

---

## CHANGING PATTERN OF HOUSEHOLD INCOME IN NORTHEAST INDIA

Melody Thangjam\*; Manjit Das\*\*

\*Research Scholar,  
Bodoland University,  
Kokrajhar, Assam, INDIA  
Email Id: thangjammelody@gmail.com

\*\*Professor,  
Department of Economics,  
Bodoland University,  
Kokrajhar, Assam, INDIA  
Email Id: manjitdas4842@gmail.com

DOI: [10.5958/2249-7315.2022.00004.1](https://doi.org/10.5958/2249-7315.2022.00004.1)

---

### ABSTRACT

*The paper provides an assessment of household income inequality in northeast India during 2004-05 and 2011-12 using India Human Development Survey. In two out of the eight states household annual income has doubled but has declined in one of the other states. There exists considerable inter and intra states inequality in household income and inequality is increasing over time. The pace of enhancement in household income is higher four households in the richest income quintile than among the households in lower income quintiles. Per capita annual income of individuals varies by occupations and the gaps are found to be statistically significant.*

**KEYWORDS:** Household, Income, Inequality, Occupation, Northeast.

---

### 1. INTRODUCTION

Northeast India comprises of eight small states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura and shares an international border with Bangladesh, Bhutan, China and Myanmar. The region lies between 22°N and 29°5'N latitude and 88°E and 97°30'E longitude, is spread over an area of 262,179 square kilometers and the total population of northeast (NE) India as per Census 2011 is 45,587,981 which is 3.8 percent of India's population. The region is inhabited by a number of ethnic tribes having different socio-cultural practices quite distinct from the tribes in other parts of the country. However the rich biodiversity and cultural heritage of the region is overshadowed by poor infrastructure and underdevelopment in terms of human development index (HDI). As on 1999-2000 in all India ranking of HDI the state of Mizoram is rank 4 followed by Nagaland at rank 8 and Assam at 25 ranks is at the bottom while the other states were between 15 and 21. However in HDI ranking of 2011-12 Mizoram slides down to 13, Nagaland to 19, Assam to 26 while the states of Tripura have moved up from 15 to 14 and Sikkim from 19 to 16 (Mukherjee et al., 2014) [1].

The slip in HDI ranking of many northeast states during 1999-2000 to 2011-12 is despite the fact that literacy rate of the states in the region is above the national average and is 88.8 percent for Mizoram in 2001 and 54.3 percent in Arunachal Pradesh, the highest and the lowest in the region in 2001 while the that for other states were between 62.6 and 70.5 percents and literacy rate improves further to 91.6 percent for Mizoram, 66.9 percent for Arunachal Pradesh and other states improvement are in the range of 73.2 to 87.8 percent. For 2006-10 life expectancy at birth for India is 66.1 and corresponding figures for the northeast states Assam, Arunachal Pradesh,

Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura are 61.9, 68.1, 76.3, 61.4, 74.5, 76.5, 70.2 and 74.7 respectively showing that overall health status of the region is better than the national average. Infant mortality rate for Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim and Tripura were 73, 39, 20, 56, 19, 42 and 39 per 1000 live births in 2001 which reduces to 55, 32, 11, 52, 34, 26 and 29 respectively in 2011 (SRS, 2002; 2012)[2,3]. For the corresponding periods the national average IMR were 66 and 44 per 1000 live births. It is evident that in two components of HDI, namely, education and health status the states of northeast India are in a better position than the national average. A cursory thought indicates that the crucial factors responsible for fading of HDI of the region is the third component, that is, income. Keeping this in view this study is oriented to assess changes household income and income inequality by source of income, household size, social group and residence background between 2004-05 and 2011-12. The study aims to provide potential policy inputs for addressing inter and intra states and social group income inequality to foster socio-economic development in the region.

## **2. REVIEW OF LITERATURE**

Empirical evidence of increase in productivity level over time but widening earning gap between agriculture and non-agriculture sectors besides declining productivity level of agriculture sector have emerged from a study of employment situation in northeast India by Saha (2012)[4]. It indicates that the region is not progressing in agricultural production despite the fact that 70 percent of the population being dependent on agriculture for livelihood. Work participation rate of the region for the period 1991-2011 is almost at par with the national average but there exists considerable interstate variation in the region (Singh and Singh, 2016)[5]. Overall work participation rate have declined during 2001-2011 in the two states of Arunachal Pradesh and Meghalaya but have increased in the other six states (Census of India; 2001, 2011)[6,7] but what is disheartening is that female work participation rate declines during 2001-2011 (Pegu, 2015)[8]. Concomitantly female workers in non-farm activities have also slides down plausibly due to limited skill of women of the region (Saha, 2012)[4]. Low skill of women is substantiated from the findings of Dhar (2015) [9] that though school enrolment in the region has been showing steady improvement since the last decade, majority of the poor children mainly girls in rural areas are deprived of the basic education. Mahanta and Nayak (2013)[10] also found that women are relatively disempowered and enjoy somewhat lower status than that of men in the region leading to gender gap exists in terms of access to education, employment and health. Ngangbam and Ladusingh (2013) [11] had found higher economic return for higher educated women in northeast India in terms of work participation and rate of return to earning. Sarma (2015) [12] analyzing trend in per capita Net State Domestic Product (NSDP) has found that increase per capita income in northeast India is leading to widening of income inequality in the recent past. Neogi (2010)[13] on the basis of analysis based on composite index of development attributed uneven development of the northeastern region to poor mechanism in place for proliferation of tapping natural and human resources and ethnic conflicts in the region. Nair et al. (2013)[14] based on an index of poverty found high land income inequality responsible for the slower growth rate of northeastern region than the country as a whole. Choudhury and Bhuyan (2005)[15] have hinted at imperfect land and labor markets, the key factor of production due to lack of land reforms in tribal inhabited areas and absence of contractual labor in hill economies of northeast India.

The foregoing studies have highlighted scenario of declining work participation particularly by women in non-farm activities, low skill and low productivity level, underdevelopment and persistent income inequality in northeast India and serves as justification for special development package for the region under the Vision 2020 of the Ministry of Development of North Eastern Region and 'Act East Policy' of India. The available literature have also provided empirical

evidence of need for boosting income and reducing income inequality for enhancing welfare of people of the region but lack details of distribution of households by source of income and extend of income inequality by important factors of inequality. Under the given process indicative of the factors of underdevelopment of northeast India it is pertinent to assess whether the household income and income inequality have changed over time in the region. Secondly, individual income gap by type of occupations is also important. Thirdly, an attempt is also made to assess determinants of individual's income.

The paper is organized as follows, next section describes data and used in this study and statistical methods followed for analysis. This is followed by a section on results of the study and ends with a section on summary and discussion.

### 3. DATA AND METHODS

#### 3.1 Data

Data used for this study comprises of macro and micro level data from three main sources, namely, Census of India, Reserve Bank of India (RBI)[16] and India Human Development Survey (IHDS). Population size, change, work participation rates used in the paper is based on data from Census of India, trend in net state domestic product (NSDP) is from the RBI and micro data on household income, sources of income, household size, household assets and socio-demographic particulars of household members are from two rounds of IHDS-I (2004-05) [17] and IHDS-II (2011-12)[18]. Data on household panel surveyed in both rounds of IHDS are used for household income analysis. IHDS is nationally representative multi-topic survey covering 41,554 households in 2004-05 and 42,152 households in 2012 in India and from the eight states of northeast India a total of 2017 households in 2004-05 and 1887 households in 2011-12 were included in IHDS. Out of these sampled households a total of 1536 households in IHDS-I were followed up in IHDS-II and the present analysis is based on these household panel.

#### 3.2 Methods

Inequality of household income distribution is depicted graphically by Lorenz curve (1905)[19]. To draw Lorenz curve household income is first arranged in ascending order as  $y_1 < y_2 < \dots < y_n$  and obtained frequencies  $x_1, x_2, \dots, x_n$  the number of households with incomes  $y_1, y_2, \dots, y_n$ . Then cumulative percent  $X_i, i=1, 2, \dots, n$  of households along the x-axis and  $Y_i, i=1, 2, \dots, n$  of income along the y-axis is plotted to get the Lorenz curve depicted in figure 1.

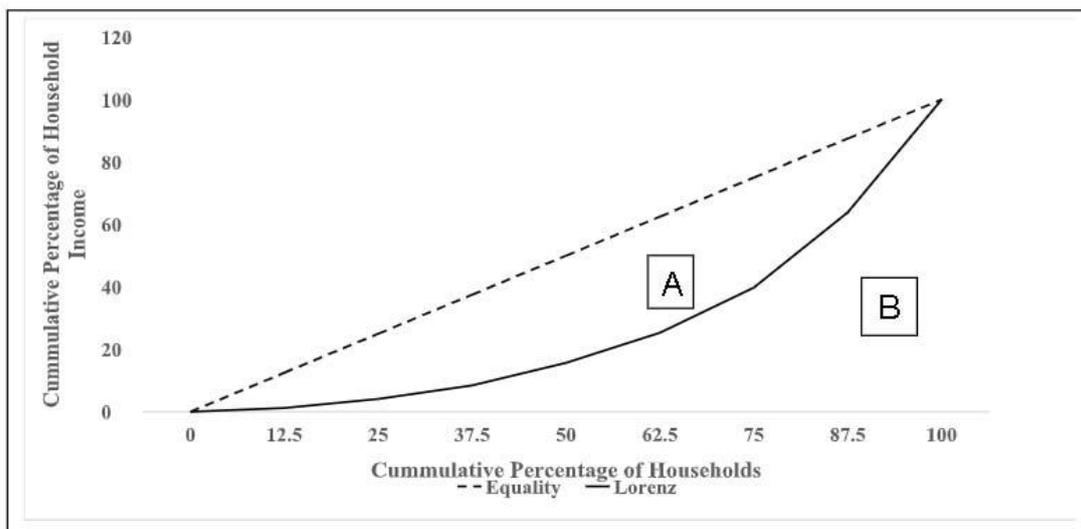


Figure 1: Lorenz curve and line of equality

The Gini concentration index (1912) is define as ratio of area A= area bounded by the Lorenz curve and the line of equality to area B= area bounded by the line of equality and the x-axis. Therefore,

$$C = \frac{\text{Area of A}}{\text{Area of B}}$$

$$\approx 1 - \sum_0^{n-1} (Y_{i+1} + Y_i)(X_{i+1} - X_i)$$

When incomes completely equally for all households, the C value is 0, and whereas when a household has all the income (the condition of maximum inequality), the C value is 1.0. Descriptive statistics and frequency distribution are also used for description and comparison. For assessment of determinants of individual income OLS briefly outline below is used,

$$y_i = \alpha + \beta_1 x_1 + \dots + \beta_i x_i + \dots + u_i, \quad i = 1 \dots n$$

Where,

$y_i$  = dependent variable (per capita annual income for individual)

$x_i$ 's = independent variables (caste, occupation, place of resident, household size, change in income and state)

$\beta_i$ 's = the slope of the regression line

$\alpha$  = the intercept point of the regression line and the y axis.

$u_i$  = error term

Further one-way analysis of variance is further used to assess household income variation by occupation.

#### 4. RESULTS AND DISCUSSION:

The objective of the study is to assess household income inequality over time. To fulfill this objective table 1 shows the decomposition of Gini Index [20] of household inequality for 2004-05 and 2011-12 by between and within income quintiles and overlapping of the two. It can be noted that inequality in per capita income between household income quintiles has significant contribution in income inequality both in 2004-05 and 2011-12, accounting for 49.5 and 51.2 percent of the inequality.

**TABLE 1: DECOMPOSITION OF GINI INDEX (C) FOR 2004-05 AND 2011-12.**

	2004-05	2011-12
Gini Index (C )	0.495	0.512
Within group	0.092	0.114
Between groups	0.269	0.278
Overlap	0.134	0.120

Per capita income within the household income quintiles accounts for 26.9 and 27.8 percent of income inequality in 2004-05 and 2011-12 respectively. Whereas the overlapping factors contributes to 13.4 and 12.0 percent of income inequality in 2004-05 and 2011-12 respectively. The analysis clearly suggests that income inequality in northeast India remains high and has not improved during 2004-05 to 2011-12 mainly accounted by the inequality between household income quintiles. Table 2 shows the per capita annual income of individuals in different occupations by household income quintiles in 2004-05 and 2011-12. It is noted that per capita annual income is the lowest for cultivators and laborers for all household income quintiles and even the retired/ self-employed persons have higher per capita annual income than individuals in these occupations. The per capita annual income of cultivator in lowest and highest household income quintiles were Rs. 3,380 and Rs. 50,416 in 2004-05 which improves to Rs. 6,948 and Rs. 84,775 respectively in 2011-12. As for the laborer in the lowest and the highest income quintiles per capita annual income were Rs. 5,833 and Rs. 43,637 respectively in 2004-05 which improved correspondingly to Rs. 10,957 and Rs. 44,960 in 2011-12. Per capita annual income of individuals in business and retired/self-employed were to a large extent at par and for both occupations it concomitantly escalates with elevation of household income quintiles.

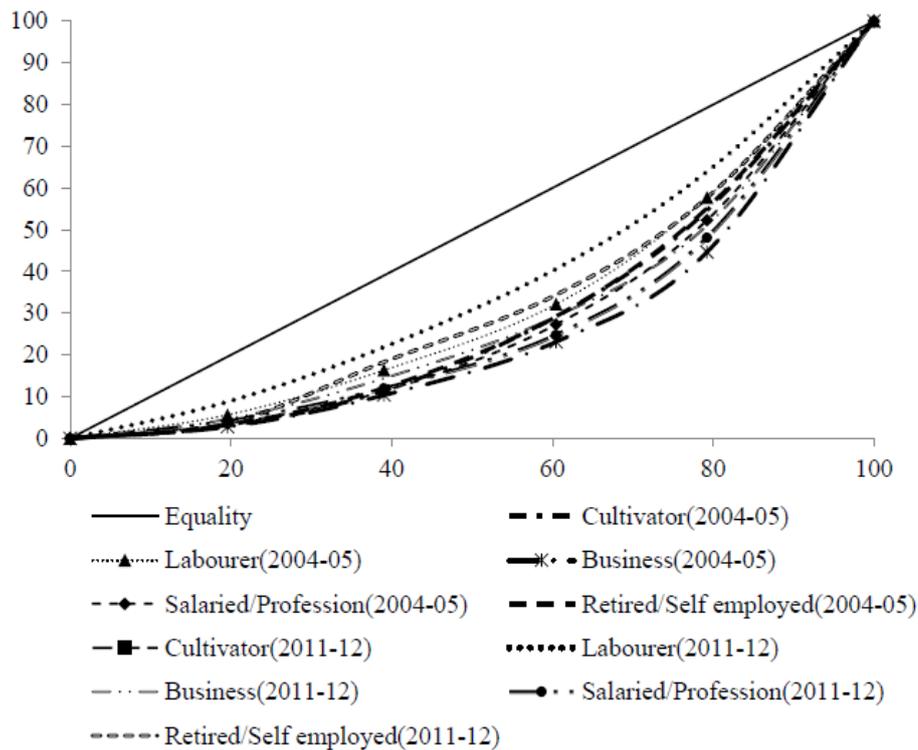
In 2004-05 per capita annual income persons in business is between Rs. 4,747 and Rs. 64,169 for those in first and fifth household income quintiles and corresponding figures for 2011-12 are Rs.7,898 and Rs.83,680 respectively. Likewise per capita annual income of retired/self employed belonging to the first and fifth household income quintiles in 2004-05 were Rs. 4,277 and Rs. 58,485 respectively and corresponding figures for 2011-12 are Rs. 7,586 and Rs. 88,966 respectively. Per capita annual income of salaried/professional persons in northeast India except for those from the fourth and the fifth household income quintiles do not differ significantly from that of persons in other occupations.

**TABLE 2: PER CAPITA ANNUAL INCOME BY INCOME QUINTILES AND OCCUPATIONS IN 2004-05 AND 2011-12.**

First	2004-05	3,380	5,833	4,117	4,747	4,277
	2011-12	6,948	10,957	7,898	9,230	7,586
Second	2004-05	9,350	11,040	11,077	10,507	11,469
	2011-12	15,975	16,317	16,724	17,405	30,964
Third	2004-05	19,685	16,346	18,707	21,500	22,387
	2011-12	22,708	23,298	25,345	28,631	33,791
Fourth	2004-05	28,196	26,333	31,418	33,568	33,718
	2011-12	35,236	28,975	37,253	51,836	48,841
Fifth	2004-05	50,416	43,637	81,045	64,169	58,485
	2011-12	84,775	44,960	83,680	1,15,666	88,966
North East	2004-05	14121	13276	27980	44464	28906
	2011-12	22370	19030	29617	75577	46666

From 2004-05 to 2011-12 for salaried/professionals in the fifth income quintile per capita annual income has nearly doubled from Rs. 64,169 to Rs. 1, 15,666.

Occupation being a single most important source having significant bearing on per capita annual income of individuals the extent inter occupation inequality is assessed using Lorenz curve shown in figure 2 and Gini concentration index (C) outline in the methodology section.



**Figure 2: Income inequality by occupations in 2004-05 and 2011-12**

Income inequality among the laborers in 2011-12 is the least as the extent inequality reduces from that of the level of 2004-05. As evident from the Lorenz curve income inequality is second lowest in 2011-12 among the retired/self-employed and also due to the reduction in inequality from that of the level of 2004-05. In 2011-12 income inequality of persons in business is the third lowest though its level of inequality was the second highest in 2004-05. Income inequality among the cultivator in 2004-05 was the highest of all occupations but the level of inequality has reduce considerably in 2011-12 but is still more that those of retired/self-employed and business for the same year. However the level of income inequality among the salaried/professional has increase during the period 2004-05 to 2011-12 while for all the other occupations level of inequality have lower over this period. To assess significance of income differential by occupation the results of one way analysis of variance for 2004-05 and 2011-12 are shown in table 3. It is found that both in 2004-05 and 2011-12 per capita annual income of individuals differ by occupations and the differential is statistically significant at  $P < 0.001$ .

Table 3: One way analysis of variance of income by occupation in 2004-05 and 2011-12

Source	2004-05					2011-12				
	SS	df	MS	F	Prob> F	SS	df	MS	F	Prob> F
Between groups	2459800	4	614950	55.1	0.000	8893100	4	2223275	107.8	0.000
Within groups	17086000	1531	11160			31576000	1531	20624		
Total	19546000	1535				40469000	1535			

Note: SS-Sum of squares, df- degrees of freedom, MS-Mean sum of squares, F-F statistics

Post-hoc Tukey test is applied to single out occupations which have significance difference in per capita annual income and the results are shown in table 4 for 2004-05 and 2011-12. The odd rows are the differences in per capita annual income between the occupation categories in the rows and the occupation categories in the columns. On the other hand the even rows are the significance

levels of the pair wise differences in per capita annual income. In 2004-05 and 2011-12 per capita annual income of laborer is higher than that of cultivator but the difference is not statistically significant.

Table 4: Differences in per capita annual income by occupations and significance levels in 2004-05 and 2011-12

	2004-05				2011-12			
Row Mean- Col Mean	CU	LA	BU	S/P	CU	LA	BU	S/P
LA	-845				-3340			
P-values	0.999				0.923			
BU	13858	14704			7247	10587		
P-values	0.000	0.000			0.435	0.108		
S/P	30343	31188	16484		53207	56547	45959	
P-values	0.000	0.000	0.000		0.000	0.000	0.000	
R/SE	14784	15630	926	-15558	24296	27636	17048	-28911
P-values	0.000	0.000	0.999	0.000	0.000	0.000	0.019	0.000

Note: CU- Cultivator, LA- Labourer, BU- Business,S/P- Salaried/Professional, R/SE- Retired/Self Employed

Per capita annual income of those in business is higher than those of cultivator and laborer much more in 2004-05 and though the gap is lower in 2011-12 the difference in both time are statistically significant at  $P < 0.01$ . The higher gap in per capita annual income of salaried/professional as compared to that of cultivator, laborer and business are statistically significant at  $P < 0.01$  both in 2004-05 and 2011-12 have widen over time. Per capita annual income of retired/self-employed is significantly ( $P < 0.01$ ) higher than that of cultivator and laborer but is significantly ( $P < 0.01$ ) lower than that of salaried/professional.

Moreover the significant gap have widen over time. To find significant individual and household factors explaining variation in income of individuals OLS described in methodology section is used and the results are shown in table 5.

It is evident both in 2004-05 and 2011-12 that controlling for other backgrounds social groups do not contribute significantly to the differential of individual’s income. Occupation is found to be a significant determinant of income variation when other factors are adjusted. The income of individuals whose occupations are business, salaried/professional and self-employed is higher than the farmers and differential is significant at  $P < 0.01$  in 2004-05 and 2011-12.

Table 5: OLS estimates of regression coefficients of individual income (log scale) on selected background for 2004-05 and 2011-12

	2004-05		2011-12	
	$\beta$	P>t	$\beta$	P>t
<b>Caste</b>				
General <sup>®</sup>				
OBC	0.08	0.539	0.05	0.359
ST/SC	-0.02	0.866	-0.08	0.099
other	0.03	0.794	-0.06	0.594
<b>Occupation</b>				
Cultivation <sup>®</sup>				
Labourer	0.20	0.006	0.05	0.416
Business	0.69	0.000	0.20	0.001
Salaried/Profession	1.16	0.000	0.81	0.000
Retired/Self Employed	0.61	0.000	0.50	0.000
<b>Residence</b>				
Rural <sup>®</sup>				
Urban	0.15	0.007	0.34	0.000
<b>Household Size</b>				
One <sup>®</sup>				
Two	-0.09	0.723	0.25	0.079
More than three	0.24	0.317	0.60	0.000
<b>Change in income</b>				
Reduce <sup>®</sup>				
Same			0.64	0.000
Higher			0.99	0.000
<b>State</b>				
Sikkim <sup>®</sup>				
Arunachal Pradesh	0.05	0.702	0.46	0.000
Nagaland	-0.12	0.357	0.17	0.132
Manipur	-0.08	0.558	0.19	0.084
Mizoram	0.16	0.226	0.50	0.000
Tripura	-0.49	0.000	-0.32	0.001
Meghalaya	-0.96	0.000	-0.05	0.641
Assam	-0.75	0.000	-0.31	0.000
<b>Constant</b>	10.73	0.000	10.16	0.000

Note: \*\*\*P<0.01, \*\* P <0.05, \*P<0.10

Urban resident earns more than their rural counterpart after controlling other factors and the differential is significant for 2004-05 at P<0.05 and for 2011-12 P < 0.01. Household size is not a significant factor of income differential in 2004-05 but in 2011-12 it is found that income of individual from higher household size is found to be higher than that of one member household adjusting for other factors and it is statistically significant at P< 0.01. Between 2004-05 and 2011-12 there is a shift in household income quintiles, some households income quintile have improved, while for some it slides down and some stick to the same income quintile. There is a rise in the income of individuals from households sticking to the same income quintile and from households improving its income quintile and the corresponding increase is higher by 0.64 and 0.99 times respectively higher and is statistically significant at P < 0.01 in 2011-12. Adjusted individual income varies significantly by states. Individuals from Mizoram has a higher income than that of individuals from Sikkim and the income gap is statistically significant at P < 0.01 in 2011-12. Individual belonging to Tripura, Meghalaya, and Assam have lower income that of counterpart Sikkim are significant at P< 0.01 in 2004-05. In 2011-12, individual belonging to Tripura and Assam have lower income that of counterpart Sikkim are significant at P< 0.01.

## **5. SUMMARY AND CONCLUSION**

The two main components of human development index (HDI), literacy rate of states in northeast (NE) India are above the national average and so is mortality rates including infant mortality rate and life expectancy at birth are better place. However all states in NE India are at the lower bottom in HDI ranking of states in India. It clearly suggests that a precondition for this land locked underdeveloped region of the country to move forward is enhanced per capita income and reduce inequality in income distribution. The paper makes an assessment of household income inequality and per capita income differential by occupations which can serve as key policy inputs for strategic planning of the development of NE India.

The pace of improvement in average household annual income is faster among the households in lower income quintile. Decomposition of Gini concentration index shows that more than 50 percent of income inequality in NE India is due to inter quintile differential in the level of income and slightly above 20 percent of income inequality is accounted by intra quintile differential in the level of income.

The paper also assesses the gap in per capita annual income by occupation. Laborer has the least per capita income while it is the highest among the salaried/professional. Per capita income of cultivator is almost at par with that of laborer except for those in the highest income quintile. Low per capita income among the cultivator and laborer is a cause of serious concerned as industrial and cooperate establishments are non-existent in northeast India and the region being depended on agricultural occupation.

## **REFERENCES**

1. Mukherjee S, Chakraborty D, Sikdar S. Three Decades of Human Development across Indian States: Inclusive Growth or Perpetual Disparity?, Working Paper No. 2014-139, National Institute of Public Finance and Policy, New Delhi, 2014; pp.1—30.
2. Sample Registration Service Bulletin. SRS Bulletin. 2002. [http://www.censusindia.gov.in/vital\\_statistics/SRS\\_Bulletins/SRS\\_Bulletins\\_links/SRS\\_Bulletin\\_Vol\\_36\\_Issue\\_2.pdf](http://www.censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS_Bulletins_links/SRS_Bulletin_Vol_36_Issue_2.pdf). Access on 15/10/2016.
3. Sample Registration Service Bulletin. SRS Bulletin. 2012. [http://www.censusindia.gov.in/vital\\_statistics/SRS\\_Bulletins/SRS\\_Bulletin-October\\_2012.pdf](http://www.censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS_Bulletin-October_2012.pdf). Access on 15/10/2016.
4. Saha PP. Employment Situation in North Eastern Region of India: Recent Trends and Emerging Challenges. NLI Research Studies Series No. 96. 2012.
5. Singh, N. S., & Singh, T. A. (2016), “Women Work Participation Rate In North East India: Levels And Patterns”, Indian Journal of Applied Research, Vol.6, No.4.
6. Census of India 2001: provisional population totals-India data sheet. Office of the Registrar General Census Commissioner, India. Indian Census Bureau. 2001.
7. Census of India 2011: provisional population totals-India data sheet. Office of the Registrar General Census Commissioner, India. Indian Census Bureau. 2011.
8. Pegu A. Female work participation in north-eastern region: An overview. International Journal of Humanities & Social Science Studies, 2015;1(4):154-160.
9. Dhar S. Gender Inequality in Education, Health and Employment in North-East India. International Journal of Humanities & Social Science Studies (IJHSSS),2015;1(4):111-116.
10. Mahanta B, Nayak P. Gender Inequality in North East India. In Proceedings of the

National Seminar on Poverty and Human Development: Issues and Challenges, Dept. of Economics, Doomdooma College, Assam, India, 2013. pp. 10-11.

11. Ngangbam S, Ladusingh L. Education, fertility and earning of women in northeast India. *Artha Vijnana*, 2013;55(3):272-288.
12. Sarma GK. Growth of income inequality and its trend in north eastern states of India. *International Journal of Science and Research*, 2015;4(7):2391-2394.
13. Neogi D. Disparity in socioeconomic development and its implications on communal conflicts: A study on India's north-eastern region. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 2010;4(3):259-266.
14. Nair M, Ravindranath NH, Sharma N, Kattumuri R, Munshi M. Poverty index as a tool for adaptation intervention to climate change in northeast India. *Climate and Development*, 2013;5(1):14-32.
15. Choudhury S, Bhuyan R. Development disparity and north-east region. *Dialogue*, 2005;7(2).
16. Reserve Bank of India. Handbook of Statistic of India Economy. 2016. <https://www.rbi.org.in/scripts/PublicationsView.aspx?id=17143>. Access on 17/10/2016.
17. India Human Development Survey. National Council of Applied Economic Research (NCAER), New Delhi. 2004. <http://www.icpsr.umich.edu/icpsrweb/DSDR/studies/36151>
18. India Human Development Survey. National Council of Applied Economic Research (NCAER), New Delhi. 2011. <http://www.icpsr.umich.edu/icpsrweb/DSDR/studies/36151>
19. Lorenz MO. Methods of Measuring the Concentration of Wealth. *Journal of the American Statistical Association (new series)*, 1905;9(70):209-217.
20. Gini C. Variabilità e mutabilità. In: Pizetti, E. and Salvemini, T., Eds., Rome: Libreria Eredi Virgilio Veschi, Memorie di metodologica statistica. 1912.