaly +0.77 C above average) this year was the highest since 1901, thus making it the warmest monsoon season. The other 5 warmest monsoon years on record in order are 2009(0.75), 1987(0.74), 0 2003(0.59), 1998(0.56) and 1995(0.54). Also, the June month this year (with anomaly +1.34 C above average) was the warmest since 1901 while July (+0.79 C) was third warmest and August (+0.70 C) was second warmest. Spatial pattern of trend in mean annual temperature anomalies suggests significant positive (increasing) trend over most parts of the country except some parts of Rajasthan, Gujarat and Bihar, where significant negative (decreasing) trend was observed. Regions with significant temperature anomaly (> or < + 2 C) during each concerned month are discussed below (Govt. of India, 2014, p1).

**Rainfall:** Rainfall activity over the country as a whole was below normal (88 % of LPA) during the year. Out of 36 meteorological subdivisions, 25 received normal rainfall and remaining 11 subdivisions received deficient rainfall. At the end of year, of the four homogeneous regions, central India and south peninsular India received normal rainfall (92% and 94 % of its LPA respectively), while Northwest India and East & Northeast India received below normal rainfall (86% and 82 % of its LPA respectively). The Standardized Precipitation Index (SPI) is an index used for and is based on precipitation. This index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. Cumulative SPI 2014 values of the year indicate, extremely wet/severely wet conditions over parts of Odisha, Bihar, Jammu & Kashmir, West Madhya Pradesh, Tamil Nadu and North & South Interior Karnataka while extremely dry/severely dry conditions were observed over parts of Arunachal Pradesh, Assam & Meghalaya, NMMT, Sub-Himalayan West Bengal & Sikkim, Jharkhand, Bihar, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Punjab, Jammu & Kashmir, East Madhya Pradesh, Gujarat Region, Marathwada, Chattisgarh and Andhra Pradesh state(Govt. of India, 2014, pp5-6).

**Tropical Storms / Depressions in the Indian Seas:** During 2014, three cyclonic storms/severe cyclonic storms formed over the north Indian seas. (One each in June and October over the Arabian sea and one over the Bay of Bengal in October). The very Severe Cyclonic Storm HUDHUD which formed over the Bay of in the month of October was the strongest storm of the year 2014. It crossed the Andhra Pradesh coast causing heavy rainfall and widespread damage to crops and property in Andhra Pradesh and Odisha. The other two cyclonic storms (NANAUK in the month of June and Very severe cyclonic storm NILOFAR in the month of October) which formed over the Arabian sea, dissipated insitu over the sea itself without making landfall. During the monsoon season, two depressions, one each during July and August, formed over the north Indian seas as against the normal frequency of four. These two depressions formed over the north/northwest Bay of Bengal, persisted for two/three days and moved westwards across central parts of the country. However, apart from the cyclonic storm and two depressions, as many as 10 low pressure areas were formed during the monsoon season. Of these, 8 formed over the Bay of Bengal (1 in June, 3 in July and 2 each in August and September), 2 over the Arabian Sea (1 each in August and September). The low pressure areas which formed over the Bay of Bengal were generally

active for four to five days and had a predominantly westerly / northwesterly movement. The three depressions and the low pressure areas caused good rainfall over the central and adjoining northern and peninsular parts of the country (Govt. of India, 2014, p5).

**Significant Weather Events:** Severe cold wave/ cold day/dense foggy conditions prevailed over the plains of northern India during January and December. Cold wave/fog related incidents claimed over 200 lives from northern parts of the country with over 140 lives from Uttar Pradesh alone during December. Similarly, there were intense heat wave events which prevailed over northeastern, central and peninsular parts of the country during May and June. These events took a toll of over 600 lives with near 450 lives from Andhra Pradesh alone. The most devastating event of the year was the floods in Jammu & Kashmir which were the worst in last six decades occurring during the second week of September. It claimed over 200 lives and left more than 4 lakh people stranded for many days besides causing widespread damage to the property and crops. A severe landslide on 5 August (due to heavy rains) completely buried a village 'Malin' (Dist. Pune, Maharashtra). Around 150 people lost their lives in the landslide. Severe floods in Assam during the last two weeks of September claimed over 60 lives. Around one million people were affected due to the flood. There was widespread damage to crops and property during the flood. Odisha received unusually heavy rains during 3 to 5 August, due to a deep depression which caused vigorous monsoon conditions. Many stations of the state received very heavy rainfall during the period. Some stations of Odisha, viz., Sambhalpur received 82 cm of cumulative rainfall during the 72 hours ending on 5 August (3-5August). Similarly, Dhenkanal reported 83.7 cm of rainfall during the 72 hrs. period. These were all time high rainfall events for the 72 hrs. This rain affected two million people of the state and damaged crops, houses and other infrastructures. About 45 people died in these rains. Unprecedented widespread hailstorm activities in 28 of 35 districts of Maharashtra and adjoining central parts of India in the first week of March severely affected crops over 20 lakh hectares. Thousands of livestock, animals and birds succumbed to the injuries and deaths. There were about 30 human deaths and economic loss estimated worth more than 20 billion (Govt. of India, 2014, p7).

## V) IMPACT OF CLIMATE CHANGE ON RURAL DEVELOPEMNT OF INDIA:

Rural areas are a spatial category, associated with certain patterns of human activity, but with those associations being subject to continuous change. Rural areas are largely defined in contradistinction to urban areas, but that distinction is increasingly seen as problematic. Rural populations have, and will have, a variety of income sources and occupations, within which agriculture and the exploitation of natural resources have privileged, but not necessarily predominant, positions. "Rural" refers generally to areas of open country and small settlements.

The distinctive characteristics of rural areas make them uniquely vulnerable to the impacts of climate change because: Greater dependence on agriculture and natural resources makes them highly sensitive to climate variability, extreme climate events, and climate change. Existing vulnerabilities caused by poverty, lower levels of education, isolation, and neglect by policymakers can all aggravate climate change impacts in many ways (IPCC, 2014, p618).

Documentation of observed impacts of climate change on rural areas involves major questions of detection and attribution. Whilst having potential, there are complications with using traditional knowledge and farmer perceptions to detect climate trends (Rao et al., 2011; in IPCC 2014). The impacts of climate change on patterns of settlement, livelihoods, and incomes in rural areas will be the result of multi-step causal chains of impact. Typically, those chains will be of two sorts. One sort will involve extreme events, such as floods and storms, as they impact on rural infrastructure and cause direct loss of life. The other sort will involve impacts on agriculture or on ecosystems on which rural people depend. These impacts may themselves stem from extreme events, from changing patterns of extremes due to climate change, or from changes in mean conditions. Seneviratne et al. (2012) give a detailed and critical assessment of the detection and attribution of observed patterns of extreme events, which shows greatly varying levels of confidence in the attribution to climate change of global and regional trends, and that “attribution of single extreme events to anthropogenic climate change is challenging”. They state that it is likely there has been a worldwide increase in extreme high-water events during the late 20th century, with a likely anthropogenic influence on it (IPCC, 2014, p.619). Climate change impacts on agriculture and ecosystems run through rising temperature and changes in rainfall variability and seasonality as well as through extreme events. Changes in temperature caused reduction in global yields of maize and wheat by 3.8% and 5.5% respectively from 1980 to 2008 relative to a counterfactual without climate change, which offset in some countries some of the gains from improved agricultural technology (Lobell et al., 2011 in IPCC 2014, p620). Badjeck et al. (2010) discuss current and future impacts on fisher folk across the world. Many local-level studies are subject to the attribution problems mentioned above, but Wellard et al. (2012) cautiously note a convergence of climate data with the perceptions of farmers and officials to the effect that over the last 30 years the rainfall in Malawi has become less predictable, that the rainy season is arriving later in the year causing delays in planting of the main crops, and that damaging dry spells during the rainy season have become more frequent (IPCC, 2014, p620).

The major impacts of climate change identified or projected for rural areas include; Lal et al. (2011) show the regional specificity of projected socioeconomic impacts across the rural USA, with different regions affected through agriculture, water stress, and energy costs Climate change will affect rural livelihoods, or “the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living” (Chambers and Conway, 1992 in IPCC 2014, p221). Many, though by no means all, rural livelihoods are dependent on natural resources (e.g., agriculture, fishing, and forestry), and their availability will vary in a changing climate. This will have effects on human security and wellbeing (Kumssa and Jones, 2010 in IPCC 2014, p622). Climate change impacts on smallholder and subsistence farmers will be compounded by environmental and physical processes affecting production at a landscape, watershed, or community level; and other impacts, including those on human health and on non-agricultural livelihoods (Morton, 2007) and also trade and food prices (Anderson et al., 2010). Despite the growing importance of non-farm livelihoods in rural areas worldwide (Ellis, 2000; Reardon et al., 2007), and households pursuing interdependent agricultural and non-agricultural livelihoods in peri-urban areas as a risk management strategy (Lerner and Eakin, 2010; Lerner et al., 2013), there is a relative scarcity of literature on the interactions of these with climate variability and climate change (IPCC, 2014, p623).

India is dominated by the rural economy, because it has higher rural population and heavy reliance on the agricultural employment as a source of livelihood. Hence it is of vital importance to assess the impact of climate change on the rural development by taking into account some of the indicators relating to rural development comprising of agriculture and allied activities and employment and water accessibility and stress as well.

Agriculture is the backbone of rural economy in particular and Indian economy in general. Hence the trends in indicators relating to agriculture sector help us capturing the impact of climate change on agriculture as well as rural development of India.

**Table 3: Agriculture Sector – Key indicators (per cent at 2011-12 prices)**

Sl. No.	Item	2011-12	2012-13	2013-14	2014-15	Change in 2014-15 over 2011-12
1	Growth in GDP in agriculture & allied sectors	-	1.2	3.7	1.1	-0.1
2	Share of agriculture & allied sectors in total GDP	18.4	18.0	18.0	N A	-0.4
3	Crops	12.0	11.7	11.8	N A	-0.2
4	Livestock	4.0	4.0	3.9	N A	-0.1
5	Forestry and logging	1.6	1.5	1.4	N A	-0.2
6	Fishing	0.8	0.8	0.9	N A	+0.1

**Source:** Central Statistical Organisation (CSO)

It is observed that during the period under consideration from 2011-12 to 2014-15, all the indicators of agricultural sector are showing negative trends. The growth of agriculture and allied activities contribution to GDP was lower and also grew at the very marginal rate of 1.2% in 2012-13 and decline to 1.1% in 2014-15. Likewise, the share of agriculture & allied activities in GDP decline by 0.4% from 18.4% to 18%. Live stock output registered a negative growth of 0.1% from 4% to 3.9% during the same period. Forestry and logging showed a decline of 0.2% from 1.6% to 1.4%. As far as fishing is concerned, its growth was very much meager but positive very marginally only.

Besides these, area, production and yield are very important indicators of agricultural development. Hence their trends enable us in capturing the impact of climate change on the agricultural development as well as rural development of the Indian economy.

**Table 4: Area, Production, and Yield (2013-14)**

(Area: million ha; Prod.: million tonnes; Yield: kg/ha)

Group/ commodity	Area	% change in area	Production	% change in production	Yield	% change in yield
<b>Food grains</b>	126.0	4.3	264.8	3.0	2101	-1.3
Rice	43.9	2.7	106.5	1.3	2424	-1.5
Wheat	31.2	4.0	95.9	2.6	3075	-1.3
Jowar	5.8	-6.1	5.4	1.7	850	-8.2
Maize	9.4	8.3	24.4	9.2	2566	-0.7
Bajra	7.9	8.0	9.2	5.5	1198	2.9
<b>Pulses</b>	25.2	8.3	19.3	5.3	764	-3.2
Gram	10.2	20.3	9.9	12.3	967	-6.7
Tur	3.9	0.0	3.3	9.7	848	9.2
<b>Oilseeds</b>	28.5	7.6	32.9	6.4	1153	-1.3
Groundnut	5.5	17.6	9.7	105.8	1750	75.9
Rapeseed and mustard	6.7	4.7	8.0	-0.5	1188	-5.9
<b>Cotton (Bales of 170 kg)</b>	11.7	-2.3	36.7	7.2	532	9.4
<b>Sugarcane</b>	5.0	0.0	350.0	2.6	70	0.0

Source: Directorate of Economics & Statistics, Department of Agriculture & Cooperation.

It is clear from the data results that a marginal increase is found in the area under cultivation for food grains, pulses and oilseeds group wise as well commodity wise, except gram and ground nut. The same trend is observed in the growth in production except groundnut, gram, maize and tur. But the increase in area as well as production of gram, tur and groundnut did not help in arresting their price rise due to shortfall of supply compared to demand. As we know, productivity is the best indicator to capture the impact of climate change on the agriculture, and it is clearly found that except groundnut, tur, bajara and cotton all other groups as well as commodities show a negative growth, which indicates the adverse impact on the development of agriculture and consequently rural development of the economy.

Employment generation in the economy has a special importance on various grounds. It is a very important indicator of development of the economy as well as its productive sectors, hence trends in the employment generation help us in capturing the impact of the climate change on the economy because it is the result of the development of the economy coupled with productive activities and sectors.

**Table 5: Employment in Organised Sectors—Public and Private**  
(Lakh persons as on March 31, 2012)

Item	2006	2007	2008	2009	2010	2011	2012	CGR
<b>By industry</b>								
1 Agriculture, hunting etc	4.7 (3)	4.8(3)	4.7 (3)	4.8 (3)	4.8(3)	4.8(3)	4.7(3)	<b>0.075%</b>
2 Mining and quarrying	11.5	11.4	11.2	11.1	11.0	10.9	10.8	<b>-2</b>
3 Manufacturing	10.9	10.9	10.4	10.6	10.7	10.2	10.7	<b>-1</b>
4 Electricity, gas and water	8.5	8.5	8.0	8.4	8.4	8.3	8.2	<b>-1</b>
5 Construction	8.9	8.7	8.5	8.5	8.6	8.5	8.3	<b>-1</b>
6 Wholesale and retail trade	1.8	1.8	1.7	1.7	1.7	1.7	1.7	<b>-2</b>
7 Transport, storage & communications	26.8	26.4	26.3	26.0	25.3	23.8	24.9	<b>-2</b>
8 Finance, insurance, real estate etc.	13.9	13.7	13.5	13.6	14.1	13.6	13.6	<b>-1</b>
9 Community, Social & personal services	91.8	90.9	88.5	90.1	90.5	91.0	90.4	<b>-1</b>
Total	178.7 (66)	176.9 (65)	172.8 (63)	174.8 (62)	175.1 (61)	172.7 (60)	173.3 (59)	-1
<b>Private sector</b>	<b>88.1 (33)</b>	<b>92.7 (34)</b>	<b>98.8 (36)</b>	<b>103.8 (37)</b>	<b>108.5 (38)</b>	<b>114.5 (39)</b>	<b>119.7 (40)</b>	<b>5.26</b>
<b>Public sector</b>	<b>181.9 (67)</b>	<b>180.0 (66)</b>	<b>176.7 (64)</b>	<b>178.0 (63)</b>	<b>178.6 (62)</b>	<b>175.5 (61)</b>	<b>176.1 (60)</b>	<b>-1</b>
<b>Grand Total</b>	<b>269.9</b>	<b>272.8</b>	<b>275.5</b>	<b>281.7</b>	<b>287.1</b>	<b>290.0</b>	<b>295.8</b>	<b>1.5</b>

**Source:** Directorate General of Employment and Training, Ministry of Labour & Employment.

It is adequately found that the present state of employment in India is the worst only. At all level a very unsatisfactory scenario of employment generation is found in the economy. Aggregate employment generation in India showed a just marginal growth of 1.5% pa during 2006 to 2012, is no doubt, a thing of concern. The important thing is that employment in India is dominated by the private sector than the public sector, which is indicated by the 5.26% growth rate of private sector employment in the economy. The industry or economic activity wise analysis of the employment generation reveals that all have shown a negative growth, except agriculture and allied activities which registered just a meager growth of 0.07% during the period into consideration. More importantly, a majority of our labor force depends on agriculture as a source of livelihood especially in the rural areas is a clear indicator of adverse impact of climate change on the rural development of the economy.

Agricultural income is the prime source of income for the rural households and consequently living conditions. It is a well known fact that a majority of rural families depend upon agriculture as a source of income.

The climate change adversely affects agricultural development and there by income and living conditions of the rural households.

**Table 6: Distribution of Agricultural Households by Principal Source of Income (%)**

No of Agri. Households	cultivation	livestock	other agricultural activity	nonagricultural enterprises	wage/ salaried employment	others (pension and remittance)
90201100	63.5	3.7	1.1	4.7	22.0	5.1

**Source:** Key Indicators of Situation of Agricultural Households in India, NSS 70th Round (January – December 2013)

It is that agricultural cultivation is the prominent source of income for the rural households, because more than 60% households are dependent on income from agricultural cultivation. Except wages, all others are just meager contributors to the income of agricultural households. As agriculture exclusively depends on climatic conditions the climate change has a significant adverse impact on agricultural households and thereby rural development.

Climate change is affecting the supply of fresh water. Hence scarcity of fresh water and its inadequate access indicates the negative impact on the satisfaction of the want for the water, which is a basic necessity of human life and consequently rural development of the economy.

**Table 6: Water Stress in India: Access to an Improved Drinking Water Source (2000-8)**

Year	Urban		Rural	
	Total (%)	Household connections %	Total (%)	Household connections (%)
2000	93	50	76	9
2005	95	49	81	11
2008	96	48	84	11

**Source:** WHO-UNICEF (2010) in Water in India: Situation and Prospects by UNICEF 2013

It is clearly observed that the access to improved drinking water to the households in the rural areas of India is very much inadequate. It is just 76% households. More importantly , only 9% rural households have access to improved drinking water in 2000, which very marginally rose to 11% in 2005 and remained the same in 2008 also shows a very bad situation of water stress in the rural areas , which can be further intensified in the coming future. This is reveals that climate change is very adversely affecting the rural development of the economy.

Rural India has more than 700 million people residing in about 1.42 million habitations spread over 15 diverse ecological regions. Meeting the drinking water needs of such a large population can be a daunting task.

The non-uniformity in level of awareness, socio-economic development, education, poverty, practices and rituals and water availability add to the complexity of the task. Despite an estimated total of Rs. 1,105 billion spent on providing safe drinking water since the First Five Year Plan was launched in 1951, lack of safe and secure drinking water continues to be a major hurdle and a national economic burden. Around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at \$600 million a year (Khurana and Sen, p. 4).

## VI) CONCLUSIONS AND POLICY SUGGESTIONS:

India was one of the early adopters of a national climate change plan. Launched way back in 2008, the National Action Plan on Climate Change (NAPCC) outlines policies directed at mitigation and adaptation to combat climate change. India is also working on the voluntary goal of reducing the emissions intensity of its GDP (excluding emissions from agriculture) by 20-25 per cent by 2020 as compared to the base year of 2005. The recent United Nations Environment Programme (UNEP) Emission Gap Report (2014) has recognized India as being one of the countries on track to achieve its voluntary pledges. India is also taking proactive steps in enhancing energy efficiency and expanding renewable to combat climate change. At the same time adaptation measures in agriculture, water resources, and urban areas remain its key priorities (Govt. of India, 2014-15, p123). India is now revisiting National Missions under the NAPCC in the light of new scientific information (IPCC AR5) and technological advances; undertaking additional interventions in areas like GHG mitigation in power generation, other renewable energy technology programmes, disaster management, protection of coastal areas, and the health sector; creating capacity at different levels of the government; exploring possibilities of new missions on wind energy, health, waste to energy, and coastal areas; and redesigning the National Water Mission and National Mission on Sustainable Agriculture (Govt. of India, 2014-15, p123). India's total renewable power installed capacity as on 31 December 2014 has reached 33.8 GW. Wind energy continues to dominate this share accounting for 66 per cent of installed capacity, followed by biomass, small hydro power, and solar power.

The thorough analysis of the present state of climate change in India and its impact on rural development reveals that no doubt, India has been facing a significant climate change. Hence the impact of climate change on India is in variety and multiple. Rural sector is a very much important sector of the India economy, because India is basically a rural country and hence consequently a rural economy. The present study adequately reveals that the impacts of climate change on rural development are visible and their intensity can further increase in the future. The important adverse impacts of climate change on rural development realised are fall in production and productivity of agriculture, forestry, fishing and livestock, income and consumption, a significant decline in employment in general and rural employment in particular, access to improved water and water stress. It is urgent need of the hour to endeavour for mitigating climate change and consequently negative impact of climate change especially on the rural development of the Indian economy. Reforms in energy sector, industrial development in rural areas, purposeful efforts for rural employment generation, incentives for forestry, animal husbandry and fishery development, rain water harvesting, water conservation and proper management,



due care of drinking water supply to the rural households especially thorough water connections are very much needed. In addition to this, rural development policy, environmental policy, green jobs, a special policy for global warming and climate change mitigation, adequate budgetary provision for mitigation programmes can be of very much use in dealing with the climate change and its negative impact on rural development in the country like use.

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