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Assessing spatial pattern and trend of rural-urban disparity in sex ratio in west Bengal, India using IRUD method: From post-independence onward analysis

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Abstract
This paper is an attempt to scrutinize the trends of sex ratio (Total, Rural, and Urban), and spatial patterns of urban-rural differential from 1951 to 2011. It is noticed that rural sex ratio (RSR) is higher than urban (USR) and total sex ratio (TSR). While the USR growth rate is higher than RSR and TSR growth rate. Growth rate and rate of change where base years 1951, clearly show that extreme northern and south-eastern districts accounted for a sound decadal change. The rural-urban differential index is found to be high in the south-eastern region in the earlier start and it tends to decline from post-independence onwards. IRUD shows RSR is leading over USR throughout the decades in the state. In the last decade, many districts noted urban dominance in sex ratio.

Keywords: sex ratio, urban sex ratio, rural sex ratio, growth rate, differential index, urbanized

1. Introduction
The sex ratio is defined as the number of females per thousand males in the population. This is an essential social indicator to quantify the degree of prevalent equity between males and females in our society at a given period of time. The sex ratio is one of the ubiquitous and the most challenging issues that people in developing nations are facing and India is a part of it. In India, Kerala has accounted for a high sex ratio while Haryana has documented a radical fall and is faced the lowest sex ratio in 2011 (Census of India, 2011) [24]. The sex ratio in India and West Bengal is characterized not only by low but also by a great disparity in the sex ratio between urban and rural, between geographical areas, and across the districts. Everywhere in the world, roughly 5 per cent more males are born compared to girls (Sen, 1992, Unisa, 2009) [29, 33] under normal circumstances that widen the gender gap. However, the worse sex ratio in Asia and northern Africa could be a result of a greater fertility rate and lesser life expectancy rate (Sen, 1992) [29]. It may be distinguished that the sex ratio is assumed to be uniform in nature. Though there are many causes of unequal sex ratio can be classified as socio-economic, technological, natural and biological causes. As stated by specialists, the major influential factors that stimulate changes in sex ratio are sex differential in mortality, the lopsided sex ratio at birth (Coale, 1991) [7], sex-selective and internal migration, (Kaur, 2004; Gautam *et al*., 2015; Banerjee, 2016) [19, 12, 2] female infanticide (Gu and Roy, 1995; George S *et al*., 1998) [14, 13], time taken to conceive (Smits L. JM *et al*., 2005), desire to have a son over daughter (Das Gupta *et al*., 2003; Clark, 2000; Pande & Astone, 2007) [8, 6, 27], high female mortality in early childhood (Oster, 2009) [25] due to inequality in nutrition and immunization (Pande 2003; Borooah 2004; Oster 2009; Mishra *et al*., 2004) [26, 4, 25, 22], low reporting of female births (Hatti N *et al*., 2004) [15], father's occupation (Friedlander and Moshe, 1986; Norberg K, 2003) [10, 23], hormonal factors (James WH, 1996) [18], gender biases (Bhat and Zavier, 2003) [3] and smoking (Fukuda M, *et al*., 2002) [11].
By discussing the regional disparity in sex ratio, this paper attempts to analyse the extent of rural-urban differences in sex ratio.
Therefore, this study targets to accomplish some pertinent objectives like

i) Finding out the total, rural, and urban sex ratio difference in West Bengal from post-independence onwards.
ii) Interpreting the district level difference in growth rate and rate of change where 1951 is

taken as a base year in total, rural and urban to see the scenario of the trend of change of sex ratio in West Bengal.

iii) To find out the degree of differences of sex ratio among rural and urban by using IRUD, consequently the degree of dominance (rural or urban) could be identified.

2. Database and methodology

2.1 Study area

West Bengal, an easternmost state which is stretched over an area of 88,752 sq. km. (2.70% of India's total geographical area). This state is located between 21° 25' North to 27° 13' North latitudes and 85° 48' East to 89° 53' East longitudes and ranging from Himalaya in its northern border to the Bay of Bengal in the south. Nepal, Bangladesh and Bhutan are the three international bordering countries. As per the 2011 Census of India, the state is divided into 19 districts (figure 1). As per the census 2011, this state has a population of 9.13 Crore where 31% reside in urban and 69% in rural areas. The sex ratio rate has increased from 934 (2001) to 950 (2011) which is more than the national average of 943 (Census of India, 2011) [24]. The growth rate of the population in West Bengal between 2001 and 2011 was 13.84%.

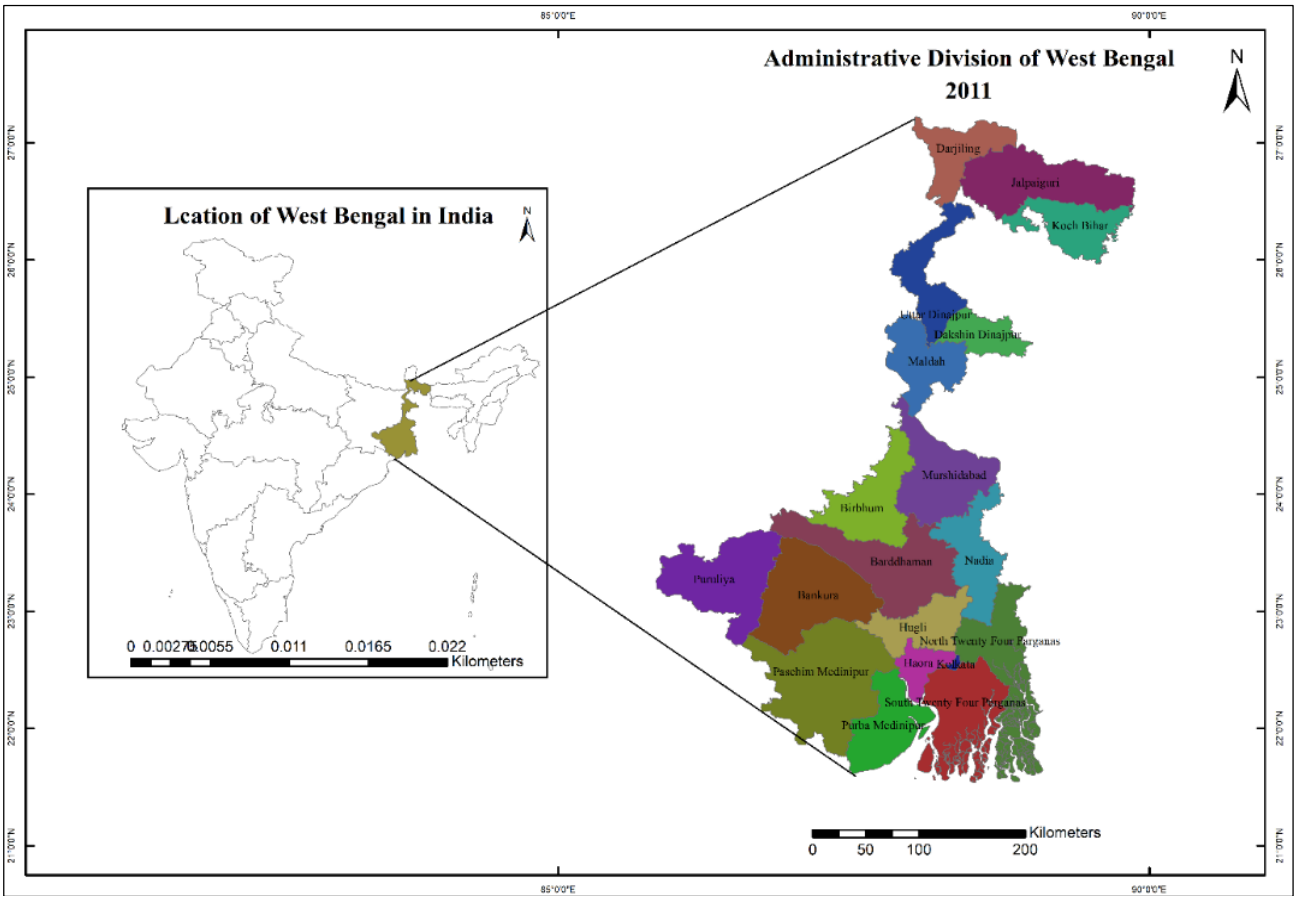

Fig 1: Location Map of West Bengal

2.2 Data source

This study is mainly secondary data based. The relevant data is obtained from the social and cultural table, District Census Handbook-West Bengal, Office of the Registrar General & Census Commissioner, India.

2.3 Data analysis method

2.3.1 Statistical processing of data

To identify the change in sex ratio between the decade, growth rate and rate of change have been calculated where 1951 has been considered as the base year by applying the following formula:

$$GRSR = \frac{SR_{pr} - SR_p}{SR_p} * 100 \quad \text{(i)}$$

Where,
GRSR = Growth rate of sex ratio.
SR_{pr}= present sex ratio.
SR_p= past sex ratio.

$$RCSR_{by1951} = \frac{SR_{pr} - SR_{by1951}}{SR_{by1951}} * 100 \quad \text{(ii)}$$

Where,
$RCSR_{by1951}$ = Rate of change of sex ratio base year 1951.
SR_{pr} = present sex ratio.
SR_{by1951} = Base year (1951) sex ratio.

To identify the degree of disparity among rural and urban areas regarding sex ratio, the index of rural-urban differential in sex ratio (IRUD) method has been used to calculate the differential index of sex ratio for each district of West Bengal. However, the consequential index values of sex ratio have been contrasted successively with the time period of 1951 to 2011.

$$IRUD = \frac{R_{sr} - U_{sr}}{T_{sr}} \quad \text{(iii)}$$

Where,
IRUD = Index of rural-urban differential in sex ratio.
U_{sr} = Sex ratio of urban population.
R_{sr} = Sex ratio of rural population.
T_{sr} = Sex ratio of total population.

IRUD of sex ratio portrays dominance of sex ratio of rural and urban on the one hand and the degree of sex ratio gap on the other hand. Therefore, if the value is positive (+) then it is indicated rural dominance of the sex ratio and if the value is negative (-) then the sex ratio is urban dominance. The larger the value of IRUD points out the greater degree of difference between rural and urban sex ratios. The concept of the index of rural-urban differential (IRUD) method has been adopted from Krishan and Shayam's (1978) [20] article "Regional Aspects of Urban-Rural Differentials in Literacy in India: 1971" and Regional analysis of urban-rural differentials in literacy in Uttar Pradesh, India by Shafiqullah (2011) [30]. But for better assessment of sex ratio in the IRUD method, the urban sex ratio is subtracted from the rural sex ratio because the rural sex ratio is more compared to the urban sex ratio while they subtracted rural from urban in the case of literacy analysis due to high urban literacy as compared to rural literacy. Therefore, the consistency in the degree of differentiation of the index could be scrutinized.

2.3.2 Cartographic representation of data
Based on the calculated data set, data has been presented through a radar diagram to show the decadal disparity within the districts and among the districts of the total, rural, and urban sex ratio from 1951 to 2011. Therefore, a differential picture of the degree of the sex ratio of the study area has been assessed through different dimensional analyses.

3. Results and Discussion
3.1 Total Sex Ratio (TSR)
TSR of the state has grown many folds from post-independence onward. At the state level, the total sex ratio increased from 865 in 1951 to 911 in 1981, and 950 in 2011. However, around 85 females have been increased per thousand males from 1951 to 2011. However, TSR across the districts is uneven from post-independence onwards. Six districts (32% of all districts); Kolkata (>300), Darjiling, Jalpaiguri, Haora, North and South 24 Parganas (>100) have reported an increasing trend of females per 1000 males from 1951 to 2011 while, Birbhum, Murshidabad, Maldah, Bankura, Puruliya and Purba Medinipur has shown a declining trend (>15) of females. In 1951, a high sex ratio (>900) is noted in economically poor districts; Puruliya, Maldah, Murshidabad, Birbhum, Nadia, Bankura, Paschim and Purba Medinipur. While Kolkata reported a very low sex ratio (593), followed by Haora, Nadia, Jalpaiguri, North and south 24 Parganas, Hugli, etc. (<900). From 1951-1961, TSR declined in Maldah (from 966 in 1951 to 965 in 1961), Birbhum (974 to 973), Barddhaman (888 to 858), Haora (810 to 808), Puruliya (983 to 973) and Medinipur (955 to 952).

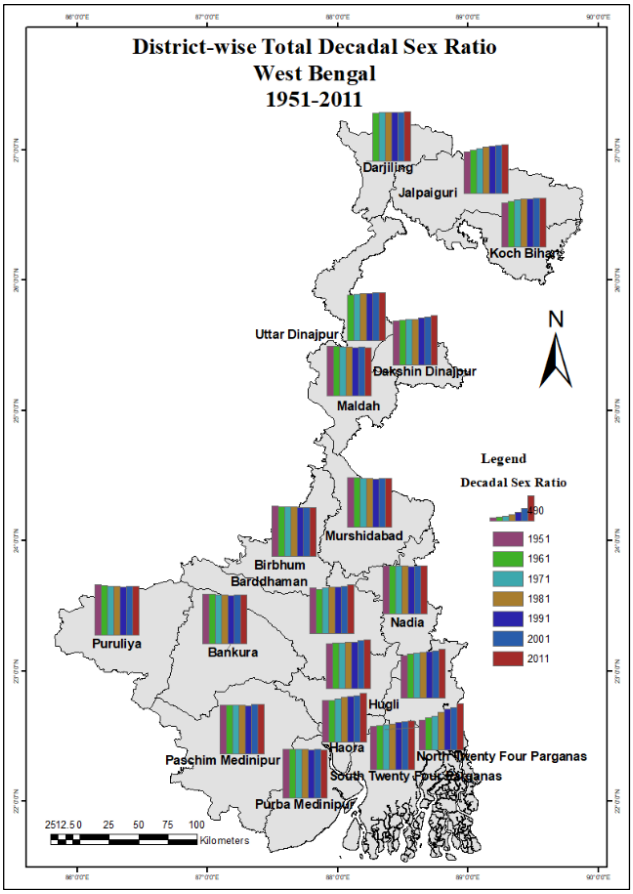

Fig 2: Districts-wise Decadal TSR in West Bengal, 1951-2011

Puruliya has shown a consistent decline in the sex ratio from 1961 to 1991 (973 in 1961, 963 in 1971, 957 in 1981, and 947 in 1991). Birbhum (973 to 946) and Maldah (965 to 938) also has observed a shrinking trend of TSR from 1961 to 1991 (figure 2). In 1991, 53% of districts namely, Uttar and Dakshin Dinajpur, Maldah, Murshidabad, Birbhum,

Bankura, Nadia, Puruliya, Paschim, and Purba Medinipur have been noted decreasing trend of TSR compared to the previous decade (1981). In 2001, all districts have registered above 900 TSR except Kolkata (829) and positive growth has been observed in all districts. Only three districts; Koch Bihar (7), Maldah (4) and Purba Medinipur (9) have noted decreasing TSR than the earlier decade (2001). In 2011, about 57% of districts; Darjiling, Jalpaiguri, Puruliya, Dakshin Dinajpur, Murshidabad, Birbhum, North and South 24 Parganas, Bankura, Paschim Medinipur and Hugli accounted for more than state average TSR (950).

3.2 Rural Sex Ratio (RSR)

RSR shows unevenness all over the districts but it is higher than the total and urban sex ratio. From 1951 to 2011, the number of females per 1000 males increased to 119 in Jalpaiguri, 68 in Darjiling, 72 in Koch Bihar while Puruliya, Bankura (-28), Birbhum (-29), Murshidabad (-23) and Maldah (-22) has noted a decreasing trend (figure 3). Maldah and Puruliya from 1961 to 1991, Murshidabad and Birbhum from 1971 to 1991, Hugli from 1961 to 1971, Nadia from 1981 to 1991, Bankura from 1991 to 2001 have noted a steady decline in RSR. All districts except Darjiling, Jalpaiguri in the north and Hugli in the south have stated positive growth compared to the previous decade (1981). Nadia experienced constant RSR (941) from 2001 to 2011 and Birbhum (984) from 1951 to 1961. In 1951, all districts except Jalpaiguri noted (838) more RSR than state TSR (865).

It is noticed that the RSR of all districts from 1961 to 2001 reported more than the state's TSR for each decade. But in 2011, many districts like Koch Bihar, Uttar Dinajpur, Maldah, Nadia, South 24 Parganas, and Purba Medinipur noted less RSR than state TSR (950). However, state TSR has increased many folds but still, several districts remained below the state's average TSR. Only two districts namely, Darjiling and Jalpaiguri reported a consistent growth of RSR after independence onwards (1951-2011). Kolkata does not have a rural population because Kolkata itself is a metropolitan city.

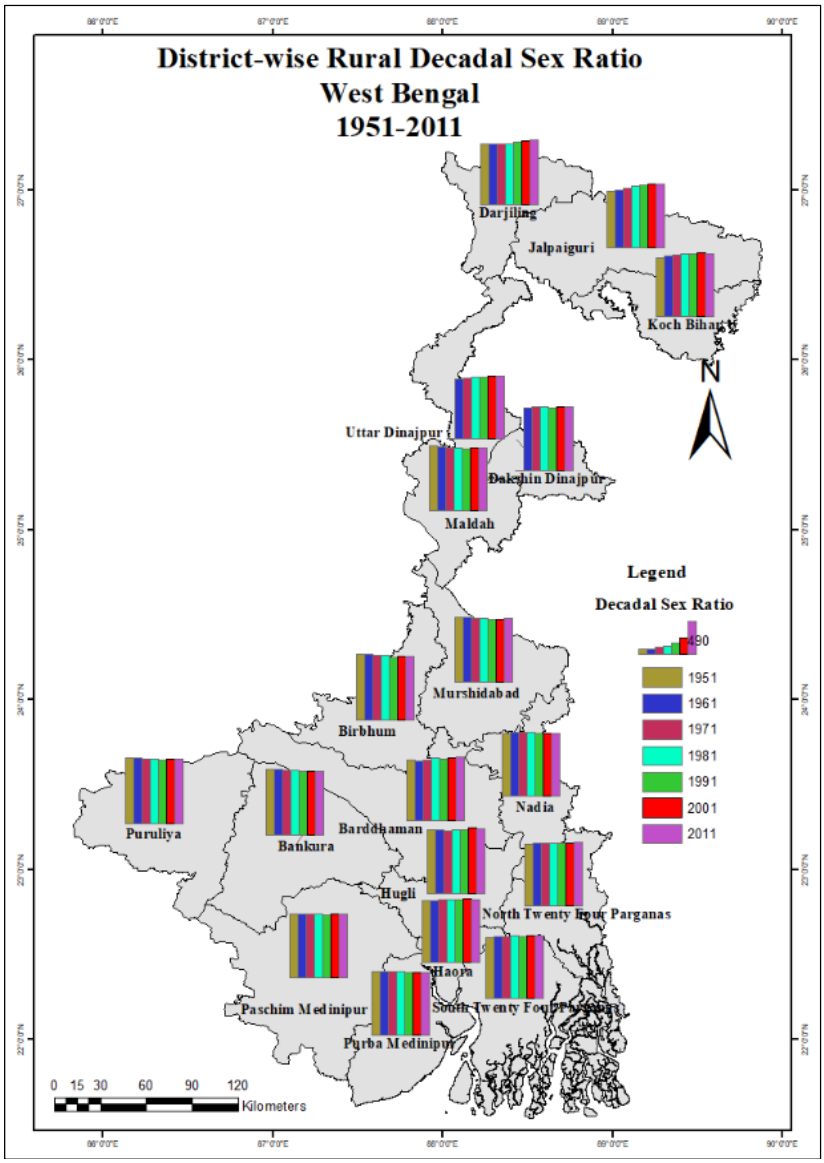

Fig 3: Districts-wise Decadal RSR in West Bengal, 1951-2011

3.3 Urban Sex Ratio (USR)

Post-independence onwards, the urban sex ratio (USR) has improved many folds but various districts still reported less than the state average. USR is lower than RSR across the districts throughout the decades except for a few districts. From 1951 to 2011, Haora (322) accounted for the highest

USR followed by Kolkata (315), North and South 24 Parganas (283), Hugli (271) in the south-east, and Darjiling, Jalpaiguri, and Koch Bihar in the north (245-264). Nearly 57% of districts like Darjiling, Jalpaiguri, Koch Bihar, Maldah, North and South 24 Parganas, Kolkata, Haora, Hugli, Barddhaman, Birbhum stated less than state average TSR (865) in 1951. However, all low to moderate urbanized districts (Nadia, Murshidabad, Bankura, and Puruliya) showed better USR than high urbanized districts. It is observed that 52% of districts namely, Darjiling, Jalpaiguri, Koch Bihar, Dakshin Dinajpur, North and South 24 Parganas, Kolkata, Haora, Hugli and Paschim Medinipur have shown consistent growth in USR from 1951 to 2011.

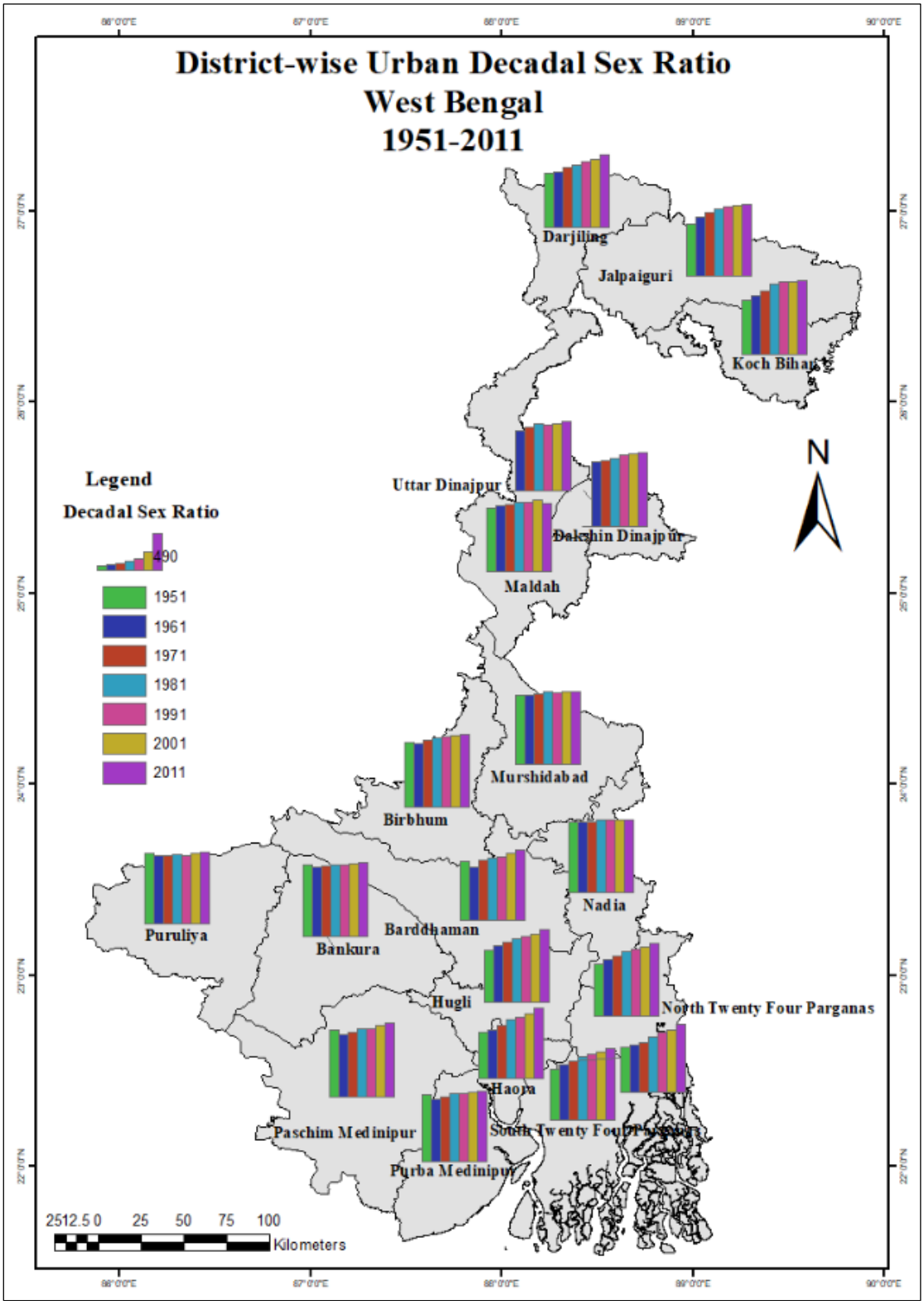

Fig 4: Districts-wise Decadal RSR in West Bengal, 1951-2011

It is worthy to mention that all high urbanized districts enumerated more USR than a low urbanized district in the last six decades. Only three districts; Murshidabad, Nadia, and Bankura accounted for above 900 USR from 1951 to 2011 while USR in the remaining districts has fluctuated (figure 4). Approximately 42% of districts such as

Murshidabad in 1961 and 1991, Uttar Dinajpur in 1991, Maldah in 1991 and 2011, Puruliya in 1961 and 1991, Barddhaman, Birbhum, Bankura, and Purba Medinipur in 1961 noted low USR than their previous decades. About 52% of districts namely, Darjiling, Koch Bihar, Dakshin Dinajpur, Murshidabad, Nadia, North and South 24 Parganas, Birbhum, Bankura, and Paschim Medinipur noted USR more than the state's TSR in 2011.

3.4 Growth rate of TSR

Darjiling, Jalpaiguri, Kolkata, North and South 24 Parganas noted a positive growth rate of TSR over the decades (1951-2011) while Maldah, Puruliya, both Medinipur have listed a negative growth rate. Kolkata in 1971-1981 has accounted highest growth rate (12%) while Birbhum and Nadia, and Puruliya recorded a negative growth rate.

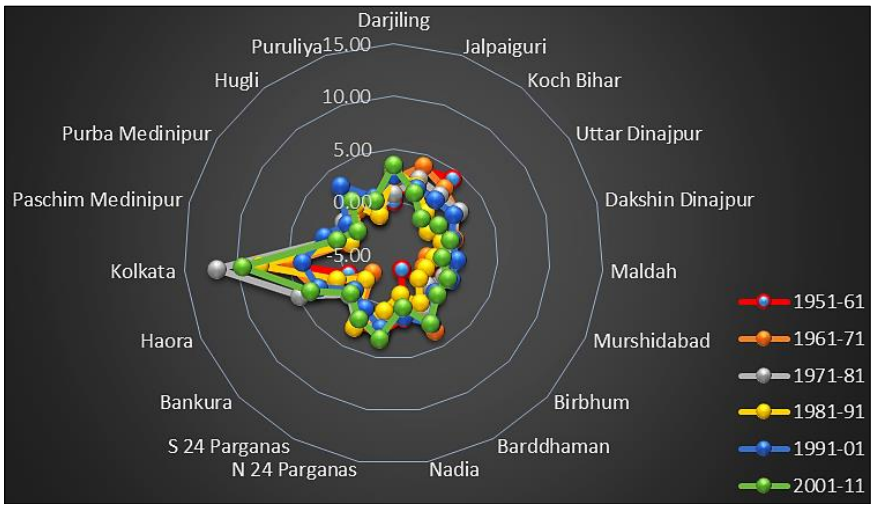

Fig 5: Districts level growth rate of TSR in West Bengal, 1951-2011

Most of the districts in 1981-1991 noted a negative rate of change (>1%). However, in the last two decades, a sound rate of change in TSR has been noticed across the districts. However, it is visible (figure 5) that TSR growth is Kolkata-centric from 1951 to 2011 while all the districts showed more or less the same degree of growth.

3.5 Growth rate of RSR

The decadal growth rate of RSR across the districts has shown uneven change over the decades from 1951 to 2011. Only Darjiling and Jalpaiguri noted a positive growth rate throughout the decades (1951-2011). In 1951-1961, Koch Bihar (3.69%) recorded the highest growth rate of RSR followed by Jalpaiguri (3%), Haora (1.62%) and Nadia (1.17%). Maldah, Barddhaman, Hugli and Puruliya registered a negative growth rate while the rest of the districts noted a less than 1% growth rate in this decade (figure 6). 1961-1971, Jalpaiguri, Koch Bihar, Uttar Dinajpur and Barddhaman accounted for more than a 2% growth rate of RSR while Maldah, Murshidabad, Birbhum, Bankura, Paschim Medinipur and Purba Medinipur presented more than 1% negative growth rate. 1981-1991, most of the districts except Darjiling and Jalpaiguri on the north and Hugli on the southeast registered a negative growth rate. Only Bankura listed a negative growth rate (-0.10%) in 1991-2001 whereas northern four districts and three south-eastern districts noted a reasonable growth rate (>1%).

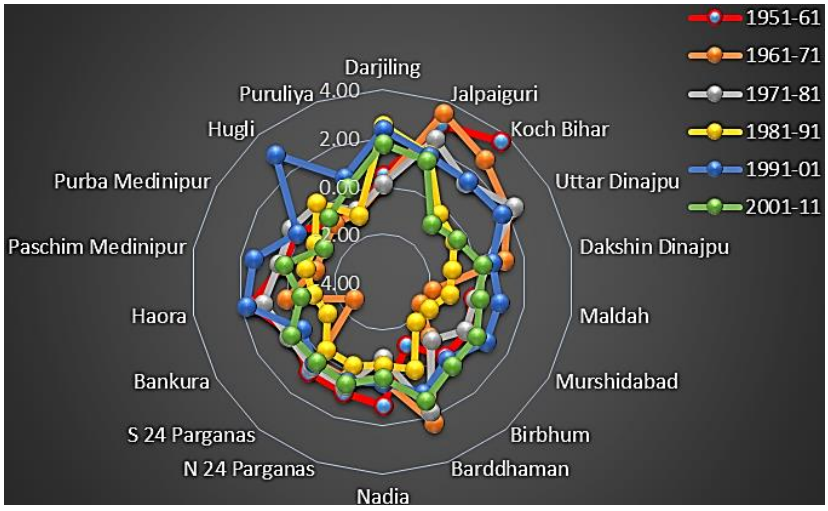

Fig 6: Districts level growth rate of RSR in West Bengal, 1951-2011

Puruliya and Maldah in 1951-1961, to 1971-1981, Birbhum and Murshidabad 1961-1971 to 1981-1991, Hugli in 1951-1961, 1961-1971, and 2001-2011, Nadia in 1971-81 to1981-1991, Bankura in 1961-1971 to 1991-2001 has stated negative growth rate.

3.6 Growth rate of USR

The rate of change of USR is quite better than RSR and it has improved from 1951-1961 to 2001-2011, yet the growth rate has varied across the districts. Hence, 21% of northern districts, (Darjiling, Koch Bihar, Jalpaiguri, Dakshin Dinajpur) and 32% of southern districts, (including Kolkata, North 24 Parganas, South 24 Parganas, Haora, and Hugli) has witnessed a positive growth from 1951-1961 to 2001-2011. A high growth rate was accounted for Jalpaiguri (13.11%), followed by Kolkata and its peripheral districts in 1951-1961. Low urbanized districts; Birbhum, Bankura, Murshidabad, Barddhaman, Puruliya, and both Medinipur has noted a negative growth rate therefore, the graph is skewed toward the centre (figure 7). A high positive growth rate was observed in the decade 1971-1981 for all districts while Kolkata, Haora, and Koch Bihar have listed above 10% growth rate. Maldah, Murshidabad, Bankura, Uttar Dinajpur and Puruliya detected a negative rate of change in 1981-1991 while Darjiling, Dakshin Dinajpur, Kolkata, and Haora listed a high and positive growth rate. Maldah accounted for a negative (-4%) USR growth rate in 2001-2011 as a result of the decline of the child sex ratio while adjacent districts of Kolkata, have stated a high growth rate due to the growth of child sex ratio (Census of India, 2001, 2011) [24].

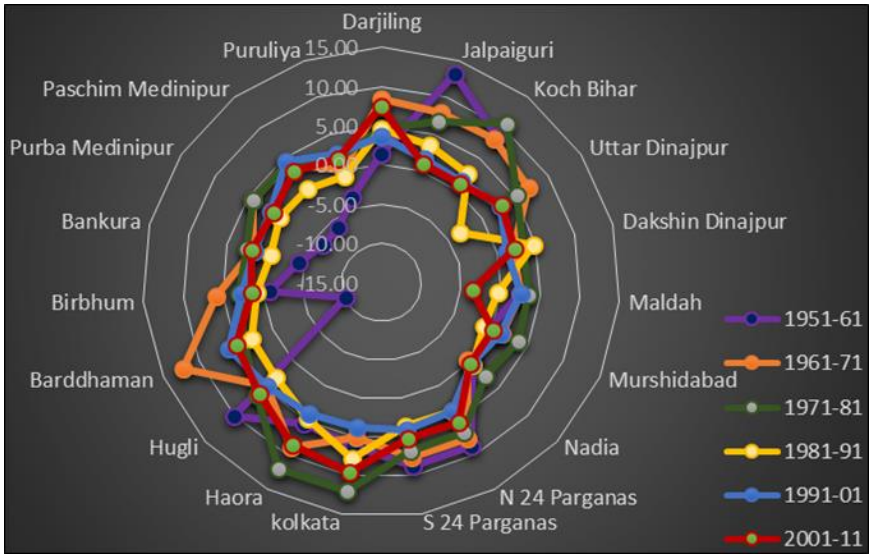

Fig 7: Districts level growth rate of USR in West Bengal, 1951-2011

A huge number of women are moving to the hilly region (northern part of the state) for work in tea industries and other prospects. Still, Kolkata Metropolitan areas are the centre of attraction in many viewpoints that encourages males to migrate (Banerjee, 2016) [2] which influenced the sex ratio pattern (Friedlander and Moshe, 1986) [10].

3.7 Rate of change of TSR (Base-year 1951)

In the last six decades (1951-2011), only Kolkata has reported a high rate of change (53%) of TSR followed by northern districts like Koch Bihar, Jalpaiguri and Darjiling and bordering districts of Kolkata in the south-east. They also show a consistent growth rate from 1951-1961 to 1951-2011. About 26% of total districts; Maldah, Murshidabad, Bankura, Purba Medinipur, and Puruliya have observed a negative rate of change throughout the decades that's why this (figure 8) shows lopsided toward the centre and on the other hand, a high growth rate reported in Kolkata, therefore, the line graph of radar graph is inclined toward Kolkata.

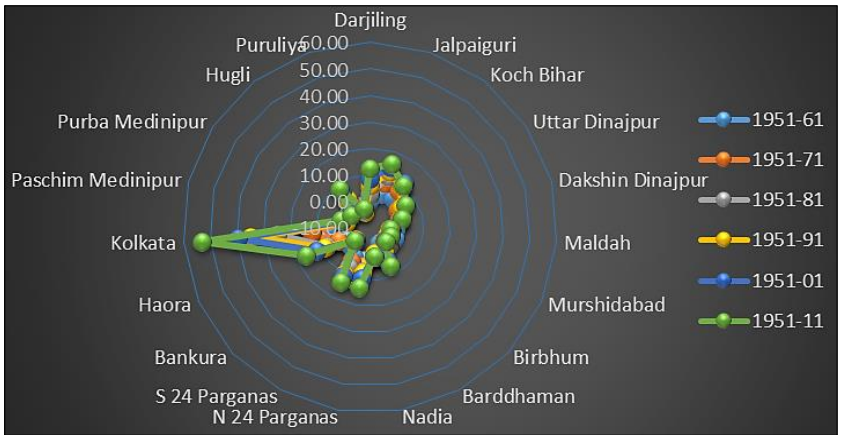

Fig 8: Districts level rate of change of TSR (base-year 1951) in West Bengal, 1951-2011

3.8 Rate of change of RSR (Base-year 1951)

In the last sixty years, the growth rate of RSR has not improved much. It is detected that five districts (Darjiling, Jalpaiguri, Koch Bihar, Uttar and Dakshin Dinajpur) in the northern part and three districts (Haora, North and South 24 Parganas) in the southern part have shown steady growth of

RSR from 1951-1961 to 1951-2011. Darjiling, Jalpaiguri, and Koch Bihar have noted a better growth rate throughout the decades and in 2001-2011, Jalpaiguri retained the top position (14%). In the last sixty years (1951-2011), Maldah, Murshidabad, Birbhum, Bankura, Purba Medinipur and Puruliya still accounted for a negative growth rate.

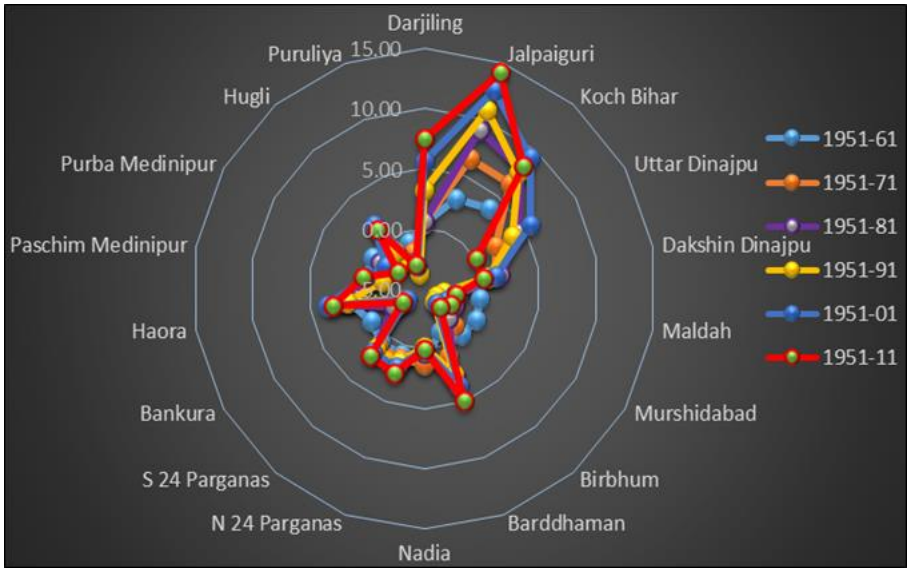

Fig 9: Districts level rate of change of RSR (base-year 1951) in West Bengal, 1951-2011

About 37% of districts; Maldah, Murshidabad, Birbhum, Bankura, Purba Medinipur, Hugli and Puruliya noted negative growth rates all over the decades. However, it (figure 9) is clearly displayed that southern and western districts observed a negative rate of change over the decades that's why the line graph of Radar skewed toward the inside while it is inclined towards northern districts which means they perceived a positive rate of change.

3.9 Rate of Change of USR (Base-year 1951)

The growth rate of USR in the last sixty years is much higher than RSR and TSR. Bankura and Puruliya accounted for a steady negative growth rate over the decades (1951-2001). It is remarked that five south-eastern districts (Kolkata, Haora, North and South 24 Parganas, and Hugli) that are 26% of all districts and three northern districts (Jalpaiguri, Koch Bihar and Darjiling) have shown tremendous growth over the last six decades. Therefore, Jalpaiguri noted a USR growth rate of about 13% to 39%, Koch Bihar 9% to 37%, Darjiling 1% to 34%, Kolkata 6% to 53%, Haora 6% to 53%, North and South 24 Parganas 9% to 42% and Hugli 10% to 40% from 1951-1961 to 1951-2011. Contrary to this, low urbanized and socio-economically poor districts such as Birbhum, Bankura, Medinipur, Puruliya, Maldah, and Nadia have presented a truncated and sluggish USR growth rate. It is remarkable that Darjiling accounted twenty-four times higher growth rate in 2001-2011 as compared to 1951-1961, while Kolkata, it's nine times higher.

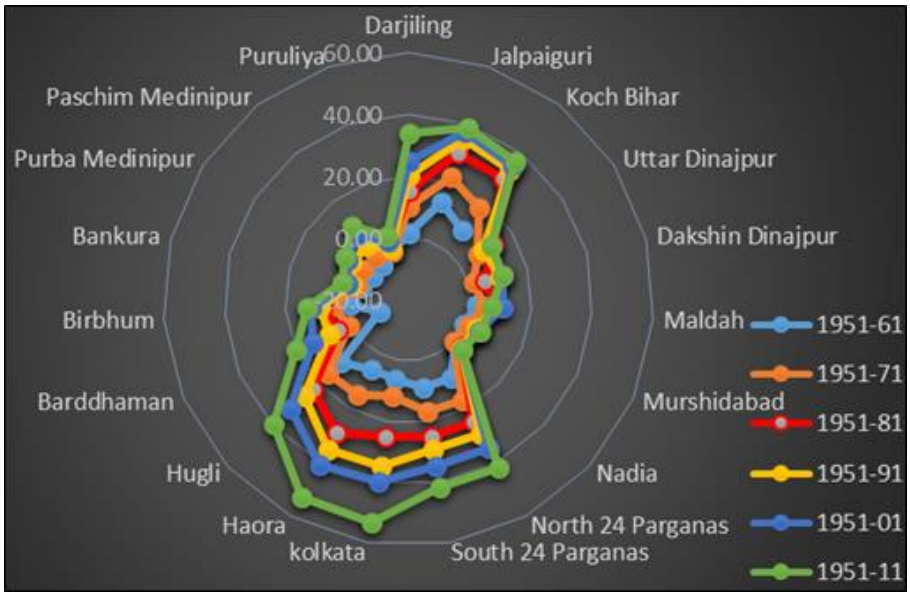

Fig 10: Districts level rate of change of USR (base year 1951) in West Bengal, 1951-2011

However, this (figure 10) makes clear that North Bengal and South Bengal districts displayed a positive rate of change of USR which tends to line graph of the radar diagram extend towards north and south while western and central-northern

districts show a contracted shape of the diagram because of a low and negative rate of change of USR.

3.10 Index of Rural-Urban Differential (IRUD) of Sex Ratio

From the IRUD (figure 11), it is noticed that most of the districts have shown positive (+) value which depicts the dominance of rural sex ratio over urban sex ratio from 1951 to 2011. However, around 37% of districts namely, Darjiling, Jalpaiguri, Maldah, Bankura, Haora, North and South 24 Parganas have shown a consistent decline in rural dominance from post-independence onward (1951-2011). Therefore the degree of differences between rural and urban sex ratios has been shrinking. Koch Bihar from 1951 to 1981 has recorded declining trends of rural dominance of sex ratio and from 1991 to 2011 urban sex ratio supremacy (negative value) has been observed. In the same way, Dakshin Dinajpur from 2001 to 2011, Murshidabad from 1981 to 2011, Birbhum from 1991 to 2011, Barddhaman, Nadia, and Hugli in 2011 has experienced negative differential index value. Therefore, the USR is predominant over the rural sex ratio in aforesaid districts and decades. Hence 37% districts of total districts have observed URS supremacy. In 1961, 32% of districts; Haora (0.18 to 0.30), Hugli (0.08 to 0.06), Puruliya (0.07 to 0.09), Paschim Medinipur (0.02 to 0.06) and Purba Medinipur (0.08 to 0.14) has noticed the increase of RSR dominance.

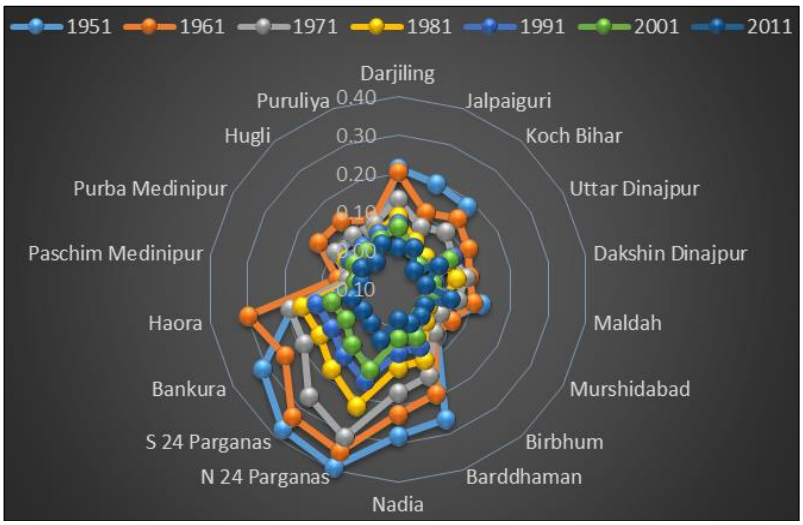

Fig 11: Index of Rural-Urban Differential of Sex Ratio, 1951-2011

Therefore, it (figure 11) represents that all districts especially southern districts have inclined very fast toward the centre from 1951 onward which signifies rural dominance of sex ratio is reducing while north Bengal districts show low differences between urban and rural sex ratio gap.

In the last, it is true that inequality in sex ratio within, outside and among the regions is the result of several factors which is concerned to need detailed research. In the north tea and tourism and industries to service sectors developed in the south-east of the state which tends to migrate more people for job opportunities from in and outside of the state. Though, due to lack of medical care given to females as compared to males are unequal which resulted in more than 132, 000 girls dying between the 1-5 years age group in India (Kristof, 2009) [21]. The child sex ratio of the state has dropped while in most of the districts, the child sex ratio (CSR) has radically deteriorated over the decade (Census of India, 2011) [24]. Though education and Health facility; components of social indicators have a strong link with sex ratio, therefore Kerala accounted for a sound sex ratio (Dawn and Basu, 2015) [9]. Although, it is assessed that literacy and economic growth have an optimistic relationship with a sex ratio (Echávarri and Ezcurra 2010; Sule and Barkade, 2012; Jadhav *et al*., 2014; Saha and Debnath, 2016) [34, 32, 17, 28], hence western districts specially Puruliya has noted a low sex ratio all over the decades as it is a low literate, health facilities and economic development district.

5. Conclusion

The significant findings reveal that the sex ratio in West Bengal has improved from post-independence onwards. The rural sex ratio is high more than the total as well as urban sex ratio in the state. The northern and south-eastern state has registered a high growth rate of sex ratio. While USR growth rate has increased more as compared to rural and total. The rural-urban gap in sex ratio has reduced after independence. On the other hand, the urban sex ratio is drastically growing in moderate to high urbanized districts which signify that more female populations are moving to urban areas for work as well as for many more opportunities. However, in developing areas, especially in India, the sex ratio is lopsided in favour of males and has constantly risen and grown in various forms. Females at birth fall in those parts where (Human Development Index (HDI) is moderately better and life expectancy is higher (Gautam *et al*., 2015) [12]. Sen (1992) [29] evaluated that due to the degree of difference in the mortality rate of females, there are above 100 million females missing worldwide while other scholars (Agnihotri 2000; Chakraborty and Kim 2010) [1, 5] have identified the trend, level and various reasons of missing women. Though there are a lot of reasons responsible for the disparity in sex ratio within the region and among the region which is pointed out above. Therefore, this has stressed the comprehensive consideration of planners and policymakers to overturn the trend to bring it back to uniformity. However, the educational level of women plays a noteworthy role in determining the child sex

ratio (Inchani and Lai, 2008) [16] which presently require great attention for every section of viewers.

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