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Research Paper

Climate Change Scenario and Its Impact on Jhum Paddy in Mokokchung District

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ABSTRACT

In the study area Mokokchung district, about 80% of the rural people depend on agriculture for their livelihood (Statistical handbook of Nagaland 2017). The farmers still depend on the monsoon for their Agriculture and practice the traditional, shifting cultivation known as Jhum. This practice, particularly the slash and burning of forest can be critically viewed because of its possible impact on the land and environment which is also one of the reasons which contributes to global warming and hence lead to climate change. It is observed that rainfall and temperature pattern in Mokokchung district have changed significantly and this change can be expected to continue in the future. Since Agriculture in Mokokchung district is dependent on monsoon, possible changes in temperature, precipitation and CO_2 concentration will affect the crop production specially Jhum paddy.
This paper studies a summary of the current state of knowledge on trends in rainfall and temperature in Mokokchung district. The detailed review presented in this paper provides sufficient evidence that climate in Mokochung district has changed significantly and is expected to continue changing in the future and justifies the urgency and importance of enhancing the adaptive capacity of agriculture and reducing vulnerability to climate change.

Key words:- Climate change, Rainfall, Temperature, Agriculture, vulnerability.

INTRODUCTION

Nagaland is agrarian state where 73% of population depends on agriculture. In fact, the Naga village society was traditionally dependent on agriculture and community life. The numerous festivals, work and leisure are centered around agriculture and have their roots in cultivation practices. The traditional practices are interwoven with social, religious and traditional values.

In Nagaland, major land use pattern continues to be shifting cultivation known as Jhum, which covers 72% of the total arable area of the state. This practice is mostly concentrated in the district of Mokokchung, Mon, Wokha, Zunheboto and Tuensang. Shifting cultivation is a system that has been practiced overtime and revolves around an agro-eco system of cultivation based on traditional knowledge and indigenous practices. In Jhum, burning the field is one of the most important operations for the success of shifting cultivation. This practices particularly the slash and burning of forest can be critically viewed because of its possible impact on the land and environment which is also one of the reasons which contributes to global warming and hence lead to climate change.

In Nagaland, rice is stable food which occupies 70% of the cultivable area and constitutes 75% of the total food grain production in the state. But the production

of rice is still deficient whereas the state population according to 2011 census is 1978502 and is expected to reach 2798539 by 2025. With this projected increase in population, emphasis on improving production and productivity of agriculture is crucial to bridge the gap between demand and supply of food grains. And also at present, rice production faces threats from frequent, heavy winds and heavy rainfall events which cause severe crop losses. Rice plant is very sensitive to atmospheric temperature. Even $1^{O}C$ rise in earth's surface temperature could drop rice production. Apart from this climate changes in terms of increase rainfall and temperature, an elevated carbon-dioxide is also likely to influence the performance of agriculture in the region.

Since rice cultivation has a long traditional, cultural and economic importance in the state of Nagaland, a drop in the production will have a negative impact on the income of the people. This shows that the economy of the people is primarily dependent on the progress of agricultural sectors.

At present, in Nagaland, deforestation due to jhumming, mining, logging, unplanned urbanization, increased population and excessive use of fossil fuel are all contributing factors to the problem of climate change. So steps need to be taken to protect and conserve our environment to counter the problems of climate change.

The present study attempts to show that climate change is already occurring and there will be significant economic damages especially in agricultural sector. So far as sustainable economic development, environment conservation and social equity are concerned, climate change matters.

Climate change scenario in Mokokchung District Nagaland:-

The Climate of Nagaland is Sub-alpine type of climate all the year round. The climate is controlled by its terrain features varying from tropical to temperate conditions. Nagaland also records a heavy rainfall. The heavy monsoon rain normally occurs from May to August with occasional dry spells during September to October. Dry season begins from November and continues till April. Mokokchung district has a sub-tropical humid type of climate which valleys and the lower range adjoining the Assam plains experience a warm climate. The temperature of the district varies from $28^{O}C$ to $32^{O}C$ in summer and in winter it varies from $10^{O}C$ to $15^{O}C$.

Rainfall pattern in recent years in Mokokchung district exhibits uncertainties. The onset of monsoon also appears to be erratic in recent years. Frequent failure of break in monsoon across the state also affects the hydro power generator. Most of the places receive heavy rainfall. Crop losses are considerably high during these extremes weather. The heavy monsoon rainfall followed by unusual summer showers affects the paddy production of the state. And in some parts, due to cyclonic storm it devastates seasonal crops and plantation to a considerable extent. Thus these frequent weather aberrations like monsoon uncertainties, heavy rainfall, drought and sunburn and heat load during the summer could be as a part of global warming and climate change.

Under the projected climate change scenario, it is certain that the temperature is likely to increase air temperature by $2^{O}C$ by 2050 (IPCC 2007b). An increase of surface air temperature by $2^{O}C$ would have tremendous adverse influence on the crops growing across the state. Even now, thermo sensitive crops across the high ranges are under threat as the temperature range is widening. Temperature range is nothing but the difference between the day minimum and the night maximum temperature. The fluctuation in temperature range not only effects agricultural sectors but also will have tremendous deleterious effects in health sectors. Proper adaptation strategies need to be developed in the event of projected temperature rise in Mokokchung for sustenance of agricultural production. Shifting cultivation, mining, quarrying,

logging, have been identified as the casual factors for climate change. Widening in temperature range along with deforestation maybe detrimental to thermo sensitive crops like paddy in the district.

In short, the climate change scenario in Mokokchung district maybe summarized as:

- Excessive Rainfall.
- Landslide.
- Decline in forest area.
- Rice likely to be under threat.

The changes in rainfall and thermal regimes may result to shifting of climate from wetter to drier zone within the humid type of climate. And agriculture is expected to be the most affected by climate changes because it is highly dependent on climate variable such as temperatures, humidity and precipitation (IPCC 2011). Therefore there is a need to study in detail about rainfall and temperature trends across the district.

The present study will assess the vulnerability of climate change in Mokokchung district. The result of the study is likely to provide an insight of the trends in rainfall and temperature in the district.

METHODOLOGY

The secondary source of information from soil and water conservation dept. and statistical handbook of Nagaland has been collected. The data period is from 2008 to 2017 i.e. for a period of 10 years. The aim is to investigate the frequency of rainfall in the study region and analyse the trends and shifts in the rainfall and temperature patterns for different time periods between 2008 to 2017 depending on the data availability and analyse it in relation to production of Jhum paddy.

Observed change in trends and pattern of rainfall and temperature:-

Agriculture is the primary sector that mostly depends on climate. The cultivation of crops, planting, harvesting times depend directly on the weather conditions prevailing in the region. This means that climate change due to increase in green house gas will have direct effect on agricultural production and productivity and consequently on farmers' income and since all dimensions of food security are closely intertwined with agriculture production, which is both a source of food and source of income for rural households. Thus, because of climate change which changes temperature and rainfall patterns will have a major impact on food security and their economy for rural households.

Singaraj 'A' and Kumar D (2011) show the impact of climate change on food production and crop yields. It would not only effect physical availability of food but also the income of the people and increased temperatures will impact agriculture production in two ways, one directly due to change in temperature, precipitation or CO2 levels and secondly directly through changes in soil, distribution and frequency of infestation by pests, insects, diseases or weeds. Agriculture will be adversely affected by shifts in the timing of the rainfall.

Stefanos, A Natis i.e. at (2012) in their research paper states that agriculture is the economic sector that is most vulnerable to climate change. According to the latest estimates, farmers' adoption of farm production to climate change is inevitable. Farmers need to adapt to the expected impacts of climate change in order to maintain their standard of living. The choice of optimal crops cultivating and harvesting times depends directly on the weather conditions prevailing in each region. This implies that the impending climate change due to increase in green house gases will have direct effect on agricultural production and productivity and consequently on farmers' income.

S. Naresh Kumar *et al* (2011) in their research paper also states that in case of rain fed rice, the projected change in yield in Western Ghats India is likely to lose rice yields by 10% and in most part of Western Ghats region the monsoon rainfall is likely to increase up to 15% the changes in rainfall causes direct impact on the production of agricultural crops. Heavy

rainfall can inferred heavy cloud cover causing low radiation, is one of the limiting factors for higher productivity and any further increase in rainfall will reduced fields.

Mokokchung district rainfall is caused by south west monsoon and generally sets in during the middle month of June till the half of September with heavy rainfall. And since in Mokokchung district almost all farm activities is rain fed. A detailed analysis of rainfall in the district is important to know the impact of climate change on agricultural crops.

Table-I Meteorological Rainfall Data of Mokokchung District year 2008-2017

Particulars	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. of Rainy day	147	133	157	152	137	112	109	127	177	182
Annual Rainfall in (m.m)	2283	2254	2713	2256	2151	1993	1456	1673	2144	1666

Source: - Deptt of Soil & Water conservation Mokokchung.

Table I shows the meteorological rainfall data in mm and number of rainy days for 10 yrs starting from 2008-2017. From the table we can see that the amount of rainfall varies from 1400mm to above 2700mm. The total rainfall from 2008-2017 of which the amount of highest rainfall was recorded in 2010 with 2713mm and the lowest with 1456mm in 2014. The total number of rainy days was recorded highest in the year 2017 with 182 days and the lowest was recorded 109 days in the year 2014. Table I shows that rainfall pattern does not have a regular rhythm i.e. variation in rainfall pattern and erratic rainfall are the most important climate events the area is facing for the past 10 years.

Observed changes in Temperature in Mokokchung district:

Kumar R and Gautum H (2014), in the Journal "Climatology and weather forecasting", states about climate change and its impact on Agricultural productivity in India. In their research paper they state that in India agriculture is directly dependent on climate change and weather so possible changes in temperature, precipitation and CO_2 concentration are impacted to significantly impact crop growth. Agricultural productivity will also be affected due to increased carbon dioxide in the atmosphere. All these changes will increase the vulnerability of the landless and the poor several analysis have concluded that the higher temperature expected in coming years will disproportionately affect agriculture in the plants lower latitudes where most of the world's poor live. In such a scenario, agriculture will need better management of natural resources like land, water and genetic resource to make it more resilient.

PD Sharma (2017) in book ecology of environment states that a 2^0C rise in global temperature predicted by the year 2030 may cause many damages to the planet. South Asian nations are likely to suffer most and will have some special challenges to tackle shifting rainfall patterns are likely to leave some parts too wet and others too dry. The floods and droughts would spread diseases and reduce agricultural output. And this is really just the tip of the iceberg. The climate change will affect monsoon and agriculture in South Asia. The World Bank estimated that by the mid 21st century crop fields could decrease by up to 30% in South Asia due to climate change related weather events. The region is already experiencing warming, increasing variability of monsoon rainfall. Heavier downpour and an increase in the frequency of droughts are already causing damage.

Thus temperature is fundamental in determining crop quality, quantity, and where it can be grown due to the nature of this fundamental relationship in biology and ecology, any change in temperature through climate changes will have large impacts on crop production.

It is also a known fact that all stages of crop development are sensitive to temperature. Higher temperature often lead to heat stress which can result in increasing sterility and lower overall productivity in

crops, an increase in temperature of 2-4^{0}C is expected to reduce yields. An increase of 2^{0}C may decrease the rice yield by 75T/ha in high yield areas (Sinha & Siva minath 1991). It is also projected that 1^{0}C rise will decrease rice yield by about 6%.

Table-2 Meteorological Temperature data of Mokokchung District 2008-2017.

Year	Max^{0}C Temperature	Min Temperature	Max Average Dew point ^{0}C	Min Average D/P^{0}C	Max Average R Humidity	Min Average R/M
2008	31	2	20.9	8.2	74.7	68.8
2009	31	5	21	5.8	76.9	68.6
2010	31	3	24	7.6	88.5	62.6
2011	29	5	24.3	5.8	90.5	61
2012	30	5	21.1	4.8	81.2	61.2
2013	31	3	21.1	4.4	80.8	60.7
2014	31.6	4.2	20.9	3.10	81	36.2
2015	29.8	5.4	21.7	1.5	85	34.3
2016	30.2	3.4	22	9.1	87	60
2017	28.2	4.4	21.3	8.5	80.2	64

Source :- Dept of soil and water conservation Mokokchung 2008-2017

From Table-2 we can observe that the temperature dew point and humidity does not show any systemic pattern, it is rather erratic and fluctuating. The temperature data shows an unpredictable pattern over the last 10 years i.e. from 2008-2017. From Table 1 and 2, a key finding and one significant implications as climate change takes place is that impact of temperature and rainfall is felt only in the extreme i.e. when temperature are much higher in 2014 (31.6^{0}C). Rainfall is significantly lower (109 days) and the number of dry days greater than normal, dew point is lowest (20.9) and humidity is also low (36.2). This will have an adverse impact on Jhum paddy which are unirrigated and rain fed. These estimates can be used to project long term weather patterns which imply that climate change could reduce annual agricultural incomes.

Erach Bharucha (2015) in his book environmental studies states that global warming is accelerating faster than that calculated by climatologist a few years ago. In 1995 IPCC predicted that Global warming would raise temperature by 3.5-10^{0}C during the 21st century. If the present trends continue it is now believed that the raise could be much greater. This would lead to not only to changes in temperature but also the amount of rainfall. India may see great annual fluctuations in rainfall leading to floods and droughts.

Agricultural land use:-

Agriculture is considered the backbone of the state economy. Nagaland is principally an agrarian economy making the single largest contribution to the state economy from agriculture and its allied sectors. Its culture and traditions are all symbolic to agriculture. This clearly indicates the dependency on agriculture sector, rice being the staple crop of the state, covers about 70% of the net cultivated area registering production of 454190 MT during 2014-15 and production of 182690 MT in the other major crops including maize, potato, soya bean, sugarcane, jute, gram, cotton and castor. However, self-sufficiency in food grains is yet to be achieved and the state is still dependent on imports.

Table-3 Nagaland district wise under Jhum paddy (14-15)

District	Area of Jhum Paddy
Kohima	5400
Phek	1800
Mokokchung	9630
Tuensang	10440
Mon	16260
Dimapur	9410
Wokha	10470
Zunheboto	9530
Peren	6650
Kiphire	8730
Longleng	6060
Total = 94380	

Source :- Statistical handbook of Nagaland 2014-15

Table -4 Basic information about Nagaland and Mokokchung:-

1.	Total population of Nagaland (2011 census)	1978502
	Rural population of Nagaland	1407536
	Urban population of Nagaland	570966
	Total cultivations	420379
	Density & per sq km	119
2.	Total geographical Area	16579 Sq.km
	Total cultivable Area	721924 ha
	Gross cropped Area	429790 ha
	Net cropped Area	331970 ha
	Net irrigated Area	103500 ha
3.	Total population of Mokokchung (2011 census)	194622
	Rural population of Mokokchung	138897
	Urban population of Mokokchung	55725
	Total cultivations	42236
	Density of population per sq km	121
4.	Total geographical area of Mokokchung (2011 census)	1615 Sq. km
	Total cultivable Area	110482 hectares
	Gross cropped Area	22433 hectares
	Net cropped Area	88049 ha
	Net irrigated Area	3944 ha
	Total agriculture labor	4863
	Total cultivator	42236
	Area under current Jhum	9630 ha
	Area under TRC/WRC	4980 ha
	Average Jhum cycle	10-15 yrs.

Land under Mokokchung district is mostly cultivated under Jhum paddy of which Ongpangkong range is the highest cultivator of all the six ranges. The district maintains Jhum cycle of 10-15 yrs but gradually it has been reduced to 8-10 yrs. Besides paddy, other crops such as cereal pulses, oil seeds, commercial crops are also cultivated. Out of the state total Jhum paddy cultivated area of 91490 hectares, Mokokchung district total cultivated area of Jhum paddy is 9350 hectares (Statistical handbook of Nagaland 2016-17).

Table-5 Mokokchung district area and production of Jhum paddy in metric ton (2008-17)

Year	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Area	9535	10970	10600	11670	9770	9690	9660	9630	9480	9350
Production	7266	19130	12950	21000	17630	18520	18610	18660	18640	18670

Source :- Statistical hand book of Nagaland 2008-2017

From Table 5 we can see that the highest overall production in terms of area and production is in 2010-11. As shown in table 5 the productivity is somewhat constant.

Another key findings from table 1,2 and 5 is that in the year 2010-11 production is the highest and that year the temperature falls to 29^0C from 31^0C in the previous year (2009-10) and minimum temperature also rise from 3^0C to 5^0C. This shows that increase or decrease in temperature is very important for paddy production.

Land is the basic asset among the Ao-Naga community. Jhumming or shifting cultivation is an age old farming practice by the Ao-Naga since time immemorial. Traditionally, it is the chief form of agricultural practice among the villages which involves the customary laws to regulate the practice among the villages i.e. it involves the customary laws to regulate the practice of its cultivation. It is categorized as the village land, clan land, family and community land. The people have absolute right over their Jhum land and recognize their rights to practice shifting cultivation like any other Naga tribes of the state.

Ownership and management of land in the district is governed by the village council, clan and individuals. Agriculture is the most important sector and means of sustenance and livelihood for the people living in rural areas. Out of 42236 total cultivators, nearly 7090 of the farmers practice shifting cultivation i.e. out of the geographical area of 161500 hectares. The total cultivated area is 110482 hectares. The current jhum covers an area of 9350 hectares followed by terrace rice cultivation and wet rice cultivation (Statistical

handbook of Nagaland 2017). So far, assessment of climate impacts of Jhum paddy in this region has not received adequate attention. From the empirical evidence we can see that climate change is already present and has a significant impact on Jhum paddy. Farmers need to adapt to the impacts of climate change in order to maintain their standard of living. The adaptation of agriculture to climate change involves both the restructuring of crops, as well as changes in cultivation practices since agricultural crop responds to climate differently. Climate adaptation research should be locally focused along with effective and systematic outreach efforts for more effective adoption and implementation. Thus policy makers should promote actions that assist in changing land use and crops, as well as crop cultivation technique. This policy should take into account the need for sustainable agriculture development through its three pillars, economic development, social equity and environment conservation since sustainable development is the essence of why climate change matters.

One of the most significant impacts of climate change on humanity in the near future is likely to be the increase of food insecurity and malnutrition. Climate change will affect all dimensions of food security i.e. food availability, food accessibility, food utility and food system. Changes in climate conditions have already affected the production of some of the world's staple crops such as maize and rice. These crops are very susceptible to rising temperatures and to more unpredictable extreme weathers. Higher temperature will have an impact on fields, while changes in rainfall could affect both crop quality and quantity.

Extreme weather events will increase the frequency and intensity of some disaster such as droughts, floods and storms. This has an adverse impact on livelihood and food security, climate related disasters have the potential to destroy crops, critical infrastructure and key community assets. Therefore deteriorating livelihood and increasing poverty without doubt the countries with existing problems in feeding their people are those most at risk from climate change. The most damaging effects would be relatively small changes in rainfall and temperature which cumulatively could decrease global crop fields.

The climate change is a unique global challenge. It doesn't discriminate based on geography and so we see its effect in every corner of the world (IPCC 22 Feb 2018).

Sankar (2017) in his book environmental (page 208) states that the large part of the arable land in India is rain fed. The productivity of agriculture depends on the rainfall and its pattern. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall but also by shifts in the timing of the rainfall. Any change in rainfall patterns possess a serious threat to agriculture and therefore to the economy and food security.

ML Jat *et al* (2016) (Page 79/80) in their research paper states that climate change is threatening the food security and livelihood of millions of people in the developing countries including south Asia and Latin America. Medals generally predict that rising temperatures increased climatic variability and extreme weather events could significantly impact upon food production, climate events like cold wave, heat wave, drought and floods have significantly influenced the production of food crops. Therefore scientific intervention coupled with indigenous mission of the farmers is a must to enhance the resilience of modern agriculture in the face of climate change. Accurate and reliable forecasting of environmental changes will be of immense importance and policies to support the dissemination of this information are required to help the farmers.

Thus cutting-edge scientific research is essential to solving global climate change. An ambitious global research agenda is a critical step in ensuring that we generate knowledge at the speed and scale which our state need to take action, we should have the

ability to pursue more ambition, climate adaptation and mitigation strategies.

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