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Demographic Profile of Bihar

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Asian Development Research Institute

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Introduction

The demographic profile of a given area provides details of past and present population characteristics across several dimensions. Apart from changes in pure demographic composition due to variations in birth, death and marriage over time, such a profile helps understanding the interaction between those and the changes in socio-economic characteristics such as literacy, workforce participation etc. in the total population. The analysis may be refined at disaggregated levels across socio-religious groups, location and gender. This understanding is a precondition to underpin 'population policy' in general, and healthcare planning in particular, to the different segments of the population groups such as children, elderly, working age population, women and youth. For example, the 'risk of diseases' and related health services among elderly are completely different from that of women 'at risk' of reproduction.

Bihar is committed to meeting its Sustainable Development Goals (SDG) by the year 2030. The hallmark of the SDGs, as different from its predecessor, the Millennium Development Goals (MDGs) is the strong emphasis on reducing inequalities of all forms. This means, it is no longer sufficient to achieve the SDG targets at the national level: they have to be achieved uniformly across relevant disaggregated sub-groups of the population such as those defined by location, caste, religion, occupation patterns to name a few. In turn, it requires a detailed picture of the population profile of the state or nation. Without such information, planning intervention and monitoring progress at regular intervals to ensure they are equitable, are difficult. Although the primary focus of the present analysis is the health sector, it is a well-established fact that SDG3 is closely inter-linked to many, if not all, the other SDGs. Therefore, it is hoped that this detailed demographic profile of the state of Bihar will be of use to development stakeholders in several sectors, not only health in isolation.

In the context of India, and Bihar in particular, socially weaker and economically vulnerable sections such as scheduled castes (SCs), scheduled tribes (STs) and minorities require special provisioning of health services because these segments of population are differently affected by ailments - especially with regards to the cost, availability and access to healthcare, as demonstrated by Ghosh, Guha-Khasnobis and Husain (2018). Their study

showed clearly that literacy and livelihoods interact with social status in complex ways in determining several important indicators related to morbidity and health care seeking. Thus, health cannot be seen in isolation – it is interlinked with other dimensions of human development including literacy and livelihoods, and many more.

In addition, quantitative projections of age cohorts are essential in estimating, and therefore, planning for the infrastructure and human resource requirements of providing health services in the future, and anticipating the costs to the exchequer in the sphere of public health care. In the present study we have presented a detailed profiling of demographic and socio-economic characteristics of Bihar at the district level. We also projected population at the district-level up to 2026.

The analysis is divided into several sections. At the outset, a comparison of demographic and socio-economic characteristics of India and Bihar is presented. Trends of demographic and socio-economic indicators at the district level in Bihar between 2001 and 2011 are analysed thereafter. Then, infant mortality rate (IMR) and total fertility rate (TFR) are computed across selected social groups, so are educational attainment levels and workforce participation rates at the district level by using indirect techniques of demographic estimation (please refer to the Appendix for the technical details). Basic socio-demographic characteristics of adolescents and youths, the population group which would be in the workforce at the end of the Sustainable Development Goals (SDGs) implementation phase, are discussed thereafter. Finally, we carried out district level population projections up to 2026 to provide disaggregated estimates pertaining to the issue of population stabilization in Bihar.

Materials and Methods

We mainly used data from the Census of India for the years 2001 and 2011. In addition, data from Sample Registration System (SRS) for the state-level comparison of different indicators were also used. Percentage-points changes are used to show the trends of different demographic and socio-economic characteristics of the population, while indirect demographic estimation techniques were used to compute IMR and TFR.

Overall district level IMR, and also by selected socio-religious categories, educational attainment and workforce participation of mothers were calculated by the Brass method (Brass 1964; 1996). Despite some caveats in the method in case of misreporting and underreporting of deaths, it is easy to understand and allows infant and child mortality rates to be estimated at the district-level and also by various categories such as social groups, educational attainment levels etc.

We also estimated TFR for overall population at the state-level by employing the P/F ratio method (Arriaga 1983; Brass 1964; Brass and Coale 1968) and then at the district-level as a whole and across socio-religious groups. The Arriaga (1983) modification of P/F method is used in the current estimation. The MORTPAK software, developed by the United Nations (1988) (www.un.org/en/development/desa/population/publications/mortality/mortpak.shtml) and freely downloadable was used in estimating IMR and TFR by employing the above procedures.

Finally, to project population at the *district* level of Bihar for the years 2016, 2021 and 2026, we used total projected population at the *state* level for 2016, 2021 and 2026 provided in the report of Expert Committee Population Projection (RGI, 2006). The UNFPA Expert Group (2009) used the **'ratio method'** for population projection at the district level (UNFPA 2009) and had projected population up to 2016 using the 1981, 1991 and 2001 censuses. However, we used the **'logistic growth curve'** method to project population at the *district* level up to 2026 using population census 2001 and 2011. Interestingly, we found a positive and highly significant correlation between total projected population of Bihar for the year 2016 ($r=0.9934$; $p<0.001$)[1].

[1]For details of methodology please refer to the Appendix.

Section 1: Basic demographic and socio-economic characteristics of India vis-à-vis Bihar

Table 1A

Parameters	India	Bihar
Decadal Population Growth rate	17.7	25.4
Rural Population Growth Rate	12.1	24.3
Urban Population Growth Rate	31.8	35.4
Percentage (%) of Urban Population	31.1	11.3
Population Density	328	1106
Overall Sex Ratio (OSR)	943	918
Child Sex Ratio (CSR)	918	935
Total Fertility Rate (2015)	2.3	3.2
Dependency Ratio (DR)	65.2	91.1
Youth Dependency Ratio (YDR)	51	76.9
Old Dependency Ratio (ODR) (≥ 60 years	14.2	14.2
Life expectancy at birth (2011-15) (Total)	68.3	68.4
Life expectancy at birth (2011-15) (Male)	66.9	68.5
Life expectancy at birth (2011-15) (Female)	70.0	68.3

Tables 1A and 1B together represent the demographic and socio-economic characteristics of Bihar in comparison to India. Slower decline in decadal population growth rate in Bihar compared to all-India average is observed during the last decade (21.5% to 17.7% during 2001-11, versus 28.8% to 25.4%). TFR was found to be almost one child higher in Bihar compared to India. The decadal growth rate in Bihar was double that of India in rural areas. Although the rate of urbanization was substantially lower in Bihar compared to all-India, the rate of urban population growth surpasses that of all-India. Due to such high population growth, population density has increased from 881 persons per square KM to 1106 between 2001 and 2011, while such increase for all-India was from 324 to 328 per square KM during the same period. Very high dependency ratios, particularly young-age dependency, implies that the population of Bihar was much 'younger' compared to the rest of India according to 2011 census.

Table 1B

Parameters	India	Bihar
Overall Literacy Rate	73.0	61.8
Literacy Rate (Male)	80.9	71.2
Literacy Rate (Female)	64.6	51.5
% of Scheduled Caste (SC) Population	16.6	15.9
% of Scheduled Tribe (ST) Population	8.6	1.3
% of Muslim Population	14.2	16.9
Overall Work Force Participation Rate (Main + Marginal Workders)	39.8	33.4
Work Force Participation rate (Male)	53.3	46.5
Work Force Participation rate (Female)	25.5	19.1

The level and trend of child-sex ratio and overall sex ratio in any population are indicators of gender differentials in mortality and the status of women in the population. Bihar's higher child sex ratio but lower overall sex ratio compared to India reflects that the survival probability of females in adult age-groups is less in the state possibly because of high maternal mortality. This is also supported by the lesser life expectancy at birth for females in Bihar compared to all India. This is one of the reasons why RMNCHA+ requires greater attention.

Literacy rate in Bihar was about 11 percentage-points less compared to all India. The same table also depicts that the gender differential in literacy is still pronounced in 2011 – literacy rate for males was about 9 percentage-points less in Bihar compared to all India, for females such difference was nearly 15 percentage-points. It may also be noted that the proportions of Scheduled Castes (SCs) (15.9%) and Muslims (16.9%) in Bihar were almost comparable to average India (16.6% and 14.2% respectively for SCs and Muslims), while the proportion of Scheduled Tribes (STs) (1.3%) was negligible in Bihar compared to all India average (8.6%).

One can also note from the Table that the work-force participation rates for both males and females were significantly less in Bihar compared to all-India average. Total work-force participation rate was about 6 percentage-points less compared to overall India, while such differences were nearly 7 percentage-points among males and 6 percentage-points among females.

Section 2: Changes/trends of demographic indicators in Bihar

Decadal population growth rate

Figure 1: Decadal population growth rate

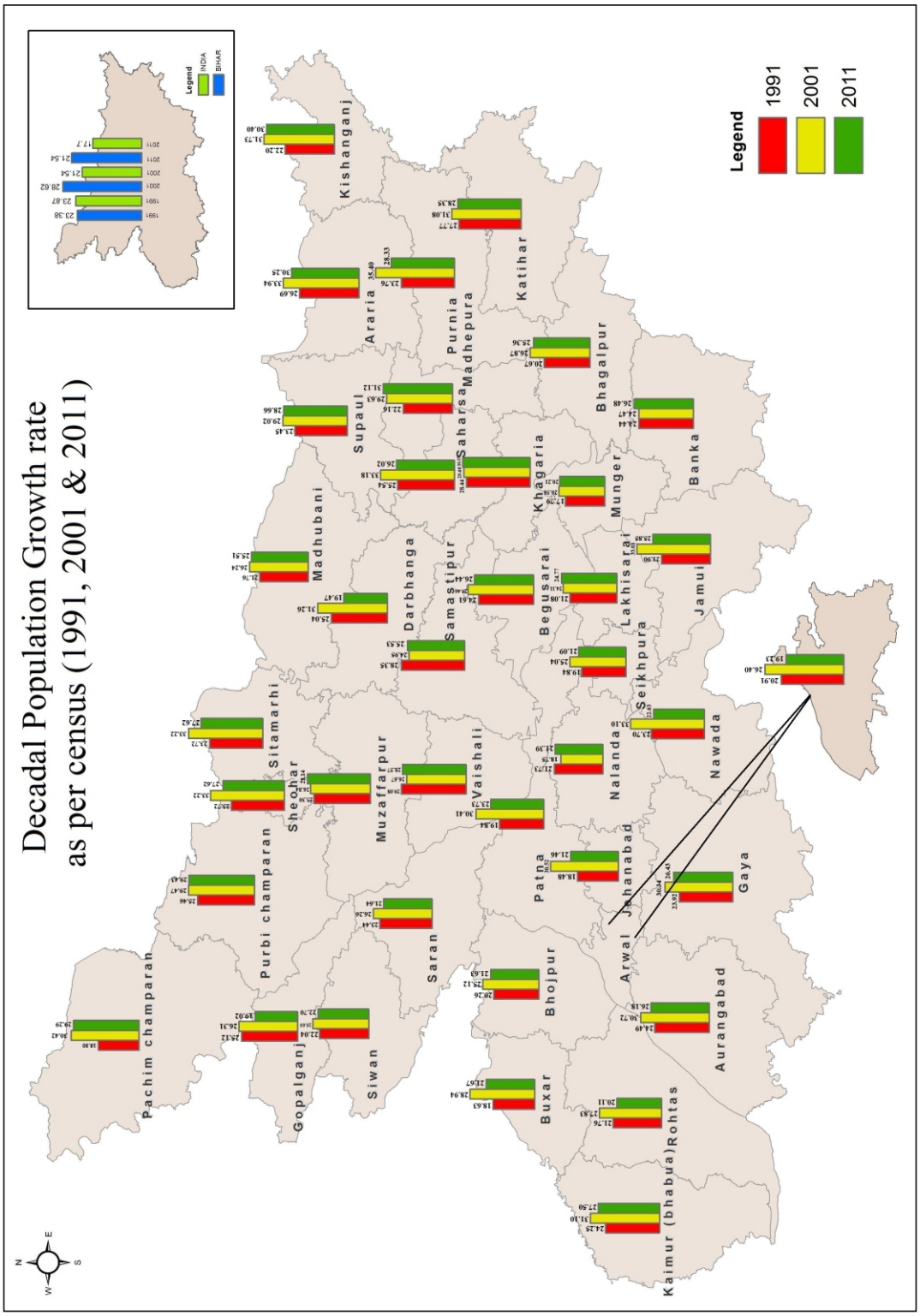


Figure 1 depicts the decadal population growth rate between 1991 and 2011. Notably, Bihar observed the highest growth rate during 1991-2001 since 1901. Decadal population growth rate was 23.4% during 1981-91, increased to 28.6% during 1991-2001 and then declined by 3.2 percentage-points between 2001 and 2011. Although decadal growth rate of Bihar started declining during 2001-11 in most of the districts, it was still increasing in *Muzaffarpur, Khagaria, Madhepura, Lakhesarai, Vaishali and Banka*. One can also observe significant regional variations of the decadal population growth rate. Decline of growth rate is more significant in the districts of western and most of southern Bihar compared to the districts of north-eastern and northern parts.

Age-sex structure

One of the most important demographic characteristics of a population is its age-sex structure. Age-sex pyramids (also known as population pyramids) are graphical representations of age-sex structure in order to facilitate understanding and ease of comparison. A broader base of the pyramid (of typically triangular shape) reflects a young age-structure, while a relatively narrow base with wider population in the middle age group (of rectangular shape) reflects older age-structure.

Figure 2: Comparison of Age-Sex Structure of India & Bihar

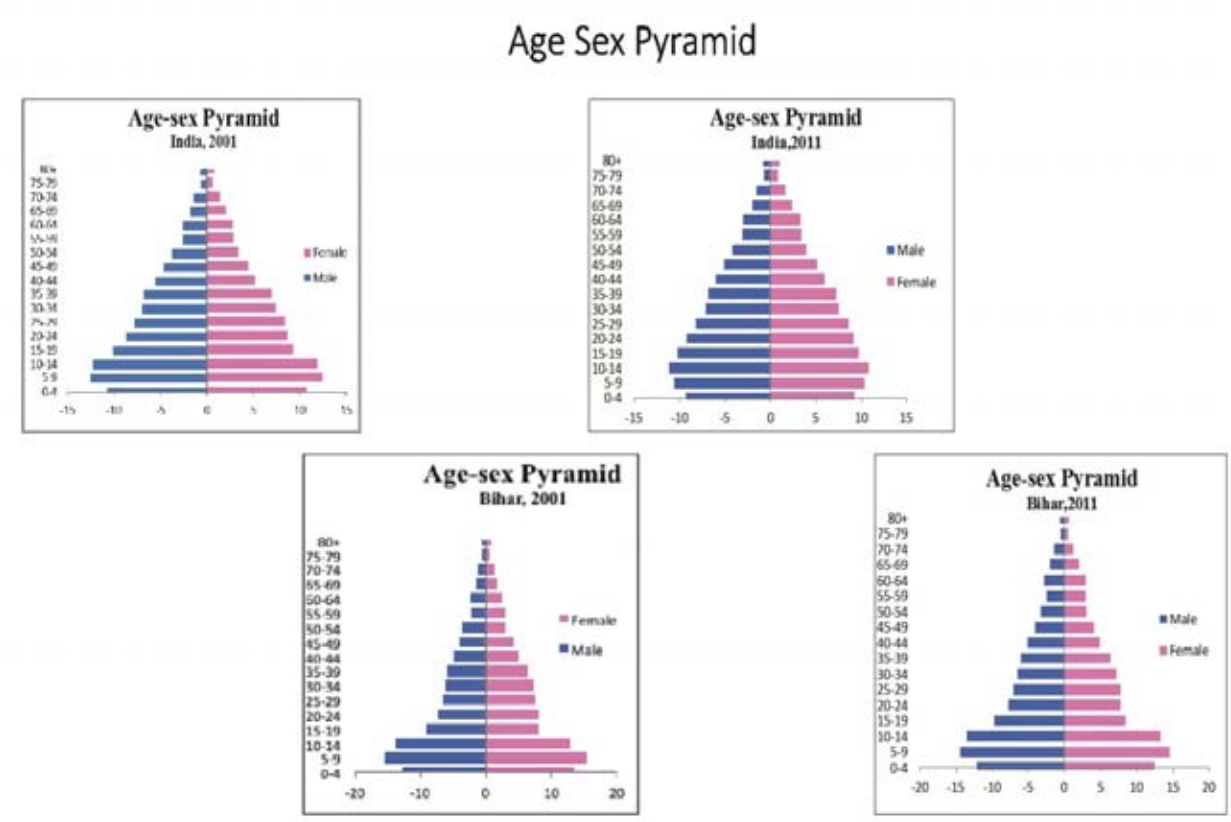
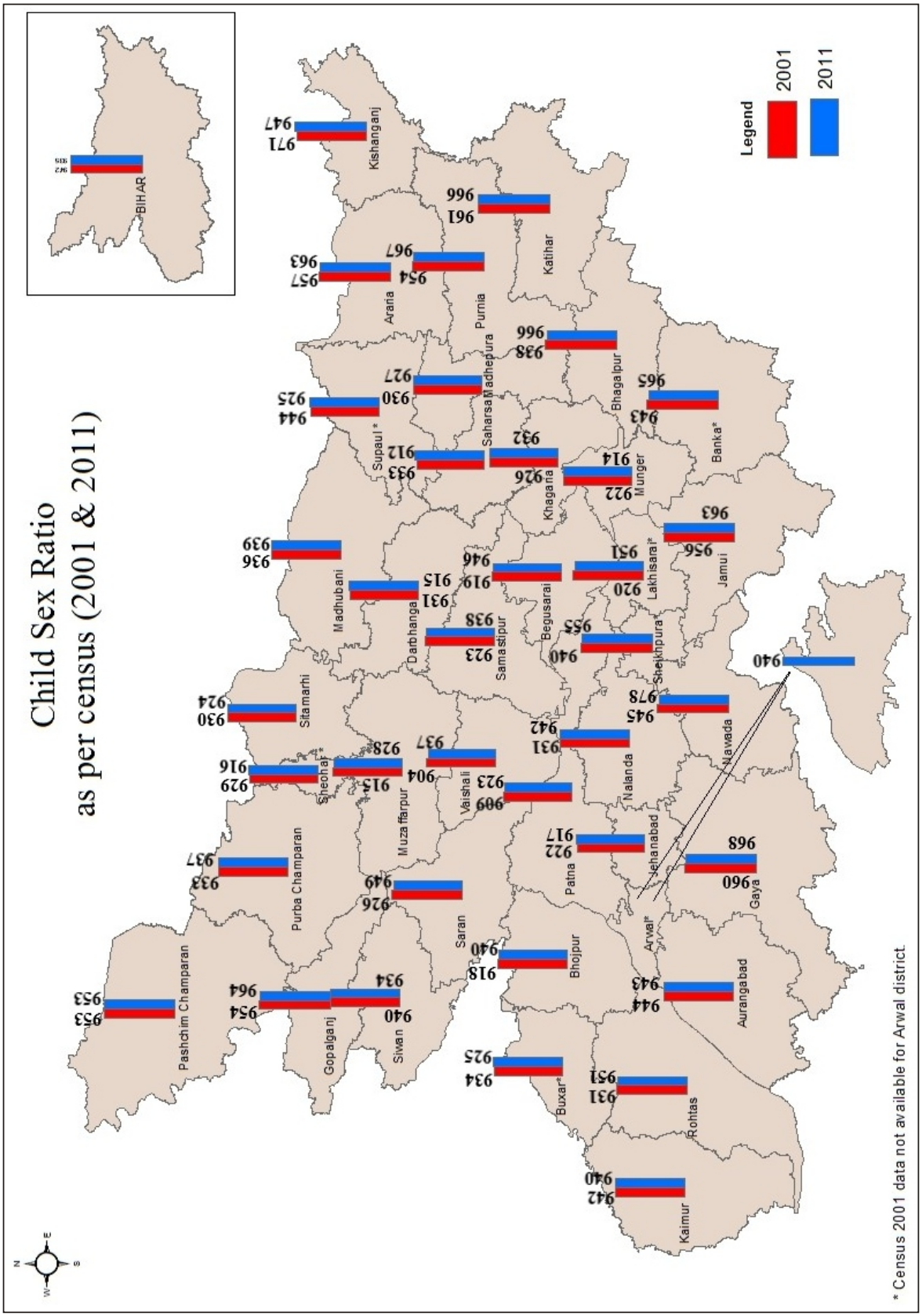
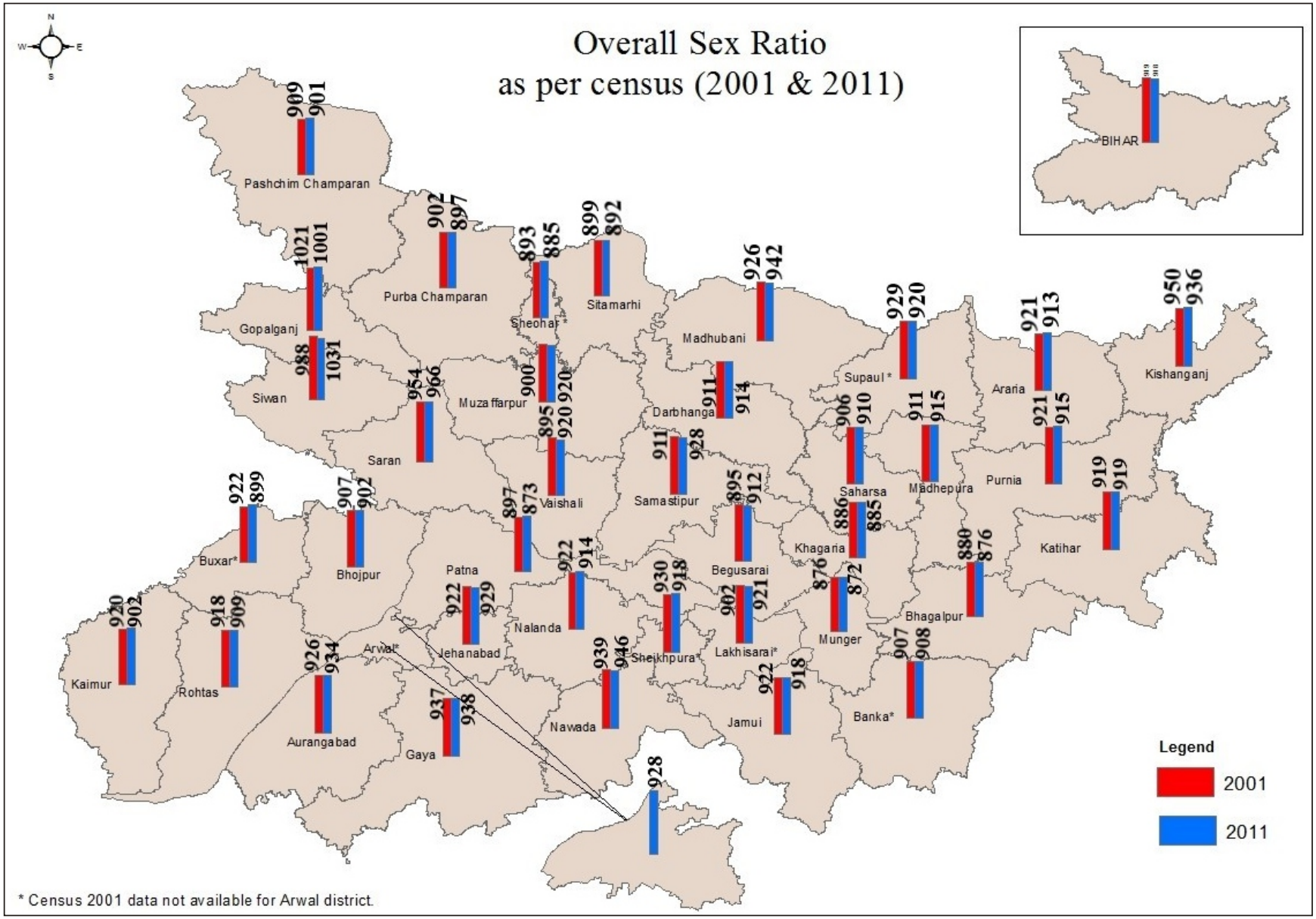


Figure 2 reveals the age-sex pyramids for overall India and for Bihar as computed from 2001 and 2011 censuses. By comparing age-sex structure of overall India and Bihar one can see that the population of India has been approaching the 'late expanding stage' or 'late transitional' stage according to the terminology of demographic transition. But Bihar has a comparatively 'young' age-structure (as indicated by a wider base of the pyramid) and the process of demographic transition has been rather slow. The age-structure of Bihar indicates the population is still in 'early expanding stage' or 'early transitional stage'. As a consequence, Bihar has a reasonably higher young-age dependency ratio compared to India because of the high proportion of infants, children and older children. Another important dimension of age-structure of Bihar is the high proportion of 'adolescents' and 'youth'. One can term these age-groups as the generation of Sustainable Development Goals (SDG) (in short, SDG Generation) as these individuals will constitute the labor force by the end of the SDG implementation period, 2030. Remarkably high prevalence of this age cohort at present in Bihar necessitates special emphasis in harnessing the opportunity of demographic dividend for the state post-2030.

Figure 3: Overall sex-ratio and child sex-ratio




Overall Sex Ratio
as per census (2001 & 2011)
BIHAR
Pashchim Champaran 909 901
Purba Champaran 902 897
Sitamarhi 899 892
Sheohar * 893 885
Gopalganj 1021 1001
Siwan 988 1031
Muzaffarpur 954 966
Saran 900 920 920
Vaishali 895 920
Samastipur 911 928
Darbhanga 911 914
Madhubani 926 942
Supaul * 929 920
Araria 921 913
Kishanganj 950 936
Saharsa 906 910
Madhepura 911 915
Purnia 921 915
Katihar 919 919
Khagaria 886 885
Begusarai 895 912
Buxar* 922 899
Bhojpur 907 902
Patna 897 873
Nalanda 922 914
Jehanabad 922 929
Arwal* 930 918
Lakhisarai* 902 921
Sheikhpura* 939 946
Munger 876 872
Bhagalpur 880 876
Banka* 907 908
Jamui 922 918
Nawada 937 938
Gaya 928
Aurangabad 926 934
Rohtas 918 909
Kaimur 920 902
Legend
2001
2011
* Census 2001 data not available for Arwal district.

The two parts of Figure 3 represent overall sex-ratios and child sex-ratios for all the districts of Bihar as per 2001 and 2011 censuses. At the aggregative level, overall sex-ratio remained stagnant between 2001 and 2011 (919 and 918 females per 1,000 males in 2001 and 2011 censuses), while child-sex ratio declined by 7-points from 942 to 935 per 1,000 males. Some regional variations can also be observed. For example, decline of child sex-ratio was more pronounced in the districts of southern and central regions. *Vaishali and Nawada* district located in the central and southern region respectively, observed the highest decline of child sex-ratio, while the district of *Siwan* of western region noticed the highest decline in overall sex ratio during 2001-11. On the other hand, *Patna* district belonging to central region registered the highest increase in overall sex ratio, while *Saharsa* district of northern region recorded the highest increase in child sex ratio. At the aggregate level, decline of child sex-ratio accompanied with near stagnation of overall sex ratio implies girls as well as women are 'at risk' of higher mortality throughout their lives and gender differentials in mortality is pronounced, particularly in the southern and central districts of Bihar.

Section 3: Changes/trends of socio-economic indicators in Bihar

Literacy rate

Literacy rate of any population is a powerful indicator of socio-economic development and well-being. It is one of the three components of the human development index (UNDP) reviewed annually across countries and often within them. A disaggregated picture of literacy reveals the inclusiveness, or otherwise, of the progress with this indicator across cohorts.

Figure 4: Change in Overall Literacy rate according to socio-religious groups

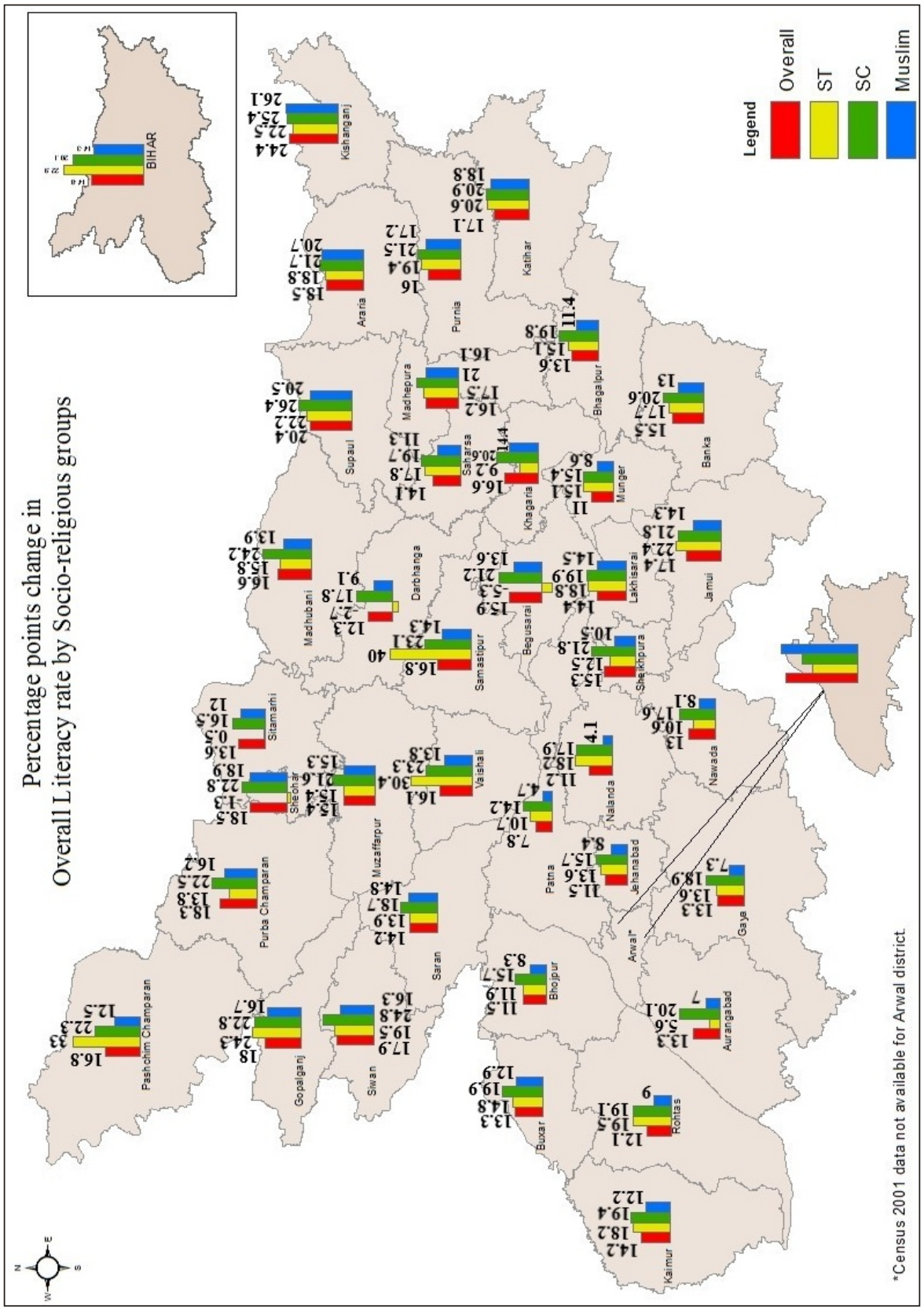


Figure 4 indicates increase in literacy rate by socio-religious categories across districts of Bihar. Being one of the high focused states, literacy rate in Bihar increased substantially (14.8 percentage-points) between 2001 and 2011. It may be noticed that literacy rates increased in every district across socio-religious categories, though disproportionately. Increase of overall literacy rates among STs was the highest in *Samastipur* (40 percentage-points) followed by *Paschim Champaran* (33 percentage-points), but declined in *Darbhanga* and *Begusarai*, possibly indicating higher migration among the literate ST population. There is a significant increase in literacy among SCs across districts except the districts of western parts. The highest increase in literacy among SCs was in *Supaul*, followed by *Kishanganj* and *Siwan*. A high increase of literacy among Muslims was also observed in the study period (42% to 56.3% i.e. 14.3 percentage-points). The highest increase of Muslim literacy rate was in *Kishanganj* (26.1 percentage-points) followed by *Araria* and *Supaul*. Thus, literacy rate improved substantially between 2001 and 2011 in Bihar, particularly among the socio-economically marginalized, excepting STs in some districts (to note, proportion of STs in Bihar is very negligible).

Figure.5A: Change in Overall Male Literacy rate according to socio-religious groups

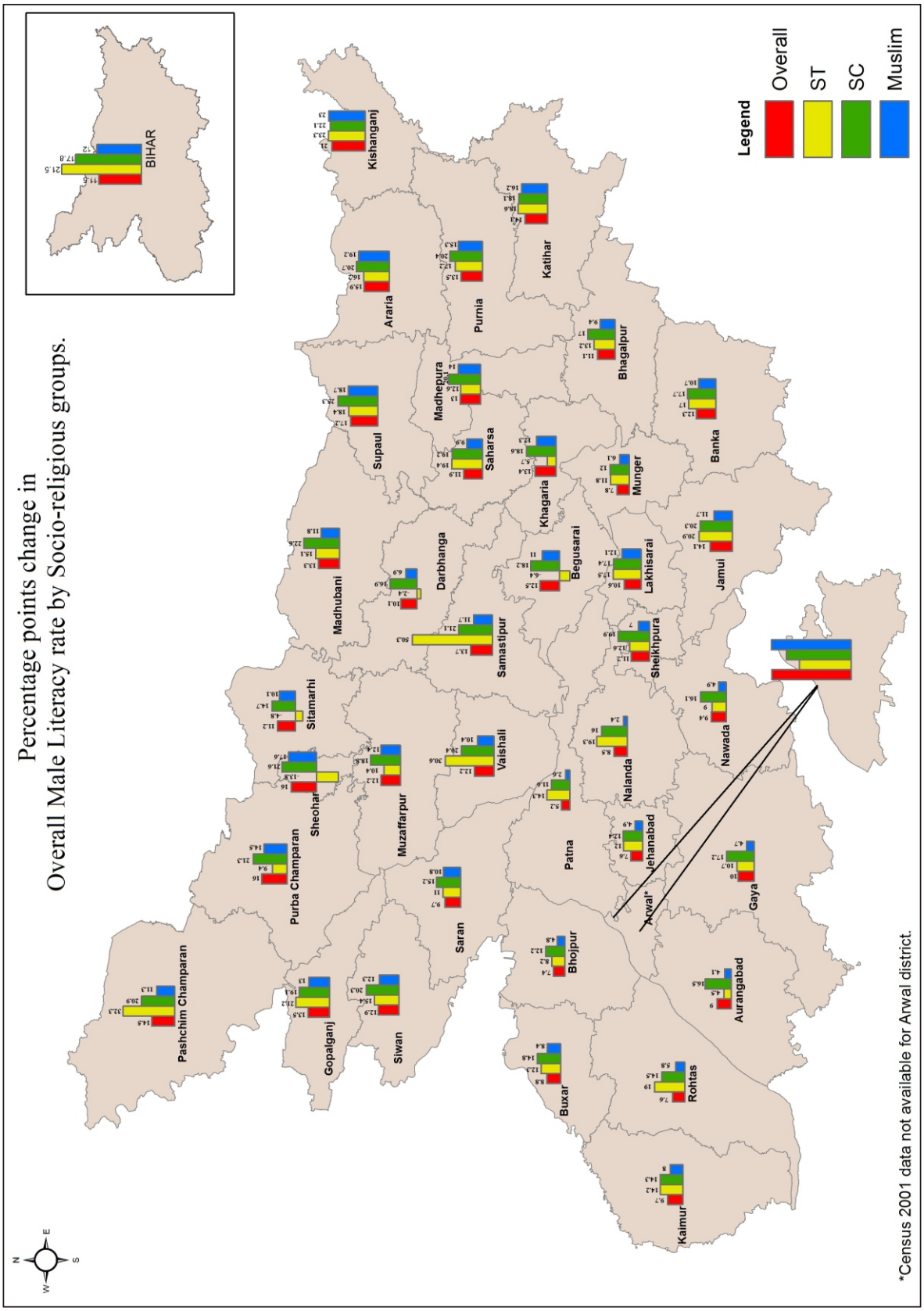
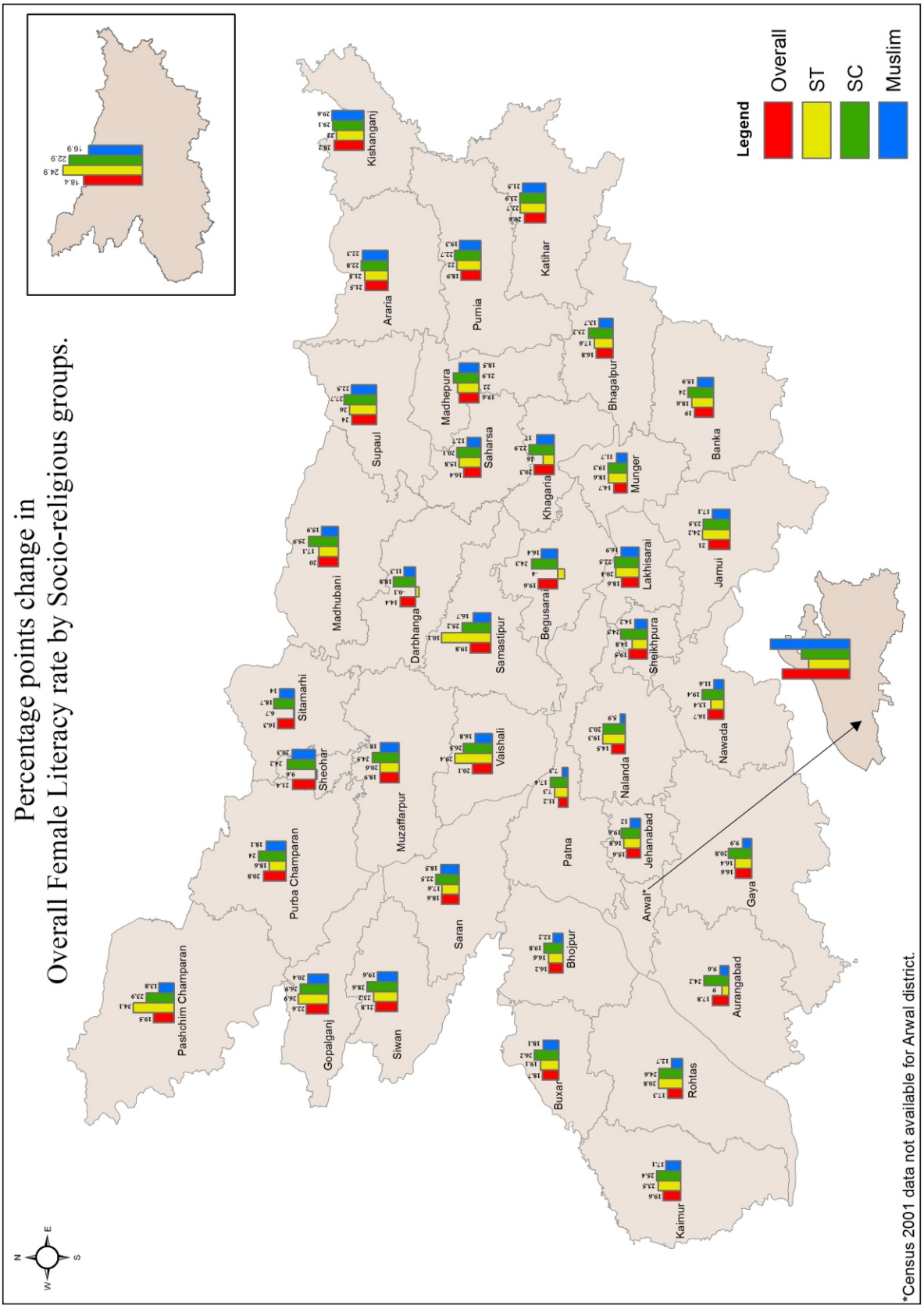


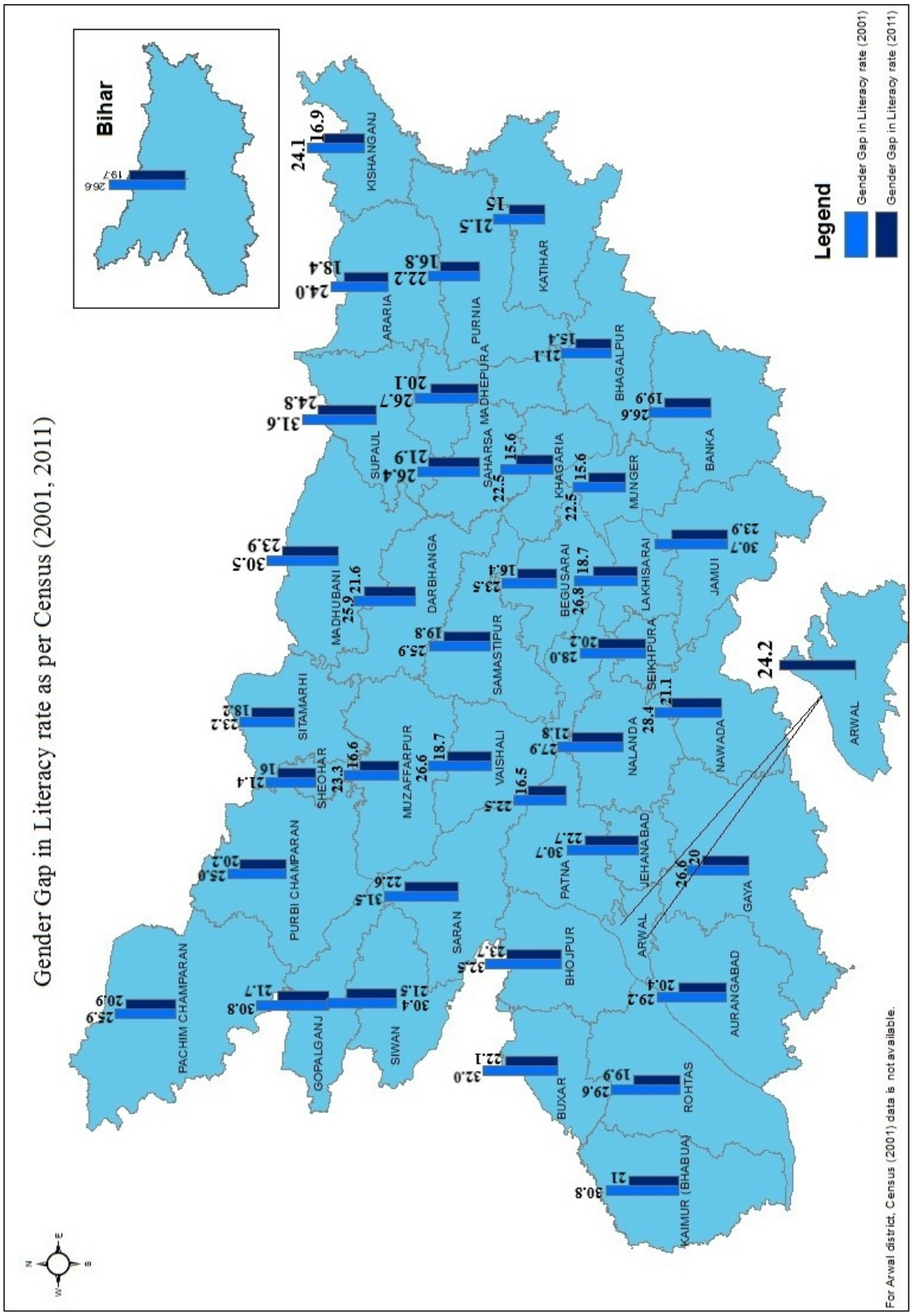
Figure.5B: Change in Overall Female Literacy rate according to socio-religious groups



Figures 5A & B depict literacy rate by gender according to social categories. Male literacy increased by 11.5 percentage-points (from 59.7% to 71.2%), while female literacy increased by 18.4 percentage-points (from 33.1% to 51.5%). One can also notice that increase in literacy rate among females was higher compared to males with remarkable similarities across districts as well as socio-religious categories. The highest increase of literacy rate among males was observed in *Pashchim Champaran* district among ST's (32.3 percentage-points), while such increase among females was observed also in *Pashchim Champaran* district among ST's (34.1 percentage-points). The lowest increase of literacy rate among males was observed in *Nalanda* district among Muslims (2.4 percentage-points), while such increase among females was also observed in *Nalanda* district among Muslims (5.9 percentage-points).

These trends contributed to a significant reduction of gender gap in literacy rate between 1991-2001 and 2001-2011 as Figure 6 shows.

Figure.6: Comparison of Gender gap in literacy rate in 2001 & 2011

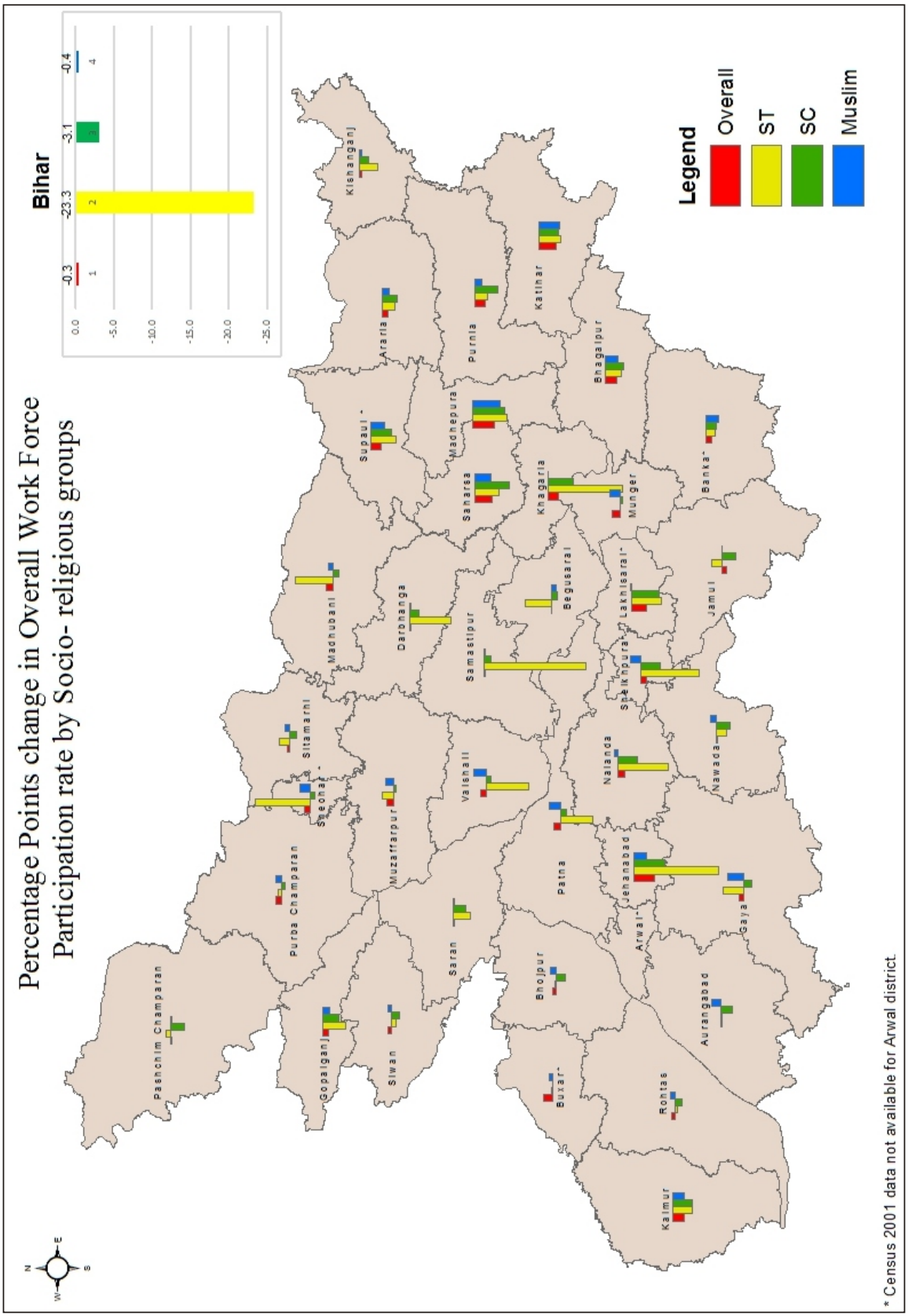


The gender gap in literacy declined from 26.6 percentage-points in 2001 to 19.7 percentage-points in 2011, but not uniformly across districts. In rural areas gender gap in literacy declined from 27.5 percentage-points in 2001 to 20.7 percentage-points in 2011, while in urban the corresponding figures were 17.3 in 2001 and 12.1 in 2011 (not shown in the figure). Regional variation of the reduction of gender gap can be observed. Districts located in the western parts of Bihar observed higher reduction of gender gap compared to other areas, while such reduction is less in the districts located in the northern parts. For example, the reduction of gender gap was the highest in *Buxar* district, and the lowest in *Darbhanga*. Overall, reduction of gender gap was found to be the highest among SCs (-5.1 percentage-points) followed by Muslims (-4.9 percentage-points) and the least among STs (-3.4 percentage-points) between the said periods.

Workforce participation rate

Analysis of workforce participation rate is important because it has direct linkage with income and livelihood. In Bihar, we found an overall stagnation of workforce participation rate between 2001 and 2011 (Figure 7).

Figure.7: Change in overall work force participation rate across districts



In fact, it has declined marginally by 0.3 percentage-points, though disproportionately among different socio-religious categories. One can notice that the workforce participation rate declined by more than 23 percentage-points among STs followed by SCs (by 3.1 percentage-points), while it remained almost stagnant (declined nominally by 0.4 percentage-points) among Muslims. Some regional variation of change in workforce participation rate was observed. For example, there was a slight increase in some of the districts of central and northern region such as *Buxar*, *Madhubani*, and *Patna*, while it declined in most of the eastern and southern districts. In districts located in the eastern and southern parts, e.g., *Madhepura*, *Saharsa*, and *Jehanabad*, the workforce participation rate declined across all socio-religious communities[2].

[2]Due to a technical problem, the figures cannot be shown on the maps for workforce participation rates. They are provided in a table in the Appendix.

Figure 8a: Change in workforce participation rate by gender across districts.

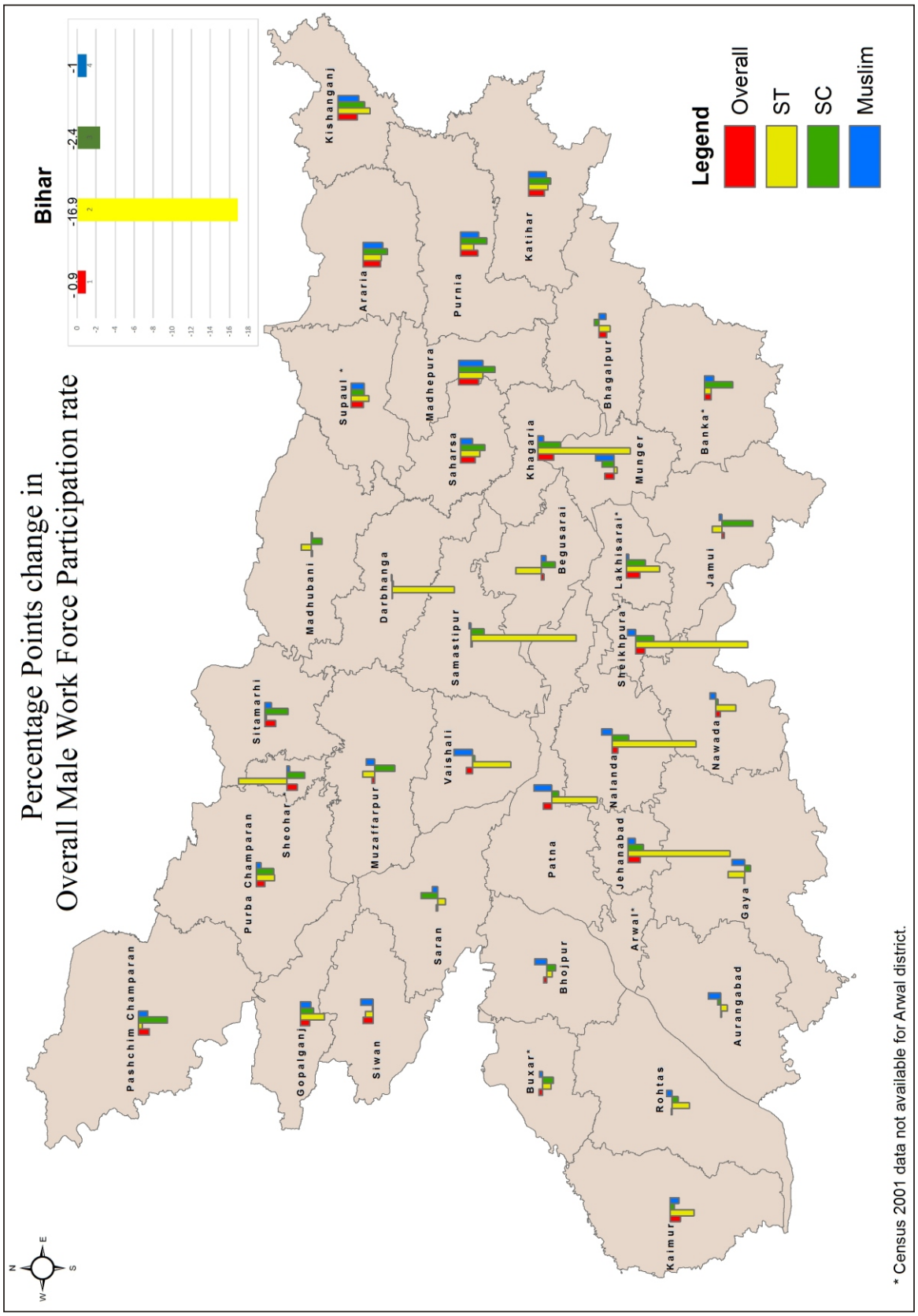
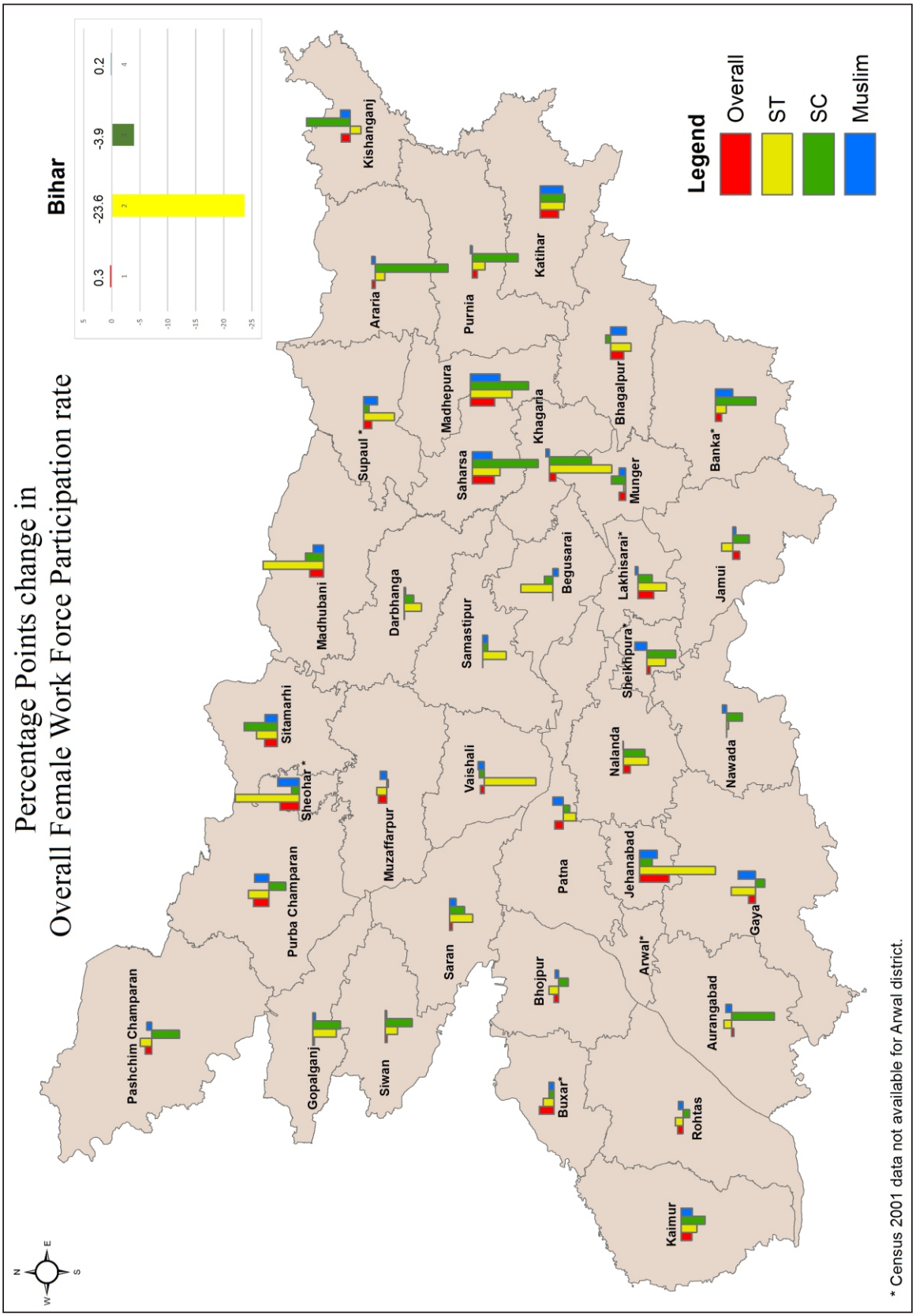


Figure 8b: changes in overall female workforce participation rates



It may be mentioned that although male workforce participation rate declined by 0.9 percentage-points between 2001 and 2011, female workforce participation rate has increased marginally by 0.3 percentage-points (Figure 8a, 8b). Some gender differentials in workforce participation rate at the district level can be observed according to socio-religious category and region. For example, although work force participation rate declined among both male and female in almost all the districts of eastern Bihar, in the northern districts such as *Sitamari*, *Seohar* and *Purba Champaran* workforce participation rates for females across almost all socio-religious communities increased, while among males it declined.

Rural-urban differentials in workforce participation rate is important to understand as it has direct bearing on relative access to livelihood in the two locales.

Figure 9a: Change in Rural Work Force Participation Rate according to socio-religious category

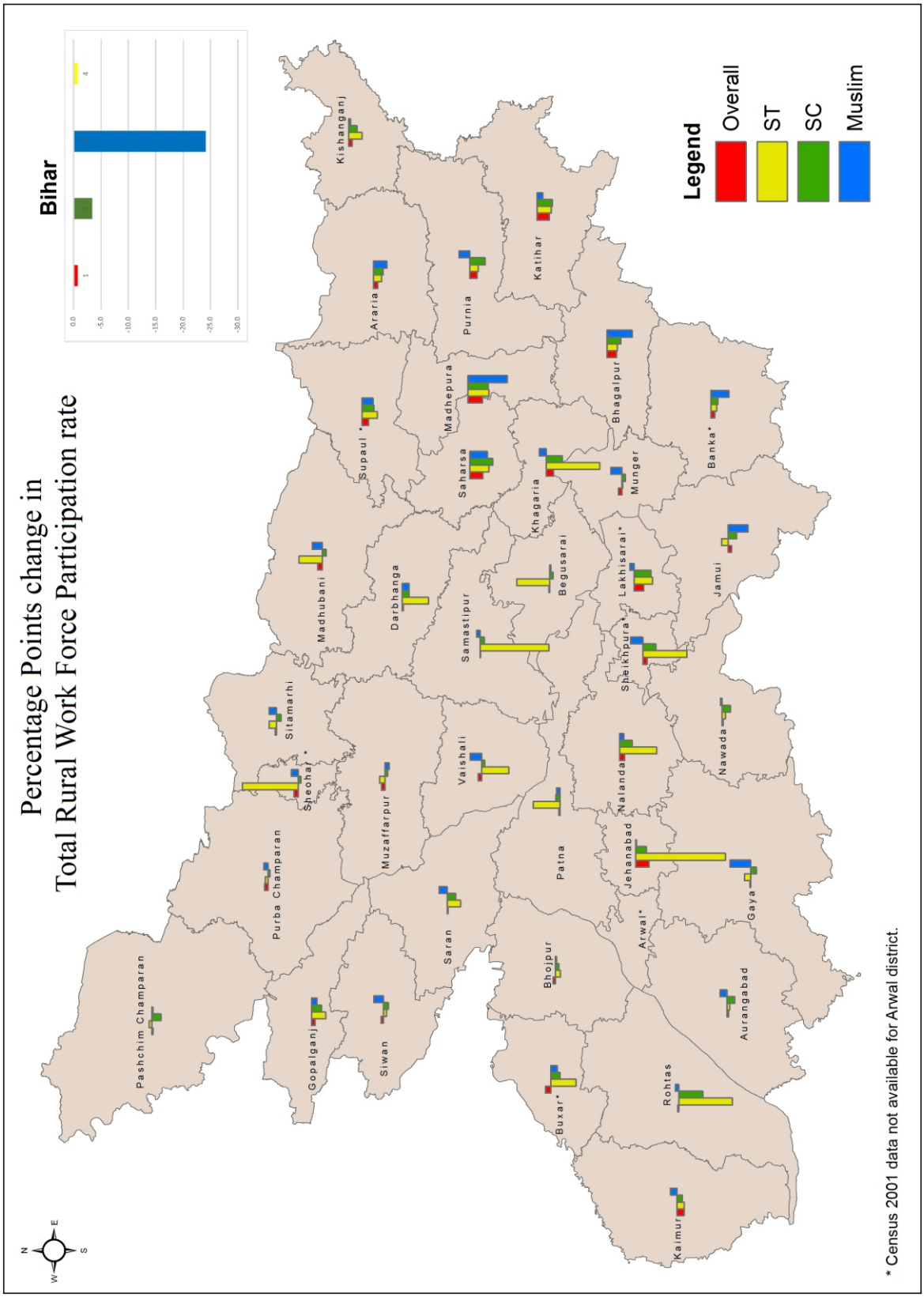
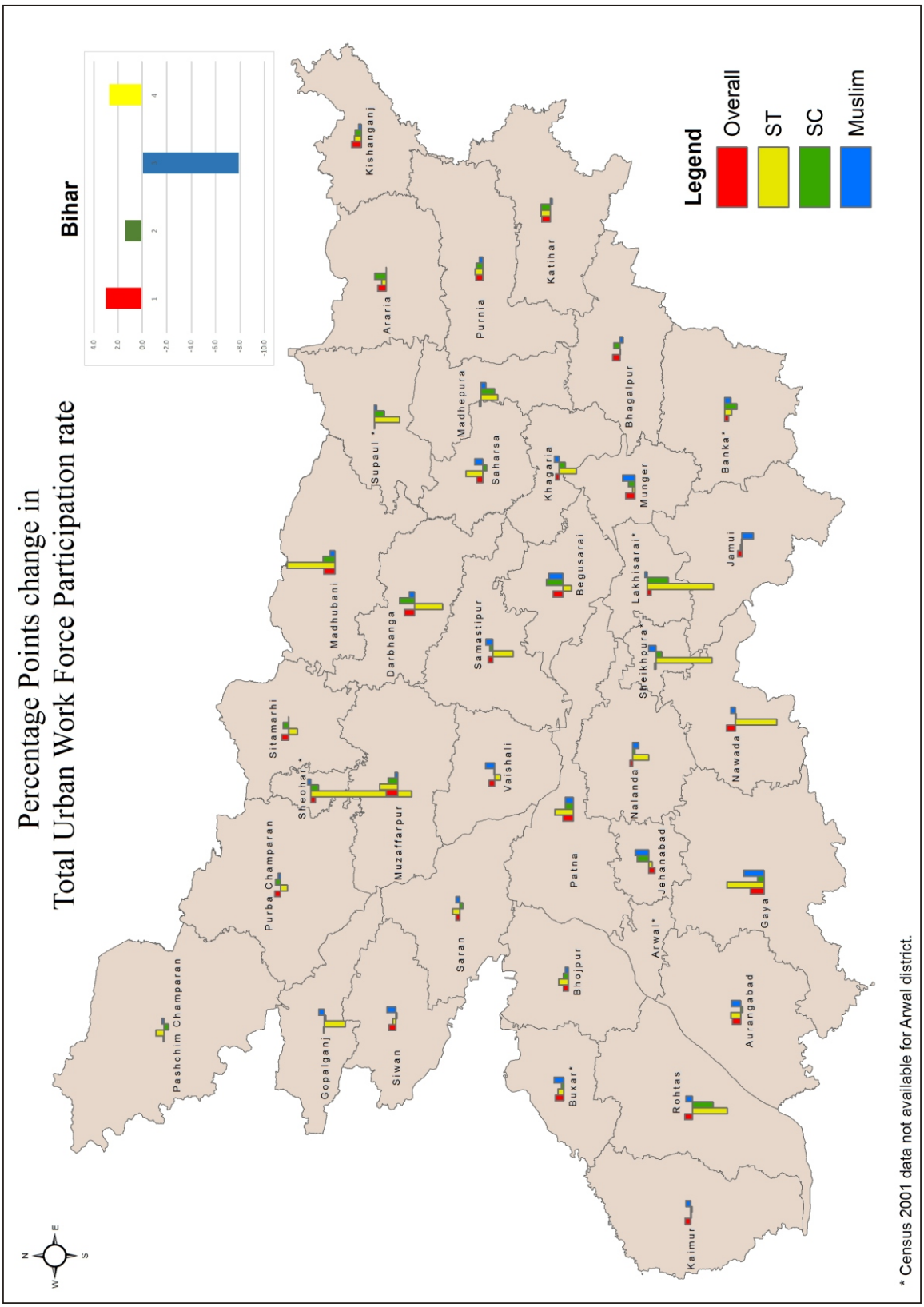


Figure 9b: Change in Urban Work Force Participation Rate according to socio-religious category



From Figures 9a & 9b, it may be observed that although there was rural stagnation in increase in workforce participation rate, it accelerated in urban areas. Workforce participation rate in rural areas declined by 0.7 percentage-point, but increased in the urban areas by 3 percentage-points, (however, disproportionately across districts). This also holds true for both males and females (not shown in map). Notably, among STs, workforce participation rate declined disproportionately across districts in both rural and urban areas, except a few northern districts such as *Madhubani* and *Saharsha*. With geographic discontinuity, workforce participation rate declined among SCs in rural areas but increased in urban areas. A similar observation holds for workforce participation rate among Muslims. Studies conducted using NSS data at all-India level argued that the lack of availability of agricultural and non-agricultural jobs in rural areas appears to be driving the declining participation in rural areas. This is also consistent with claims made by Kannan and Raveendran (2012), and, Chand and Srivastava (2014), who also see poor agricultural performance and the lack of non-farm rural jobs as the main driver of low workforce participation rate in rural India. At the same time, Lahoti and Swaminathan (2013) argued that structural change in India, which led to a rapidly shrinking agricultural sector in favour of a rapidly expanding service and construction sector, mainly contributed to the stagnating/declining female labour force participation in rural areas. The lack of a shift towards manufacturing and a persistently low female share in manufacturing ensured that the labour force as a whole did not include more females.

Section 4: Infant mortality rates (IMR) across socio-religious categories, educational attainment of mothers and occupational categories according to 2011 census

IMR is one of the important indicators in assessing the level of human development and well-being of any population. It is a key component in the Human Development Index (HIDI) created by United Nations Development Program (UNDP). In this exercise, we have calculated IMR at the district level across different socio-religious categories, level of educational attainment of mothers and occupational categories by using census data for 2011. As mentioned earlier, we have used Brass's CEB-CS method using the MORTPAK software.

Figure 10: Infant Mortality rate in Bihar across districts

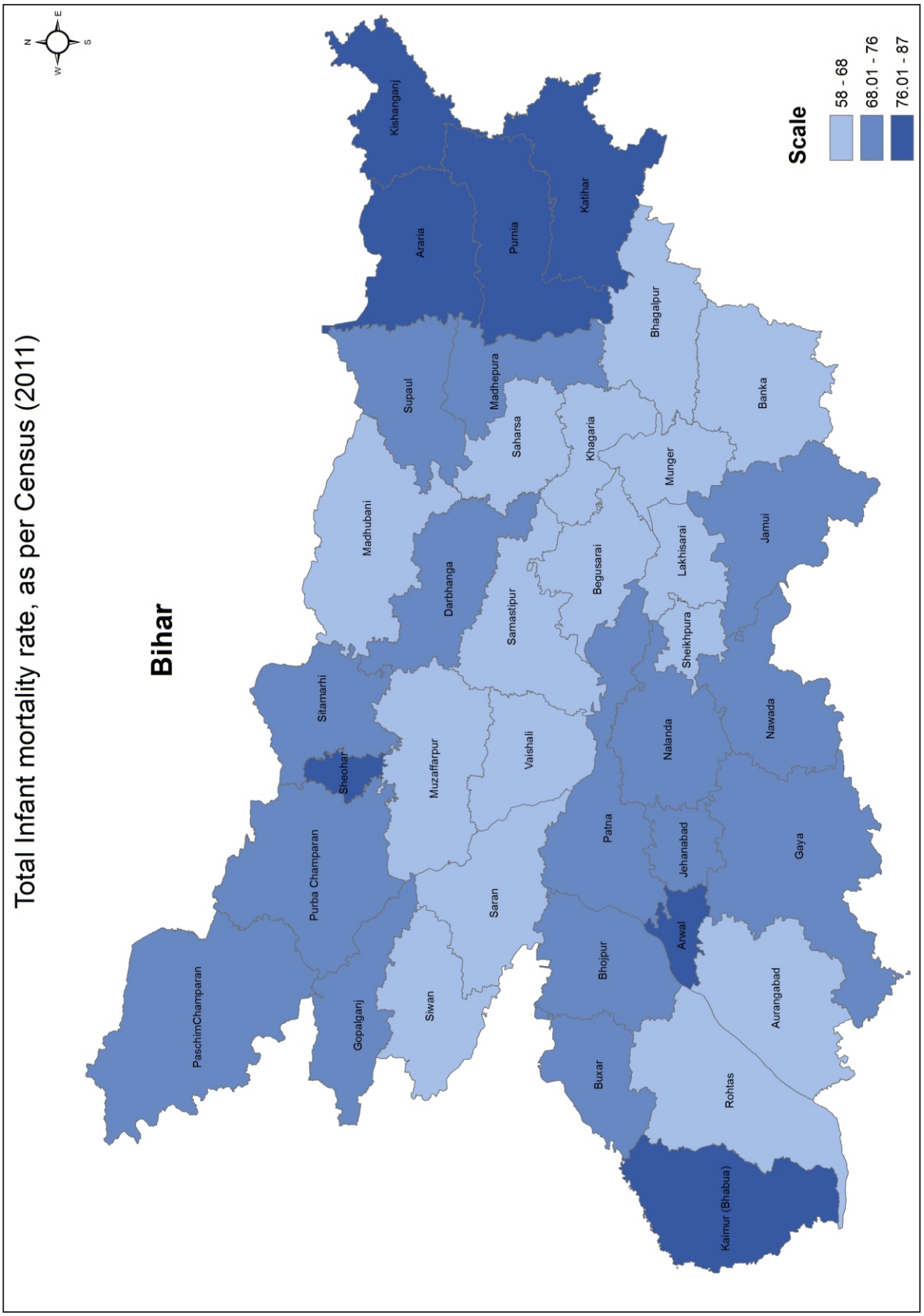


Figure 10 shows IMR in the districts of Bihar. One can observe a spatial **continuity** in IMR in Bihar. IMR was comparatively higher in the districts of north-eastern Bihar compared to other parts of the state with outliers such as *Sheohar* in the north and *Kaimur* in the west. On the other hand, IMR was relatively lower in the districts of central region with outliers such as *Aurangabad* and *Rohtas* in the south-west. Medium IMR zones are located in the southern and northern parts of the state. Such spatial continuity of IMR necessitates studying the independent role of space in determining IMR, research on which is scarce.

Figure 11: Infant Mortality rate according to socio-religious categories

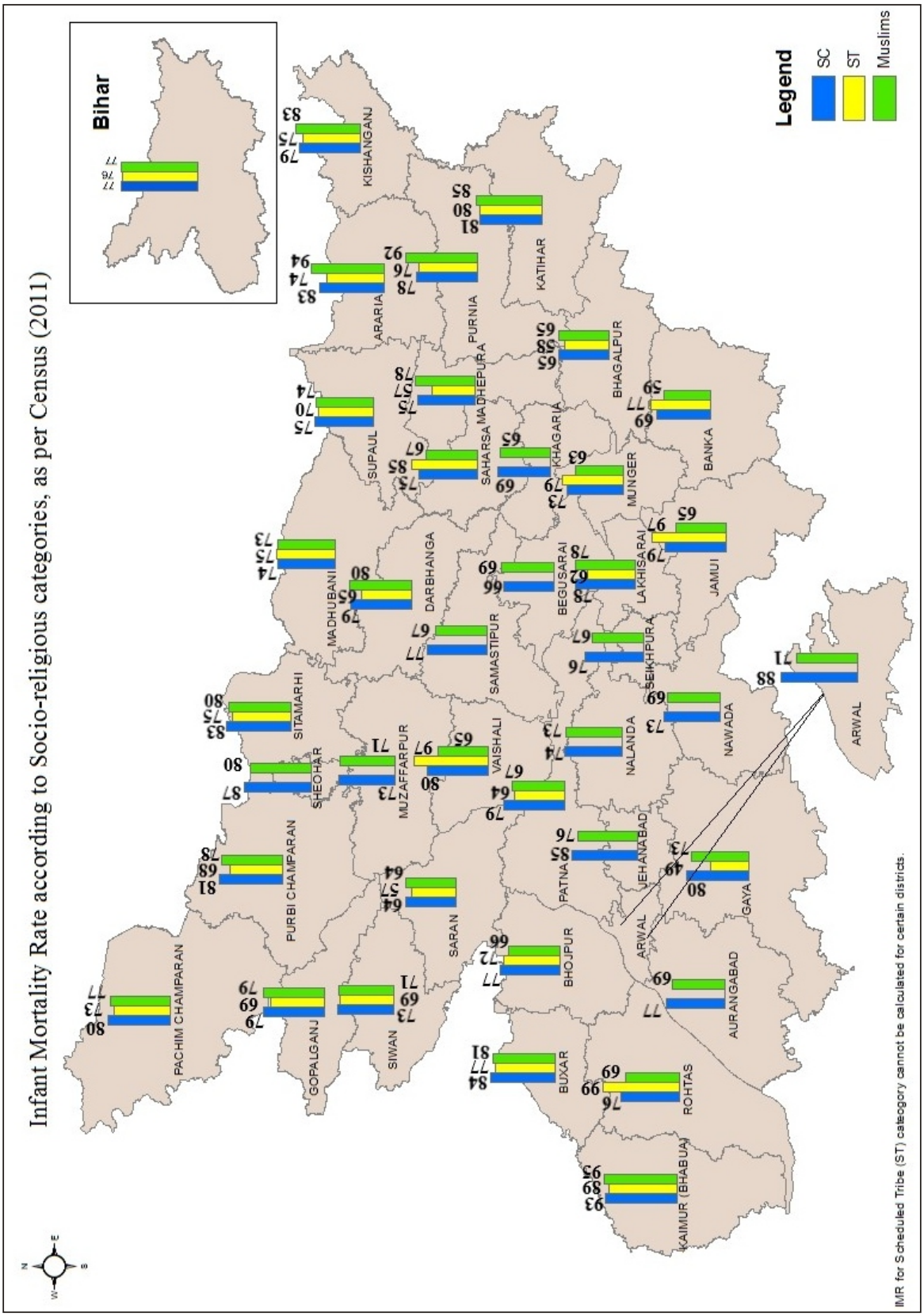
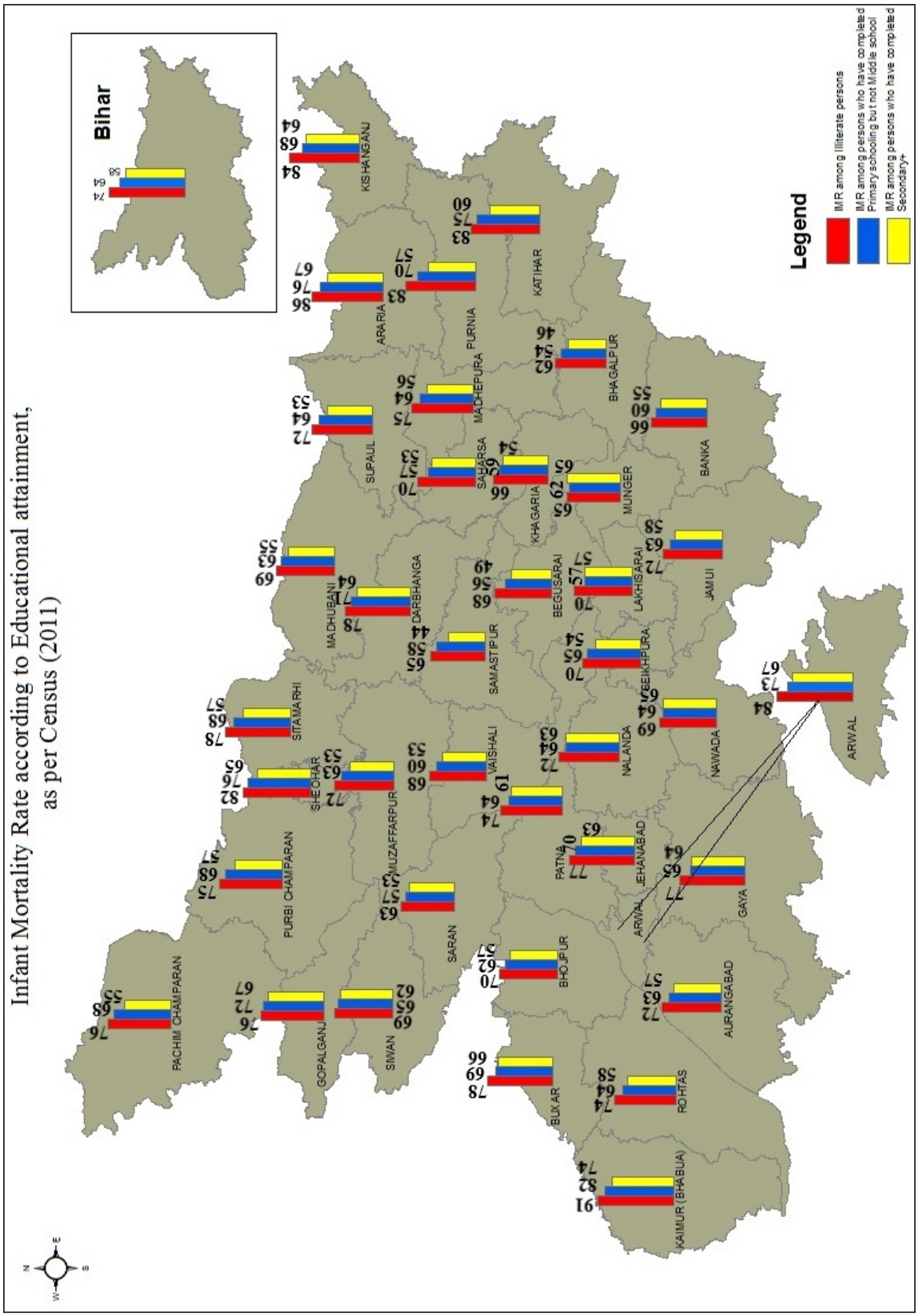


Figure 11 reveals the incidence of IMR by socio-religious categories across districts. We found that in almost all the districts IMR was significantly higher among SCs and Muslims. For example, *Kaimur* has the highest IMR among Muslims, while it was the highest among SCs in *Arwal*. STs also have higher IMR in many districts such as *Rohtas*, *Vaishali* and *Jamui*. From our analysis, one could conclude that socio-economically marginalized sections and minorities possess higher risk of infant mortality compared to others. Ghosh (2007) has noted such spatial clustering of districts in terms of social vulnerability and potential for social capital formation. This also implies that such *spatiality* related to the socio-economic well-being has not changed during last decade.

The importance of maternal education on child health and survival has been well-established in the demographic literature (Caldwell 1979, Cochrane and others, 1980; United Nations, 1985, 1994; Da Vanzo and Habicht, 1986; Cleland and Van Ginneken, 1989; Bicego and Boerma, 1993; Defo, 1994; Pandey et al., 1998). Educated women tend to be more aware of child bearing and child rearing norms including knowledge of vaccinations, signs and symptoms of common childhood illnesses and possible treatment options. In Bihar, we found educational attainment of mothers having a significant positive impact (in lowering) IMR (Figure 12).

Figure 12: Infant Mortality rate according to educational attainment of the individual



At the state level, IMR decreases by 16 points as educational attainment of women increases from not-literate to secondary and above. We found such a quantum jump of survival probability among infants in almost all the districts as maternal education reached up to a certain level. From our findings, it can be argued that once female educational attainment crosses a certain threshold (for example, secondary level in the present case), IMR is reduced substantially. It reiterates the importance of maternal (women's) education in maternal and child health.

Workforce participation among women can influence child health outcomes in two conflicting ways. On the one hand, women's workforce participation enhances women's income and thereby decision-making power in the family. A woman would more likely spend her income on better child rearing, thereby enhancing the probability of child survival. At the same time, working women would have less time for child care in the absence of appropriate public (or private) childcare facility, thereby adversely affecting child health outcomes (for an excellent review see United Nations 1985; Sivakami 1997).

Figure 13: Infant Mortality rate according to work force participation rate

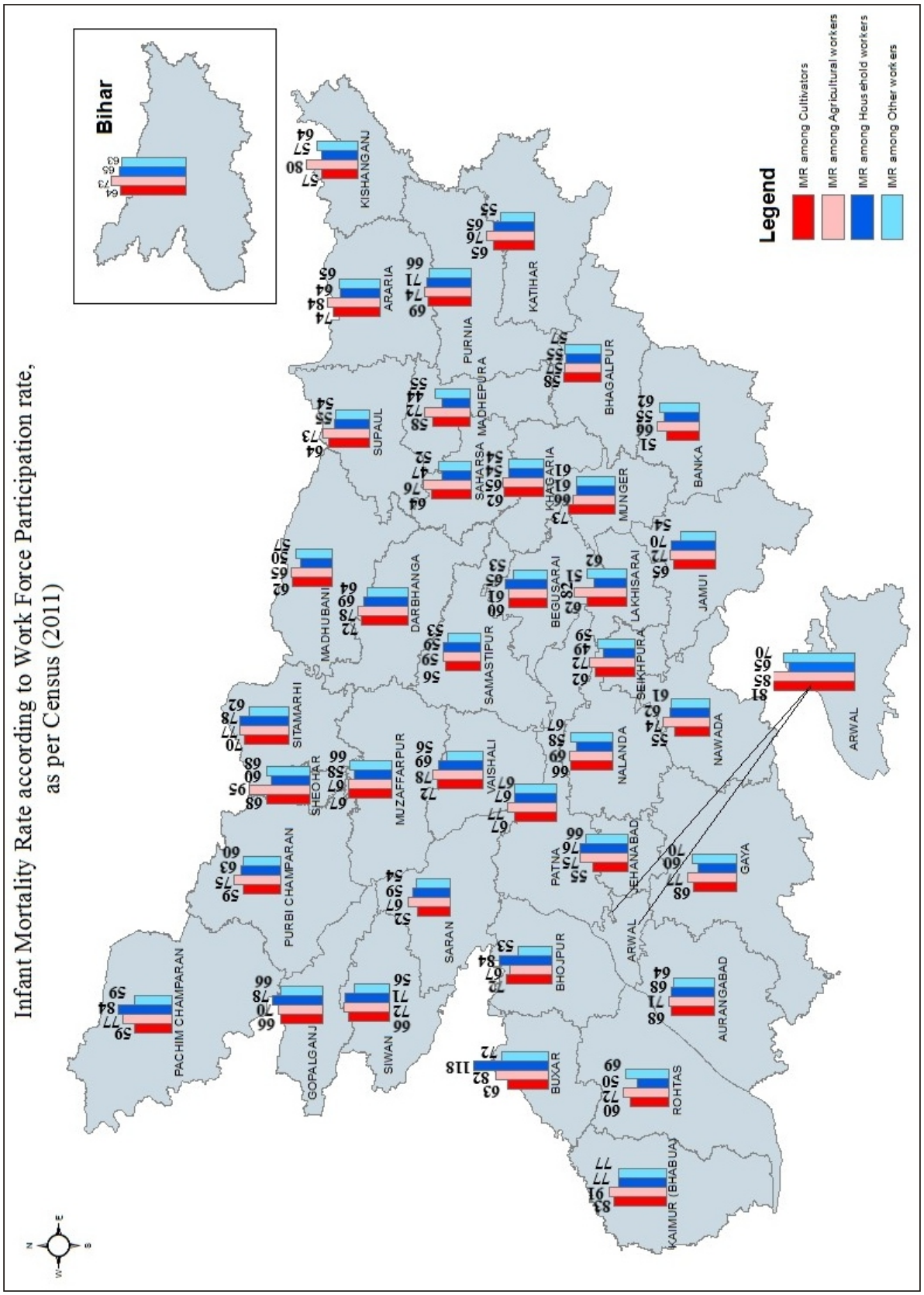


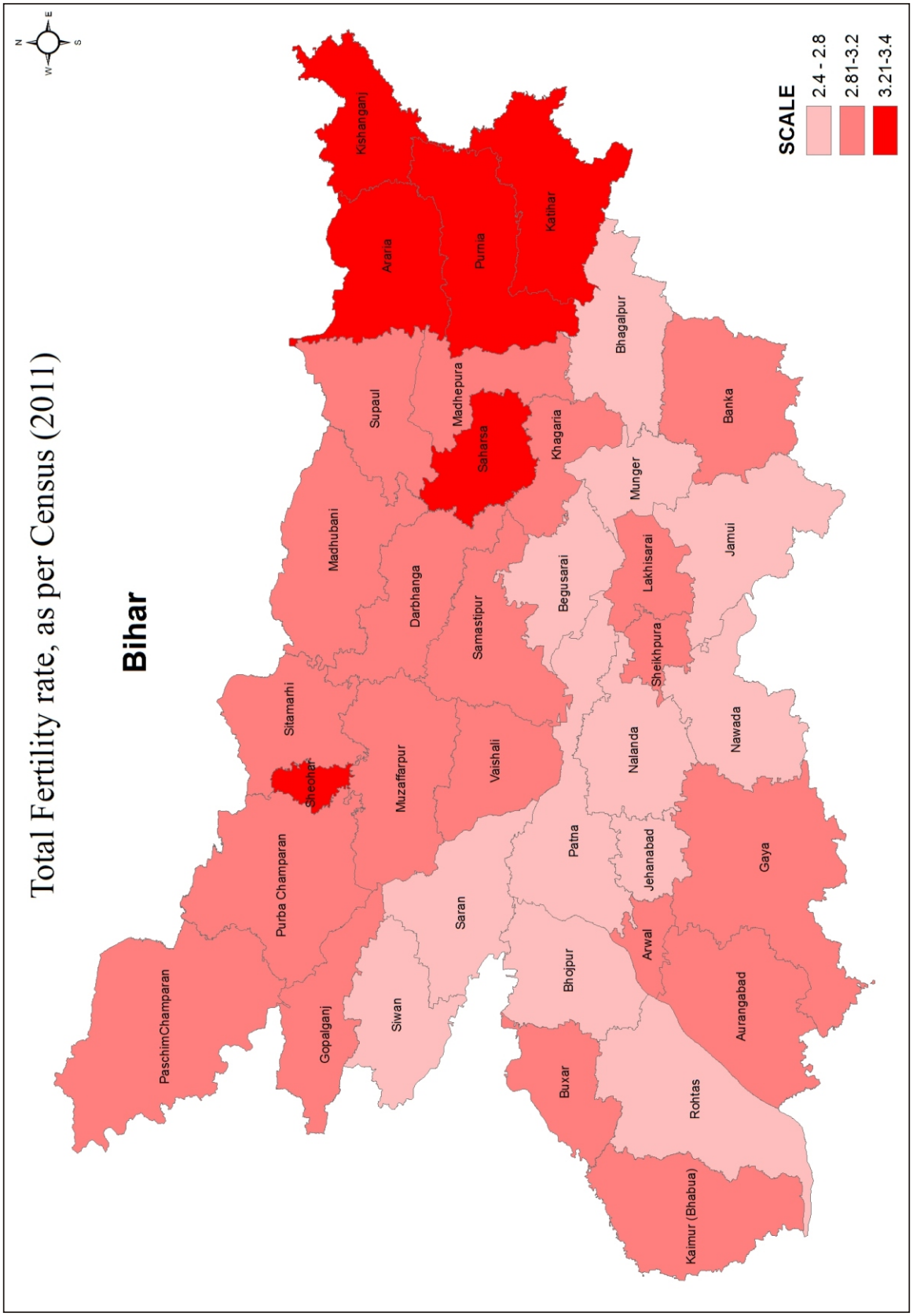
Figure 13 depicts the association between women's workforce participation by activity and IMR in Bihar. Without loss of generality, we found that time allocated for child care is an important issue that affects child health outcomes. IMR was substantially higher among children belonging to female agricultural labourers, who generally have less time for childcare, while IMR was relatively lower among female household industry workers, who would have more time for childcare. However, exceptions to this pattern include some of the western districts of Bihar such as *Buxar*, *Bhojpur*, *Paschim Champaran* and *Gopalganj*. Such findings reiterate the necessity of societal arrangements of childcare for working mothers.

Section 5: Total fertility rates (TFR) across socio-religious categories, educational attainment and workforce participation according to 2011 census

TFR is one of the parameters of current and future population growth of a population. High TFR results from early marriage, early and repeated child bearing and young age-structure of a population. The level of TFR describes the current stage of demographic transition of the study population, while the pattern of TFR indicates the time needed to achieve replacement level of fertility. In the present study, we have calculated district level TFR across different socio-religious categories, educational attainment and workforce participation rate of overall population and of females by using 2011 census data. The Arriaga version of P/F ratio method was used to estimate TFRs across districts of aforesaid categories using the MORTPAK software. However, a note of caution needs to be mentioned on the results, which has been obtained by using the method. For example, according to our calculation TFR was 3.0 at the state level in and around 2011. However, SRS report of the same year during the same period reported somewhat higher TFR (according to SRS, TFR for Bihar was 3.6 during 2011) compared to our estimate. Such discrepancy in estimates obtained by applying indirect methods has been well discussed by Ghosh (2016). As in the case of IMR, in the present study we focus on associations between various socio-demographic indicators and TFR, and their spatial variations at the district level rather than the level of TFR per se.

Spatial variations of TFR has been depicted in Figure 14.

Figure 14: Total fertility rate in Bihar across districts



As with IMR, spatial continuity in TFR is also observed. Districts located in the north-eastern parts followed by the northern parts of Bihar have higher TFR compared to other parts, while districts of south Bihar have lower total fertility rates. However, some spatial outliers still persist. For example: *Buxar, Kaimur, Arwal, Aurangabad, Gaya, Shiekhpura, Lakhisarai, Banka* belong to medium fertility zone. This also supports the earlier findings of Ghosh (2007).

Studies in several parts of India have demonstrated that socio-economically marginalized sections of the society tend to have higher TFR compared to rest of the population (see Chatterjee 2009 for a detailed review).

Figure 15: Total fertility rate according to socio-religious categories

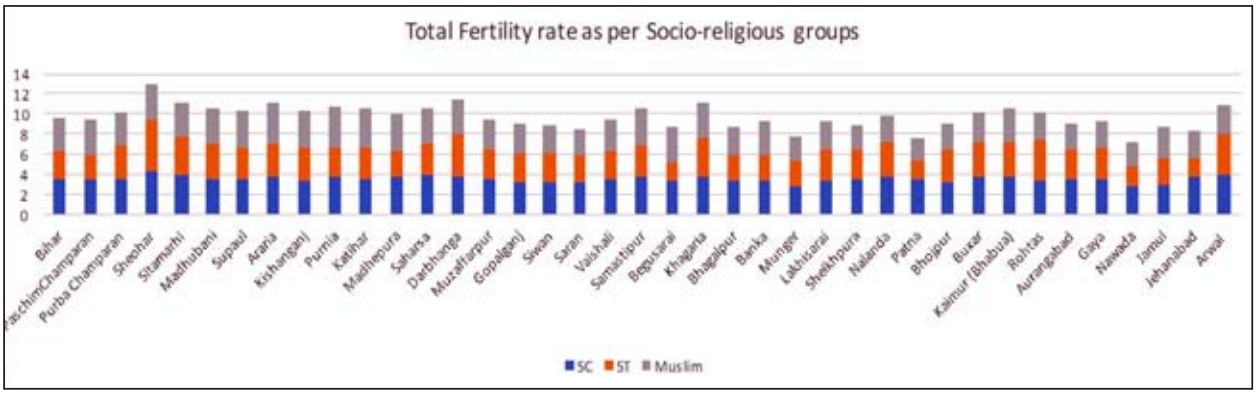
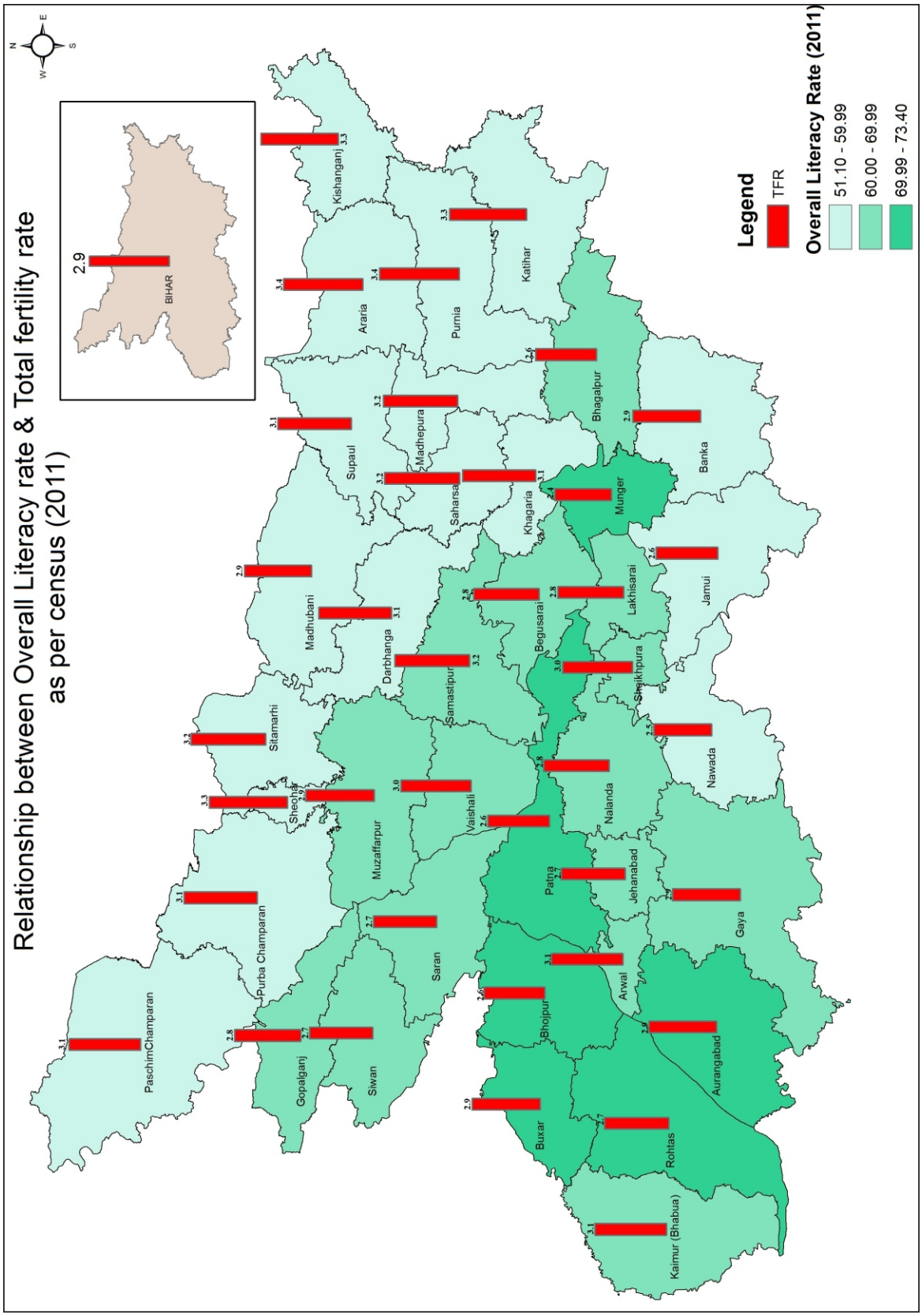


Figure 15 elucidates that variations in TFR according to socio-religious affiliation has been very high in Bihar. At the aggregate level, TFR among SCs was the highest (3.5 per woman) followed by Muslims (3.3 per woman) and STs (2.8 per woman). Although TFRs were found to be <3 in 17 districts among Muslims and in 15 districts among STs, they were found to be at such level in only 2 districts among SCs. In 20 out of 38 districts TFR among SCs was found to be more than 3.5. **These districts comprise of 48.4 percent of total population and 54.4 percent of SCs**. Controlling TFR among these segments of population is imperative to bringing down TFR to or below replacement level.

Literacy rate, particularly that of females, turns out to be an important determinant of fertility in a number of studies conducted in India and other developing countries (for an excellent review, see Bulatao and Lee 1983). Female literacy rate (or educational attainment per se) negatively affects fertility primarily by delaying age at marriage and by contracting the reproductive period, although there are other economic and ideational factors which could also be responsible for such effect. More educated women tend to have higher opportunity costs of bearing and rearing children in terms of lost income. Further, educated women are more likely to be employed in wage earning sector activities which increases their bargaining power, including decision on family size. Ideation theory

suggests that more educated women may be able to learn different ideas of desired family size through school, community, and exposure to global communication networks. Finally, more educated women tend to be more knowledgeable regarding pregnancy and child birth, and hence might have lower fertility because of greater confidence on child survival. Some of these factors hold true for men as well. In our analysis, we found ssignificant negative correlation between overall literacy and TFRs ($r=-0.705$, $p<0.01$) implying districts with higher literacy has significantly lower TFRs (Figure 16).

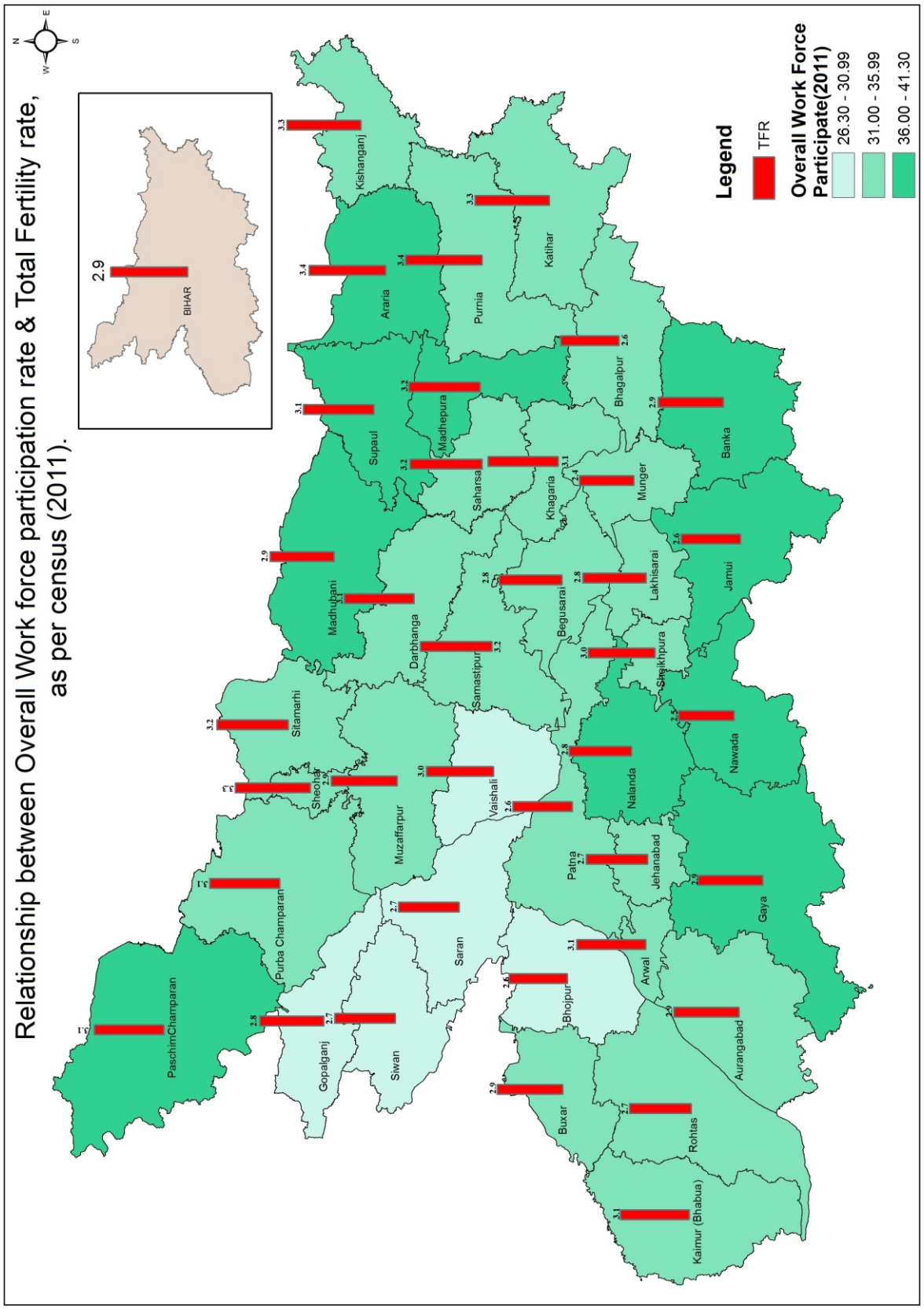
Figure 16: Relationship between Overall literacy rate and Total fertility rate



Such association also holds if we consider female literacy alone ($r=-0.681$, $p<0.01$) implying that districts with higher female literacy have significantly lower TFRs. Thus, literacy, particularly that of females, again turns out to be a significant correlate of TFR as we observed in case of IMR.

As mentioned earlier, increase in work participation rate, particularly among women might have negative impact on fertility. However, Figure 17 depicts a weak correlation between overall work participation rate and TFR ($r=0.298$, NS).

Figure 17: Relationship between work force participation rate and total fertility rate

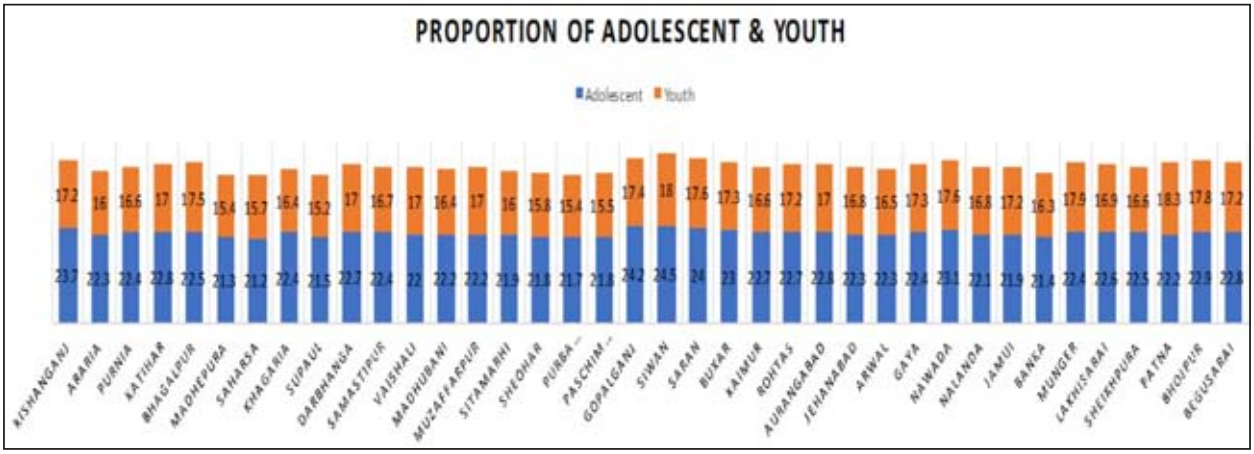


Such weak correlation between female work participation rate and TFR (r=0.071, NS) is also observed. Although one would expect a negative association between overall workforce participation rate, particularly female workforce participation and TFR, it is not the case here, indicating socio-cultural factors are the dominant determinants of TFR.

Section 6: Basic socio-demographic and economic characteristics of 'SDG Generation'

Young people have an enormous potential to contribute to Bihar's 'inclusive development'. There are more people between ages 10 and 24 today (more than 30.2 percent of total population) than at any other time in Bihar's demographic history. In absolute terms, Bihar has more than 30 million population in the said age cohort. This highlights the fact that demographic changes in Bihar as one of the key factors that would shape the inclusive development of the state. If engaged and invested in, youth and can be Bihar's greatest asset to realize the SDGs. Figure 18 represents the proportions of youth and adolescents in Bihar at the district level as well as at the aggregate level (Figure 18).

Figure 18: Proportion of population of adolescent and youth in Bihar



Adolescents and youth comprised 22.5 and 16.8 percent of the population respectively in 2011. Proportions of male in both age-cohorts were found to be higher compared to females (23.2 and 17.5 percent males in adolescents and youth age group against 21.6 and 16.1 percent females in the respective age groups). Marginal differences can be observed at the district level regarding overall proportion and between proportions of males and females belonging to these age cohorts. One can note that the percentage of youth ranges from 18.3 percent in *Patna* to 15.2 percent in *Supaul*, while percentage of adolescents was the highest in *Siwan* (24.5 percent) and the lowest in *Saharsa* (21.2 percent). Proportion of male and female youths were the highest in *Munger* and *Patna* respectively (19 and 17.7 percent respectively), while male and female adolescents were the highest in *Siwan* (25.1

and 23.9 percent respectively). Without loss of generality, one can say that the share of adolescents and youth are higher in the western and southern districts compared to other parts.

Figure 19 reveals the proportion of youth and adolescent by social categories across districts.

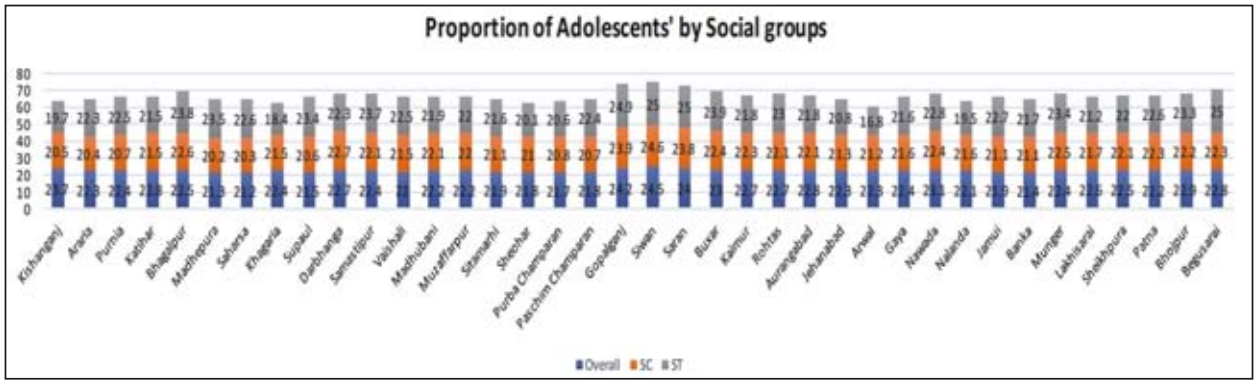
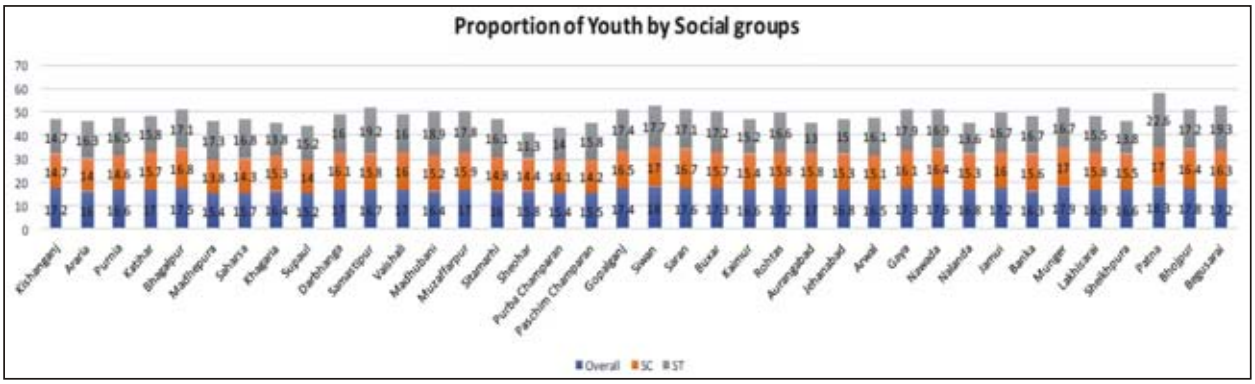


Figure 19: Proportion of adolescent and youth population according to social categories



Some district-level variations in proportion of youth and adolescent can be observed. For example, ST adolescents were found to be the highest (25 percent) in *Siwan* and *Saran* closely followed by *Gopalgung* (24.9 percent), while it was the lowest in *Khagaria* (18.4 percent). The highest proportion of SC adolescents was found in *Siwan* (24.6 percent), while such proportion was the lowest in *Madhepura* (20.2 percent). Among youth, proportion among STs was the highest in *Patna* (22.6 percent) and among SCs in *Munger* and *Patna* (17 percent).

Educational attainment among SDG generation is one of the indicators reflecting their future possibility to harness better livelihood opportunities. Figure 20 and 21 depicts literacy rate and educational attainment among adolescents and youths in Bihar according to 2011 census.

Figure 20: Percentage of literates among adolescent and youth population in rural and urban areas

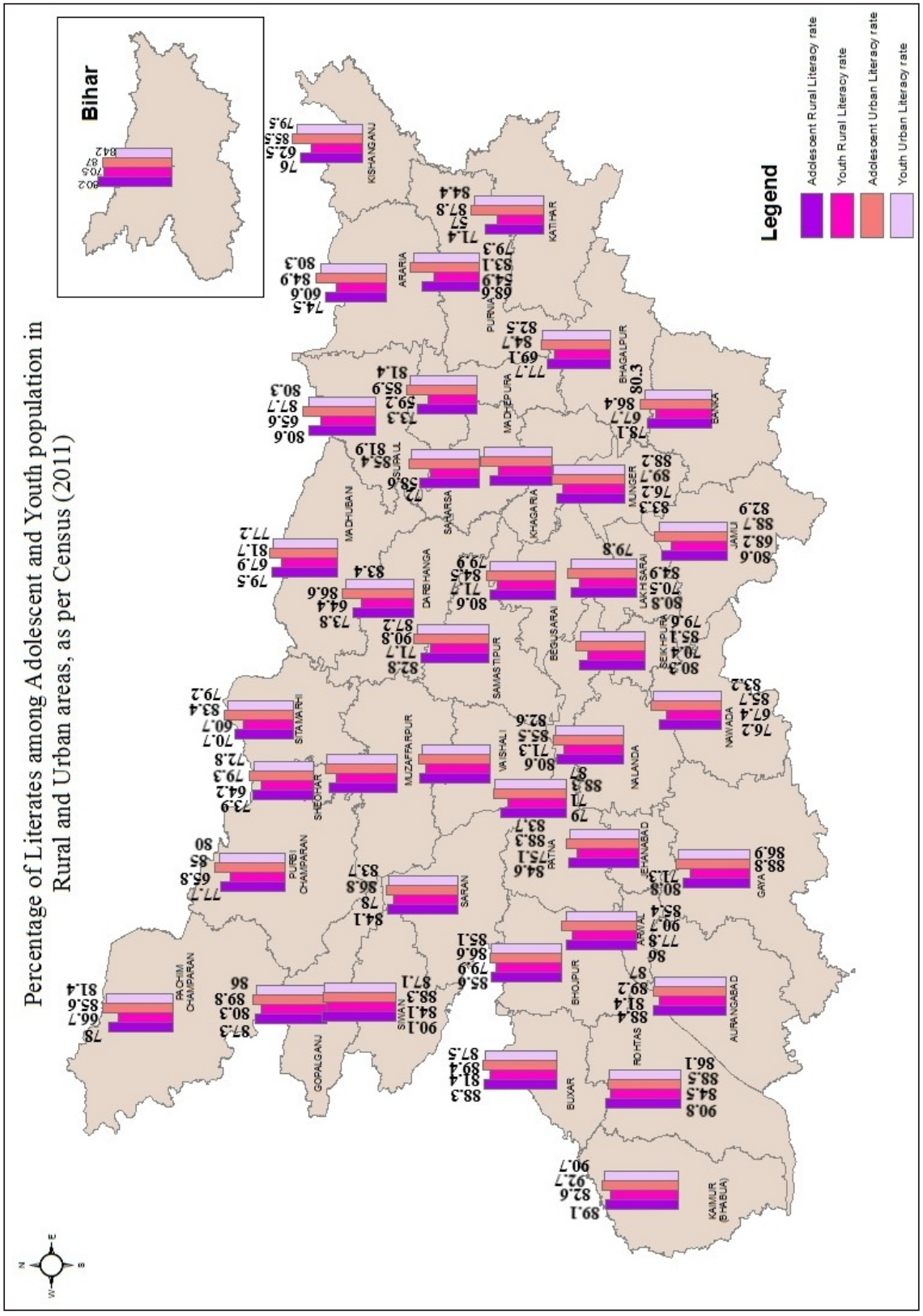
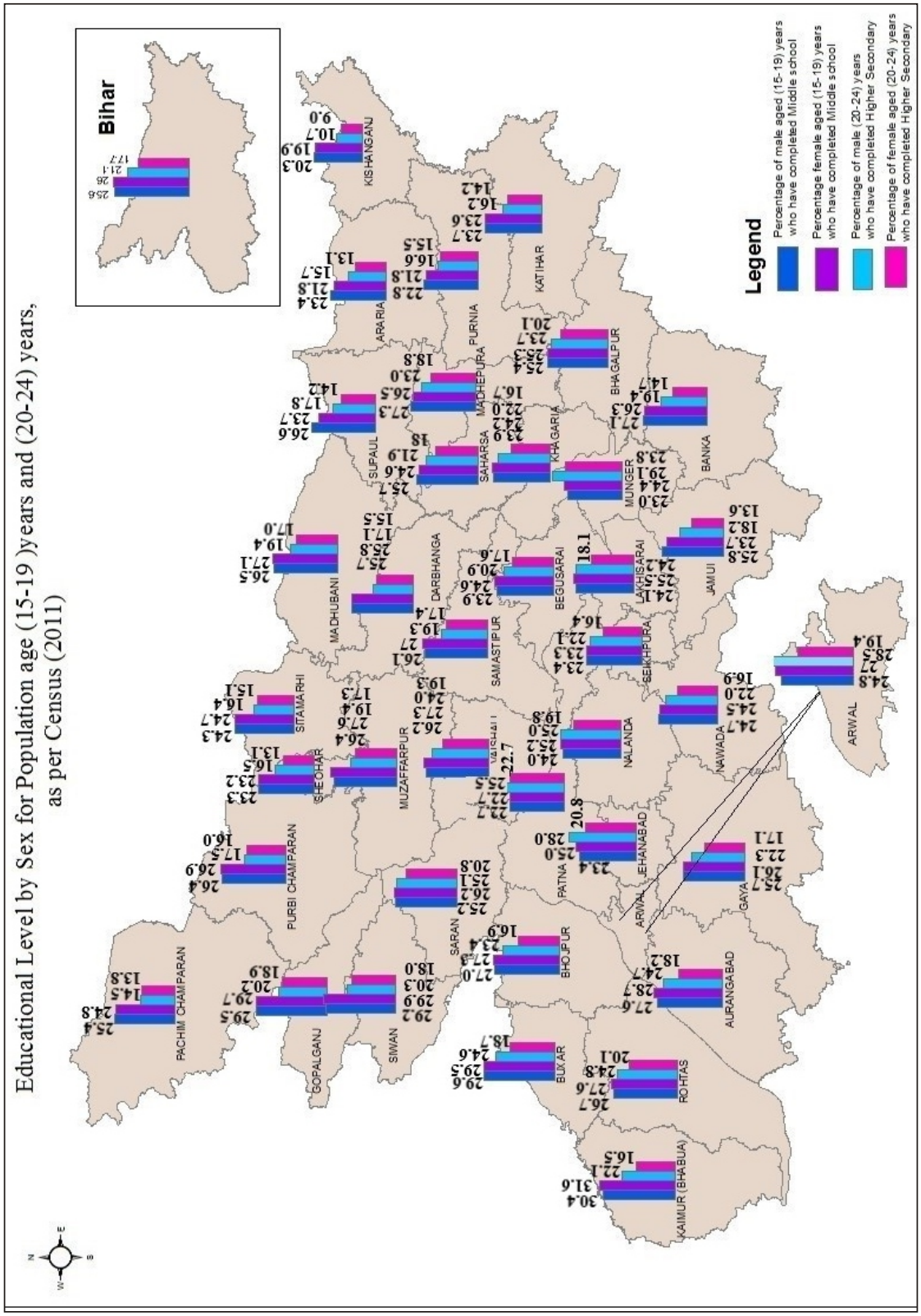


Figure 21: Educational attainment across genders within the adolescent and youth population

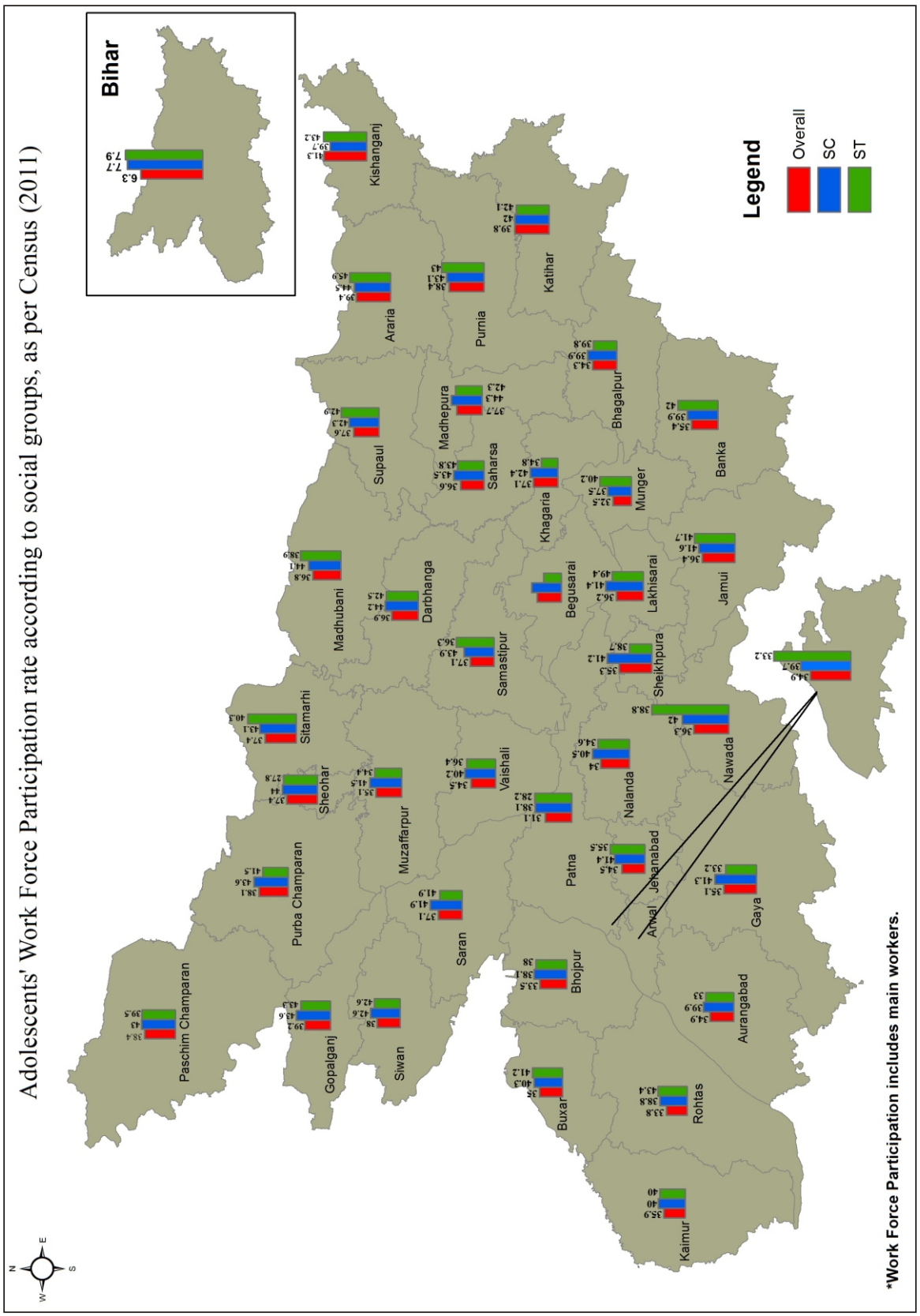


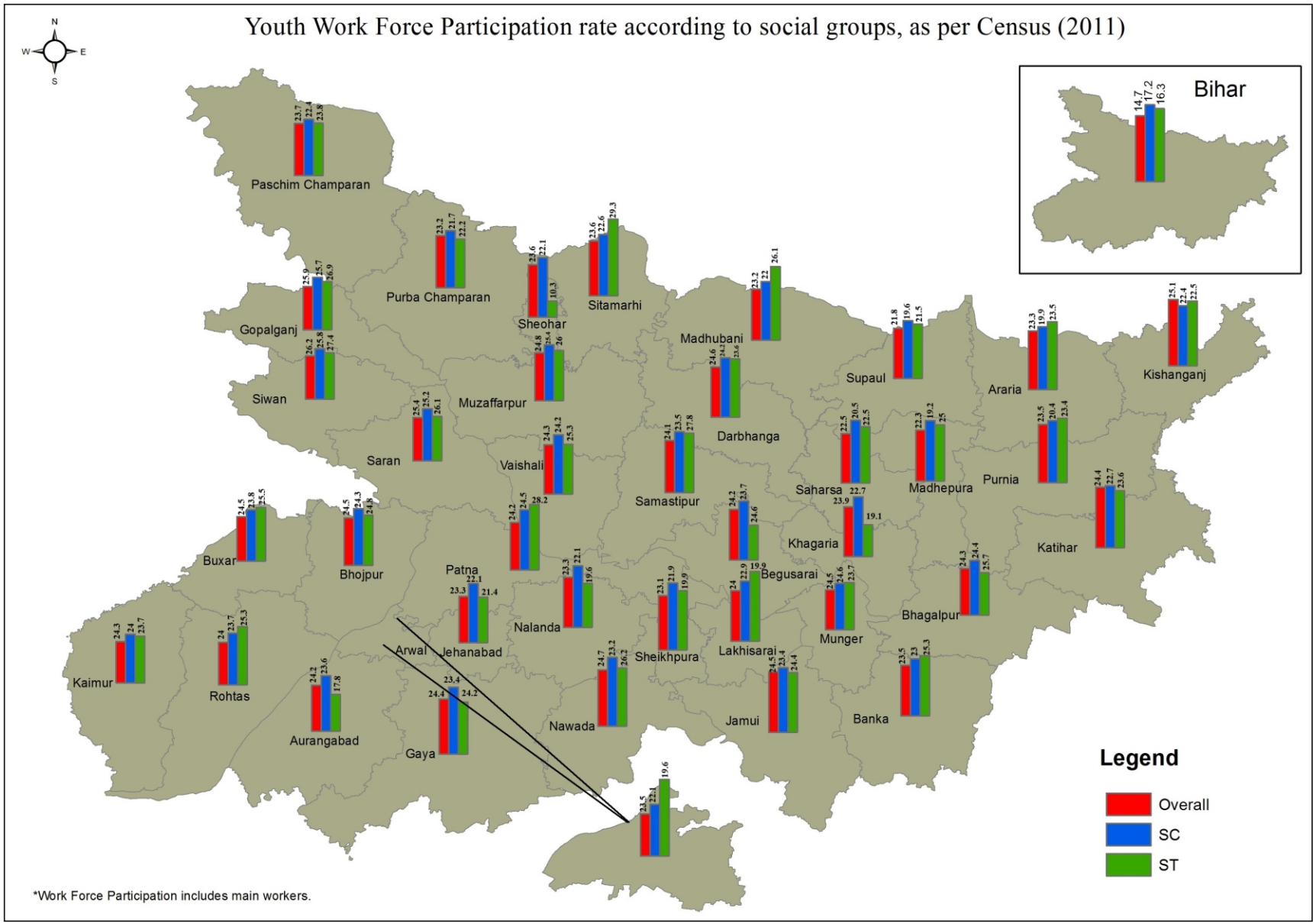
Literacy rate is substantially high among adolescents as well as among youth compared to the Bihar average, indicating higher motivation of education among the younger generation. At the same time, one can also observe spatial variation, particularly regarding the rural literacy rate among adolescents and youth. Literacy rate was found to be lower among districts of eastern parts, and higher among western and southern parts of Bihar.

As far as gender differentials in literacy rates among adolescents and youth are concerned, spatial continuity of such differences is evident. Districts of eastern parts and some districts of northern parts have more gender gap in literacy compared to western and southern districts. Although 2011 census shows vast differences between literacy rate among adolescents and youth and their successful completion of middle school, the recent UDAYA survey found 79 percent of boys, 73 percent unmarried girls and 64 percent married girls have completed middle school successfully (Santhya et al. 2017). This implies that government intervention programmes on education have been reasonably successful in the ground in retention of boys and girls in school. Although similar differences are observed in completion of higher secondary education in 2011 census with significant gender gap, it is not unreasonable to presume that the completion rate has increased substantially during preceding years and we can expect to see a huge jump of these figures across gender in the next census.

As far as workforce participation among youth is concerned, earlier studies have documented that the young (16–24 years) are particularly more prone towards the negative effects of recession, which create a spell of unemployment (Bell and Blanchflower 2010). Low literacy rate and health problems among female youth are obstacles for the development of youth in India (Dreze and Sen 2011). Figure 22 shows that overall 5.8 percent of adolescents participated in workforce according to 2011 census.

Figure 22: Work force participation rate among adolescent and youth population



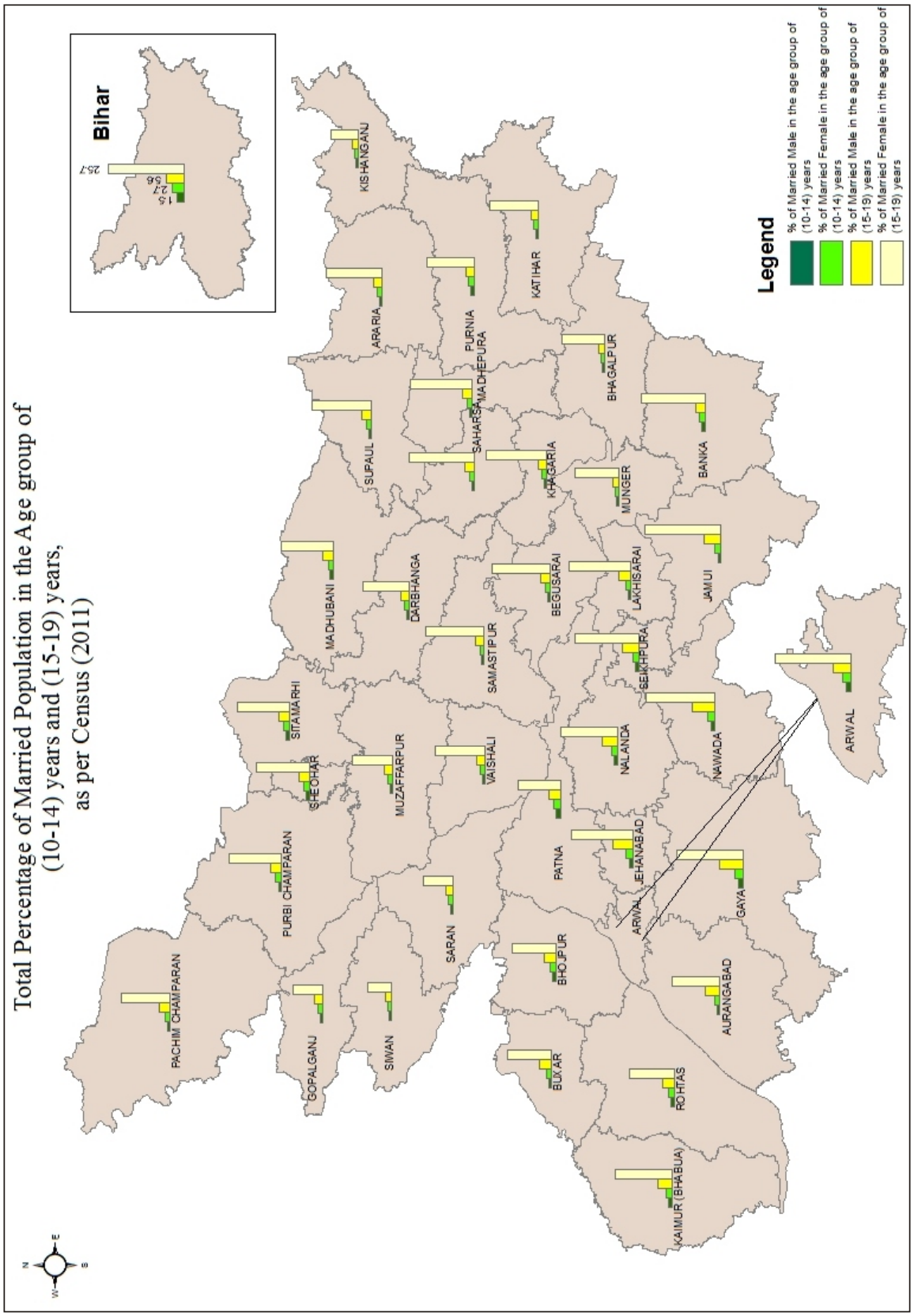

Youth Work Force Participation rate according to social groups, as per Census (2011)
N
W
E
S
Bihar
14.7
17.2
16.3
Paschim Champaran
23.7
22.4
23.8
Purba Champaran
23.2
21.7
22.2
Sheohar
23.6
22.1
10.3
Sitamarhi
23.6
22.6
29.3
Madhubani
23.2
22
26.1
Supaul
21.8
19.6
21.5
Araria
23.3
19.9
23.5
Kishanganj
25.1
22.4
22.5
Gopalganj
25.9
25.7
26.9
Siwan
26.2
25.8
27.4
Muzaffarpur
24.8
25.4
26
Darbhanga
24.6
24.1
25.6
Saran
25.4
25.2
26.1
Vaishali
24.3
24.2
25.3
Samastipur
24.1
23.5
27.8
Saharsa
22.5
20.5
22.5
Madhepura
22.3
19.2
25
Purnia
23.5
20.4
23.4
Katihar
24.4
22.7
23.6
Buxar
24.5
23.8
25.5
Bhojpur
24.5
24.3
24.9
Patna
24.2
24.5
28.2
Khagaria
23.9
22.7
19.1
Begusarai
24.2
23.7
24.6
Bhagalpur
24.3
24.4
25.7
Nalanda
23.3
22.1
19.6
Jehanabad
23.3
22.1
21.4
Sheikhpura
23.1
21.9
19.9
Lakhisarai
24
22.9
19.9
Munger
24.5
24.6
23.7
Banka
23.5
23
25.3
Jamui
24.5
23.4
24.4
Nawada
24.7
23.2
26.2
Arwal
Gaya
23.4
24.4
24.2
Aurangabad
24.2
23.6
17.8
Rohtas
24
23.7
25.3
Kaimur
24.3
24
23.7
Legend
Overall
SC
ST
*Work Force Participation includes main workers.

Notably, in the adolescent age groups, females were more likely to participate in wage earning sector activities compared to males (5.4 percent among males against 6.9 percent among females) (not shown in the figure). Such gender differential tends to persist in the youth age group as well, though overall workforce participation rate was substantially higher among males compared to females as mentioned in earlier section. This plausibly indicates the 'risk' of lesser educational attainment among females compared to males – a structured gender disparity where parents are more likely to invest in educational attainment of son compared to daughters. The recently conducted UDAYA study re-affirms such structured inequity which found that 6 percent boys and 8 percent girls of age group 10-14 were engaged in paid work prior to one year of the survey (Santhya et al. 2017). However, such trend was not found for the 15-19 age group.

At the same time, at the aggregate level and in the majority of districts, workforce participation rate among adolescents were found to be higher for marginalized communities, namely, SCs and STs compared to overall population (7.7 and 7.9 percent among SCs and STs respectively against 6.3 percent in overall population). Proportion of main workers among youth is also somewhat higher with similar pattern. Thus, it possibly indicates that adolescents and youth belonging to the marginalized communities are in greater need of livelihood options and there is a scope of intervention for life-skill education.

Presumably, high prevalence of marriage among adolescents would potentially jeopardize their future educational attainment and better livelihood options. Figure 23 portrays prevalence of marriage among age-group 10-14 and 15-19 years of age by gender.

Figure 23: Percentage of married adolescents and youth in Bihar



Although prevalence of marriage was less than 3 percent among girls of age group 10-14, it is worth mentioning that more than one out of four adolescent girls (10-19) were likely to get married before getting out of their teens. Such high prevalence of marriage among adolescent girls was evident across Bihar except a few districts of western region. UDAYA study also pointed out that nearly 44% girls currently of age 18-19 years are already married and the mean age at marriage was 16 years. More recently, the fourth round of National Family Health Survey says that the median age at first marriage is 17.5 years among women aged 20-49 years and 21.8 years among men age 25-49 years. Nearly half of the women aged 20-24 years (42%) got married before the legal minimum age of 18. The survey also found that nearly 12 percent of adolescent married girls of age-group 15-19 already began childbearing. It is also important to note that, 35 percent of men aged 25-29 years got married before the legal minimum age of 21. These findings indicate that low age at marriage among girls as well as boys is a structural phenomenon and deeply rooted in the social system of Bihar. Recent campaign of GoB on eliminating early marriage could be very helpful to reduce this social menace through sustained community involvement.

Section 7: District-level population projections up to 2026

Following the 73rd and 74th Constitutional Amendments, the emphasis in the process of planning and development programmes was a bottom-up approach with devolution of powers to local self-government (UNFPA, 2009). Consequently, data on different demographic indicators for disaggregated levels (such as district) became a necessity for the local program managers. Although the Census of India, conducted every after 10 years, provides population figures at the national and subnational levels – right from the district to the village, data at sub-national levels are required annually for planning and monitoring. Keeping this in mind, UNFPA commissioned an exercise for estimating district-level population by age and sex for the eight states including Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and Maharashtra from 2006 to 2016 at intervals of five years (UNFPA, 2009). In the present exercise, we have extended the projection up to 2026 with a slightly different methodology as discussed in earlier section.

It should be noted that the population at the state level, projected by the Expert Committee of Population Projection (RGI, 2006) made certain assumptions on the declining trend of mortality and fertility. For Bihar, the assumption on TFR was that it would reach at replacement level of fertility (TFR=2.1) by 2021. However, with the current level of TFR, 3.3 according to the latest estimates of SRS (RGI, 2018), it seems highly unlikely that it would come down to 2.1 in 3 years. Our estimates of district-level population projection are also guided by this assumption.

According to the Expert Committee Population Projection (RGI, 2006), the decadal population growth rate will drop significantly to below 10% in 2026, which is also evident from our exercise with the same assumption (decline of TFR to 2.1 by 2021) (Figure 24).

Figure 24: Population projection for Bihar

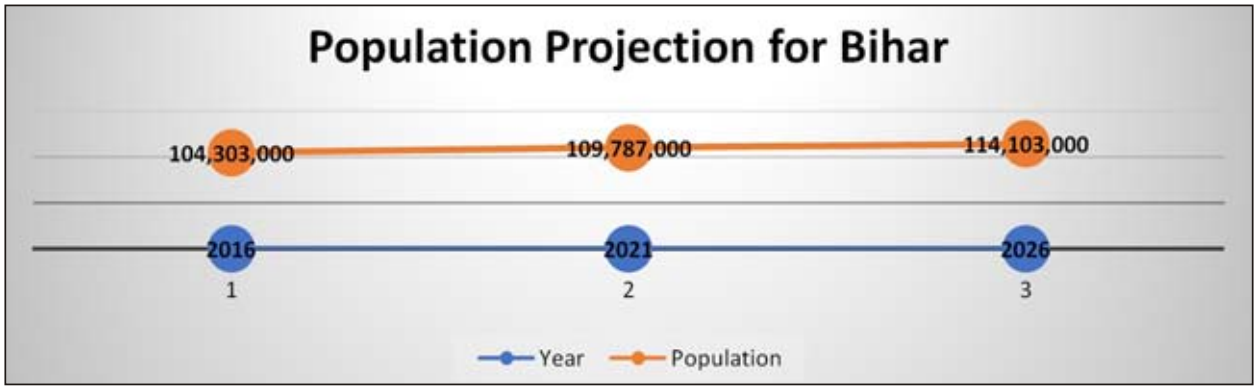
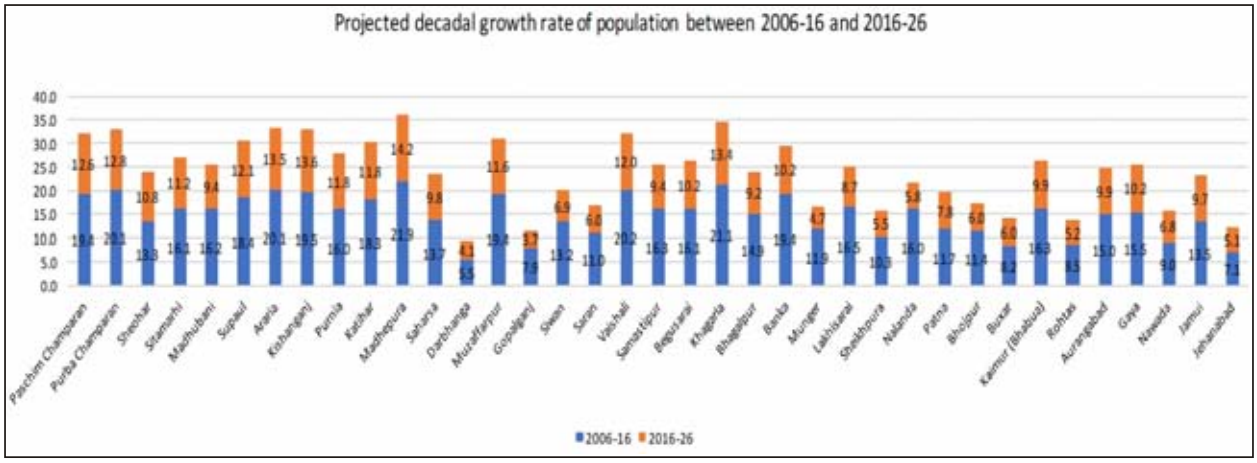


Figure 25: Population growth rate at the district-level for 2016 and 2026



One can notice a significant decline of population growth in all the districts – the largest declines are noticed in *Nalanda* (10.2 percentage-points), *Banka* (9.2 percentage-points) and *Vaishali* (8.2 percentage-points), and the lowest declines are in *Darbhanga* (1.2 percentage-points), *Jehenabad* (2.1 percentage-pints) and *Buxar* (2.2 percentage-points). However, it should be interpreted with caution because of both the 'level' effect in addition to the assumption on TFR.

One can argue that in light of current stagnation of decline in TFR, the assumption of the Expert Committee of Population Projection (RGI, 2006) could be re-examined and population projection made with more realistic assumptions. Further, there is an urgent need from the policy makers to re-think and re-orient their strategies of population

stabilization by formulating a Population Policy for the state of Bihar like other high focused states.

Section 9: Key messages

- Health outcomes cannot be seen in isolation. There is a great deal of interaction between health outcomes, educational attainment and livelihood according to our study. There are other factors affecting health outcomes as well.
- Excess" female mortality throughout their life course as observed from declining child sex ratio and lesser life expectancy at birth compared to males – a major area of concern.
- Spatial proximity is noticeable for IMR and TFR – this may be due to behavioural norms and other socio-cultural factors. Nevertheless,
- eastern districts require stronger intervention in health and family planning – particularly for socially weaker sections and economically marginalized communities.
- "SDG Generation" – concentrated efforts are required to optimize their education and livelihood skills to harness "demographic dividend". We found adolescent women tend to marry early (reducing their potential workforce participation). Therefore, the recent initiative of the GoB on "early marriage" could not have been more appropriate.
- Population Policy for Bihar is the need of the hour.

References

Arriaga, E. E. (1983). Estimating fertility from data on children ever born, by age of mother. *International research document; 11 ISP-RD-11*. Washington: US Deptment of Commerce, Bureau of the Census.

Bell, D. & Blanchflower, D. (2010). Young people and recession: a lost generation? Stirling: Division of Economics, University of Stirling; 2010.

Bicego, G. T. & Boerma, J.T. (1993). Maternal education and child survival: a comparative study of survey data from 17 countries. *Social Science and Medicine,* 36(9):1207-1227.

Brass, W. & Coale, A.J. (1968). Methods and analysis and estimation. In W. Brass, A.J. Coale, P. Demeny et al. (Eds.) *The Demography of Tropical Africa*: Princeton University Press; Princeton, NJ, 1968.

Brass, W. (1964). Uses of Census and Survey Data for the Estimation of Vital Rates. United Nations, E/CN.14/CAS/7. November.

Brass, W. (1996). Demographic data analysis in less developed countries: 1946-1996. *Population Studies*, 50(3):451–467.

Bulatao, R. A. & Lee, R.D. (eds). 1983. *Determinants of Fertility in Developing Countries*. 2 Vols. New York: Academic Press.

Caldwell, J.C. (1979). Education as a factor in mortality decline: an examination of Nigeria data. *Population Studies,* 33(2):395-413.

Chand, R. & Srivastava, S.K. (2014). Changes in the rural labour market and their implications for agriculture. *Economic and Political Weekly*, XLIX(10):47-54.

Chatterjee, B. (2009). *Globalization and Health Sector in India*. Deep & Deep Publications Private Limited: New Delhi, India.

Cleland, J. & van Ginneken, J. (1989). Maternal schooling and childhood mortality. In Hill, A.G. & Roberts, D.F. (eds.) *Health Interventions and Mortality Change in Developing Countries*. *Journal of Biosocial Science*, Supplement 10, Suppl:13-34.

Cochrane, S.H., O'Hara, D.J. & Leslie, J. (1980). The Effects of Education on Health. Washington, D.C: *World Bank Working Paper No*. 405.

Davan Zo, J.D & Habicht, J.P. (1986). Infant mortality decline in Malaysia 1946-1975: the roles of change in variables and changes in the structure of relationships. *Demography,* 23:143-160.

Defo, B.K. (1994). Determinants of childhood mortality in Cameroon: the role of socio-economic factors, housing characteristics, and immunization status. *Social Biology*, 41(3-4).

Dreze, J., Sen, A. (2011). Putting growth in its Place- It has to be but a means to development, not an end in itself, University of Oxford.

Ghosh, S., Guha-Khasnobis, B., & Husain, Z. (2018). Morbidity and health seeking behaviour in Bihar, 2004-2014, CHP Working Paper 01/2018.

Ghosh, P.P. (2007). Poverty and social assessment: A district-wise study of Bihar. Monograph no. 02/2007. Asian Development Research Institute (ADRI), Patna.

Ghosh, S. (2016) Estimating District Level Hindu-Muslim Fertility Differentials in India from 2011 Census: An Application of P/F Ratio Method. *Paper presented in 37th Annual Conference of Indian Association for Study of Population (IASP)*, Institute of Economic Growth, 7-9 December, 2016, New Delhi.

Kannan, K.P. & Raveendran, G. (2012). Counting and profiling the missing labour force. *Economic and Political Weekly*: 47(6).

Lahoti, R. & Swaminathan, H. (2013). Economic growth and female labour force participation in India. *Working paper no. 414*. Indian Institute of Management, Bangalore.

Pandey, A, Choe, M.K., Luther, N.Y., Sahu, D. & Chand, J. (1998). Infant and childhood mortality in India. Mumbai, India and Honolulu, USA: *NFHS Subject Report No. 11*. IIPS and East-West Center, Population and Health Studies.

Registrar General of India (2006). *Population Projection for India and States (2001-2026)*. Report of the technical group on population projection. Office of the RG India, Ministry of Home Affairs, Government of India, New Delhi.

Santhya, K.G., R. Acharya, N. Pandey et al. (2017). Understanding the lives of adolescents and young adults (UDAYA) in Bihar, India. New Delhi: Population Council.

Sivakami, M. (1997). Female work participation and child health: an investigation of rural Tamil Nadu, India. *Health Transition Review*, 7(1):21-32.

UNFPA (2009). *District level population projections in selected states of India – 2006-2016*. UNFPA, New Delhi.

United Nation (1985). *Socio-economic Differentials in Child Mortality in Developing Countries*. New York, USA: United Nation.

United Nation (1994). *The Health Rationale for Family Planning: Timing of Births and Child Survival.* New York, USA: United Nations Department of Economic and Social Information and Policy Analysis.

Appendix

Brass Children Ever Born (CEB)-Children Surviving (CS) method for estimating IMR

Brass developed the method of converting the proportion dead of children ever borne by women in age groups 15-19, 20-24, etc. into estimates of the probability of dying before attaining certain exact childhood ages. The basic input for this method are: (i) CEB as classified by sex and by five-year age groups of women; (ii) CS (or the number of children dead) as classified by sex and by five-year age groups of women; (iii) the total number of women (irrespective of marital status), classified by five-year age groups.

As a first step, average parity per woman is computed as P(i) = CEB(i)/FP (i), where CEB (i) is the children ever born by women in age group i and FP (i) is the total number of women in age group i. In the second step, the proportion of dead children for each age group of mothers is defined as D (i) = CD (i)/CEB (i) or D(i) = 1-CS (i)/CEB(i), where CD (i) is the number of children dead reported to women in age group i. The multiplier k (i) is calculated for non-mortality factors determining the value of D(i) from the equation of k(i)= a(i) + b(i)(P(1)/P(2)) + c(i)(P(2)/P(3)). The probability of dying is then calculated as q(x)= k(i)* D(i). The data required are mean CEB and mean CS by five-year age groups, mean age at child bearing and month and year of census or survey. The demographic package MORTPAK, developed by the United Nation was used for such an exercise. The main data source of such estimates was Census 2011. Differences in estimates obtained by employing indirect methods are well-known and discussed adequately in earlier studies (for example, see Rajan & Mohanchandran, 1998; RGI, 1998).

Arriaga version of P/F ratio method for estimating TFR

The P/F ratio method obtains current fertility by comparing the cumulative fertility equivalent derived from recent fertility data "F" by trusting the age-pattern of fertility but not level, and life-time average parities "P" trusting the overall level of fertility but not the age distribution (Brass 1964; Brass and Coale 1968; United Nations 1983). The method is very useful to adjust estimates of current fertility level, which is computed from data on recent births from incomplete Census or civil registration. The method requires data on the total number of children ever born by 5-year age groups of mothers, recent fertility by 5-year age groups of mothers measured either by births in the past year of Census or from vital registration system, and the total number of women in each 5-year age group. The assumptions of this method are: (i) age misreporting of current fertility is constant across all age-groups, (ii) increasing under-reporting of parity by women's age, and (iii) constant fertility for the youngest age groups to 35 years or so. With perfect data, the ratio should be the same for all age groups and close to 1. However, in practice, it is acceptable if the ratios

for 20-24, 25-29, and 30-34 age groups are close enough. Typically, P/F ratio will decrease with women's age and deviation from the above typical pattern indicates violations of the assumptions or different patterns of under-reporting. Imperfections of P/F ratio method were discussed in Zlotnik and Mill (1981) and in Feeney (1998). Arriaga version of P/F ratio method, which is used in the current analyses makes provision for changing fertility levels by using a linear interpolation of children ever born by age of the mother from two or more censuses (Arriaga, 1983). The method provides estimates of children ever born for one year prior to the census date. In case of Arriaga (1983), it takes the combinations of P2/F2, P3/F3 and P4/F4 by default.

Logistic growth curve method for district-level population projection

The logistic growth curve method is used when the growth rate of population, which is determined by births, deaths and migrations, takes place under normal situation and is not subjected to any extraordinary changes. Further, it is also presumed that the population follows the growth curve characteristics of living beings within limited space and economic opportunity. If the population of a city is plotted with respect to time, the curve so obtained under normal condition looks like S-shaped curve and is known as logistic curve (see figure in nptel.ac.in/courses/105105048/M5L5.pdf).

Tables on workforce participation

Changes in Overall Workforce Participation Rate by socio-religious categories												
	Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
Pashchim Champaran	37.6	37.9	-0.3	41	44.8	-3.8	47.6	46.3	1.3	34.5	34.9	-0.4
Purba Champaran	34.1	32.7	1.4	37.4	38.3	-0.9	38.5	37.5	1	32.4	30.7	1.7
Sheohar *	33	31.2	1.8	33.8	35	-1.2	38.7	23.4	15.3	32.5	29.5	3
Sitamarhi	32.6	31.9	0.7	34.1	35.9	-1.8	34.5	31.6	2.9	31.1	29.9	1.2
Madhubani	36.5	34.3	2.2	38.1	39.6	-1.5	41.1	30.6	10.5	32.9	31.4	1.5
Supaul *	39.4	42.0	-2.6	41.2	46.6	-5.4	39	45.8	-6.8	35.4	39.1	-3.7
Araria	38.1	39.5	-1.4	44.3	48.2	-3.9	47.6	51.1	-3.5	34.4	36.1	-1.7
Kishanganj	31.3	32.2	-0.9	34	36.6	-2.6	44.8	50	-5.2	29.2	30	-0.8
Purnia	35	37.8	-2.8	40.5	46.9	-6.4	43.6	47.1	-3.5	30.5	32.3	-1.8
Katihar	33	37.5	-4.5	36.9	42.3	-5.4	39.9	45.8	-5.9	29.3	34.8	-5.5
Madhepura	38.8	44.8	-6.0	40.9	49.6	-8.7	42.4	51.6	-9.2	36.8	44.1	-7.3
Saharsa	34.2	39.1	-4.9	36.7	46.3	-9.6	40.7	47.2	-6.5	31.7	36	-4.3

	Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
Darbhanga	31.1	31.2	-0.1	33.5	36.1	-2.6	33	44.2	-11.2	27.7	27.9	-0.2
Muzaffarpur	32.2	30.4	1.8	34.5	35.2	-0.7	35	31.9	3.1	29.6	27.3	2.3
Gopalganj	28.4	29.8	-1.4	32.3	36.5	-4.2	29.8	36	-6.2	25.4	27	-1.6
Siwan	28	26.9	1.1	30.6	32.8	-2.2	29	30.2	-1.2	26	24.8	1.2
Saran	26.3	26.5	-0.2	28.8	32.3	-3.5	25.3	30.2	-4.9	25	25.4	-0.4
Vaishali	30.3	28.8	1.5	32.1	33.4	-1.3	34.3	45.9	-11.6	28.8	25.4	3.4
Samastipur	31.5	31.6	-0.1	33.9	35.7	-1.8	35.1	62.9	-27.8	29.1	29.4	-0.3
Begusarai	31.6	31.8	-0.2	33.7	35.5	-1.8	34.8	27.6	7.2	29.8	31.1	-1.3
Khagaria	33.6	36.5	-2.9	35.3	42.2	-6.9	32.4	53	-20.6	30.8	31	-0.2
Bhagalpur	32.4	35.3	-2.9	33.4	38.4	-5	36.4	40.8	-4.4	30.6	33.8	-3.2
Banka*	37.9	39.6	-1.7	39.5	42.5	-3	46.1	48.6	-2.5	34.3	38	-3.7
Munger	31.2	29.1	2.1	33.4	34	-0.6	39.1	39.1	0	25.4	22.5	2.9
Lakhisarai*	32.6	36.5	-3.9	37.4	44.9	-7.5	41.4	49.6	-8.2	30.2	29.9	0.3
Sheikhpura*	35.3	37.0	-1.7	40.5	46.1	-5.6	32.1	48.3	-16.2	28.2	25.4	2.8
Nalanda	36.3	38.1	-1.8	39.5	44.7	-5.2	40.5	54.3	-13.8	29.7	28.6	1.1
Patna	32.2	30.2	2.0	36.1	37.6	-1.5	37.3	46.1	-8.8	28.8	25.6	3.2
Bhojpur	30.1	29.1	1.0	33.5	35.8	-2.3	30.7	30.2	0.5	27	25.2	1.8
Buxar*	31.5	29.1	2.4	35	35.1	-0.1	31.5	31.3	0.2	27.7	26.8	0.9
Kaimur	31.4	34.4	-3.0	34.2	39.3	-5.1	37.4	42.6	-5.2	27	29.9	-2.9
Rohtas	31.2	30.4	0.8	34.3	36.1	-1.8	38.6	39.4	-0.8	26.9	25.7	1.2
Aurangabad	33	33.3	-0.3	36	39.1	-3.1	40.7	41	-0.3	28.6	26.1	2.5
Gaya	37.9	36.8	1.1	41.4	43.7	-2.3	46.9	41.2	5.7	32.7	28.4	4.3
Nawada	36.8	37.3	-0.5	41.6	45.3	-3.7	45	48	-3	29.2	27.8	1.4
Jamui	41.3	42.7	-1.4	44.1	47.7	-3.6	50.2	47.4	2.8	38.1	38.2	-0.1
Jehanabad	32.5	38.4	-5.9	36.1	44.8	-8.7	37.7	61	-23.3	27.7	31.2	-3.5
Arwal*	33.7			38			40.5			29.9		

Changes in Workforce Participation Rate among Males by Socio-religious Categories											
Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
48.5	50.8	-2.3	49.2	53.5	-6.1	52.9	53.7	-0.8	46	48	-2
47	48.8	-1.8	47.4	50.9	-3.7	48.2	52.1	-3.9	45.3	46.3	-1
48.1	50.3	-2.2	47.2	51.7	-3.8	50.3	40	10.3	47.7	48.3	-0.6
48	50.3	-2.3	47.9	52.1	-5	49.7	50.1	-0.4	46.3	47.7	-1.4

Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
47.5	47.8	-0.3	47.1	49.8	-2.3	49.5	47.4	2.1	44.6	44.9	-0.3
47.8	50.4	-2.6	47.5	51.7	-2.8	46.1	49.9	-3.8	44.4	47.2	-2.8
48.4	52.1	-3.7	48.9	53.9	-5.2	51.8	55.7	-3.9	46.1	50.3	-4.2
48.6	52.7	-4.1	48.7	53	-5.7	53.2	60	-6.8	47.2	51.6	-4.4
47.3	51.0	-3.7	47.3	52.8	-5.6	50.3	53.1	-2.8	45.6	49.5	-3.9
47.5	50.9	-3.4	47.2	50.9	-4.7	49.6	53.7	-4.1	46.2	50	-3.8
47.4	51.7	-4.3	46.2	52.6	-7.7	48.2	53.4	-5.2	45.4	50.6	-5.2
45.8	48.9	-3.1	44.9	51.3	-5.2	47.7	51.8	-4.1	43.4	45.9	-2.5
46	46.1	-0.1	46.1	47.9	-0.3	43.4	56.7	-13.3	43.1	43	0.1
47.3	46.7	0.6	47.6	48.5	-4.3	47.7	45.1	2.6	45	43.2	1.8
42.6	44.6	-2.0	44.2	46.6	-2.8	42.4	47.5	-5.1	38.9	41.1	-2.2
43.6	41.5	2.1	43.8	42.6	0.1	43.8	42.2	1.6	41.8	39.2	2.6
42.4	42.1	0.3	42.7	43.5	3.5	40.9	42.6	-1.7	41.1	40	1.1
46.6	45.3	1.3	47	47.3	-0.5	47.5	55.7	-8.2	45.2	41.3	3.9
46.5	46.8	-0.3	46.8	48.1	-2.8	48.6	71	-22.4	44	43.6	0.4
45.6	46.2	-0.6	45.3	47	-3	47.3	41.9	5.4	42.8	43.8	-1
45.1	48.5	-3.4	44	50.1	-4.9	44.6	64.3	-19.7	42.9	44.2	-1.3
45.8	47.4	-1.6	45.2	47.5	1	46.1	48.5	-2.4	45.1	46.6	-1.5
48.5	49.9	-1.4	48.5	50.7	-6	53.3	54.7	-1.4	46.5	48.5	-2
44.9	42.9	2.0	44.7	44.7	2.6	48.1	48.7	-0.6	41.8	37.8	4
45.7	48.6	-2.9	47.3	51.5	-4	46.8	53.9	-7.1	45.4	45.9	-0.5
46	48.0	-2.0	47.5	50.7	-3.9	37	60.9	-23.9	44.4	42.7	1.7
47	48.3	-1.3	46.8	50.3	-3.6	46	63.9	-17.9	44.4	42.2	2.2
46.7	44.9	1.8	46.7	47.4	-1.5	48.4	58.1	-9.7	45.6	41.8	3.8
44.8	44.1	0.7	45.9	47.1	-1.9	43.7	44.8	-1.1	43.2	40.6	2.6
45.3	44.6	0.7	45.2	46.6	-2.3	44.8	46.6	-1.8	42.8	42.2	0.6
44.4	46.6	-2.2	44.3	47	-0.9	46.7	51.8	-5.1	41.3	43.2	-1.9
45.9	45.7	0.2	46.1	47.5	-1.3	47.2	50.9	-3.7	43.2	42	1.2
45.4	45.6	-0.2	46.2	48	0.6	50.4	51.8	-1.4	43.4	40.8	2.6
47.5	47.4	0.1	48.6	50.1	-1.3	54.7	51.2	3.5	44.9	42.2	2.7
47.1	48.1	-1.0	48.8	51.1	-0.5	50.1	54.4	-4.3	44	42.8	1.2
49.4	49.9	-0.5	50.6	52.7	-6.6	54.2	52.1	2.1	46.8	46.2	0.6
45.5	48.1	-2.6	46.1	50.3	-3.3	45.9	67.6	-21.7	42.3	43.8	-1.5
46.2			47			48.8			44.4		

Changes in Workforce Participation Rate among Females by Socio-religious Categories											
Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
25.6	23.6	2.0	26.4	35.3	-8.9	42.1	38.5	3.6	22.2	20.7	1.5
19.7	14.7	5.0	18.9	24.3	-5.4	28.1	21.5	6.6	18.5	13.9	4.6
16	9.8	6.2	18.7	16.2	2.5	24.1	3.4	20.7	16.5	9.5	7
15.3	11.2	4.1	28.5	17.8	10.7	17.3	10.6	6.7	14.8	10.9	3.9
24.6	20.1	4.5	34.5	28.7	5.8	32.2	12.7	19.5	20.7	17.4	3.3
30.4	33.0	-2.6	39.3	41.1	-1.8	31.5	41.5	-10	26	30.5	-4.5
26.8	25.8	1.0	18.6	42	-23.4	43.1	46.2	-3.1	21.9	20.7	1.2
13.1	10.2	2.9	33.2	19.1	14.1	36.2	39.6	-3.4	10.4	7.2	3.2
21.7	23.3	-1.6	25.8	40.5	-14.7	36.6	40.7	-4.1	14.3	13.7	0.6
17.2	23.1	-5.9	25.2	33.1	-7.9	29.7	37.4	-7.7	11.2	18.5	-7.3
29.5	37.3	-7.8	27.8	46.5	-18.7	36.3	49.7	-13.4	27.6	37.1	-9.5
21.4	28.4	-7.0	19.7	40.9	-21.2	33.3	42.2	-8.9	19	25.3	-6.3
14.7	14.9	-0.2	20.1	23.2	-3.1	23	28.6	-5.6	11.3	11.8	-0.5
15.5	12.7	2.8	20.5	20.9	-0.4	21.1	17.8	3.3	13	10.8	2.2
14.6	15.1	-0.5	17.2	26.1	-8.9	17.6	25.2	-7.6	12.6	13.4	-0.8
12.2	12.8	-0.6	14.3	23	-8.7	14.3	18.3	-4	10.2	10.7	-0.5
9.5	10.4	-0.9	15.7	20.6	-4.9	9.9	17.4	-7.5	8.6	10.7	-2.1
12.2	10.9	1.3	20	18.4	1.6	18.7	35.3	-16.6	11.1	9.1	2
15.1	15.1	0.0	20.7	22.3	-1.6	20.6	28.2	-7.6	13	14.6	-1.6
15.9	15.9	0.0	25.7	23	2.7	20.7	10.4	10.3	15.6	17.3	-1.7
20.8	22.9	-2.1	20	33.5	-13.5	19.2	39.3	-20.1	17.3	16.2	1.1
17.1	21.4	-4.3	29.5	28	1.5	25.5	32.1	-6.6	14.7	19.8	-5.1
26.2	28.2	-2.0	20.7	33.7	-13	38.7	42.1	-3.4	21.2	26.8	-5.6
15.5	13.4	2.1	26.5	21.9	4.6	29.6	29	0.6	7.1	5.1	2
18.1	23.3	-5.2	33.1	37.8	-4.7	35.7	44.9	-9.2	13.7	12.9	0.8
23.8	25.0	-1.2	31.6	41	-9.4	27.2	33.3	-6.1	11.1	7.3	3.8
24.8	27.0	-2.2	31.6	38.5	-6.9	34.9	43	-8.1	14.1	14	0.1
16.1	13.3	2.8	24.4	26.5	-2.1	25.4	29.5	-4.1	10.7	7.3	3.4
14	12.6	1.4	20	23.1	-3.1	16.4	13.4	3	9.7	8.6	1.1
16.6	11.9	4.7	23.9	22.3	1.6	16.7	13.2	3.5	11.6	10	1.6
17.3	20.7	-3.4	23.1	30.8	-7.7	27.6	32.6	-5	11.8	15.4	-3.6
15.3	13.5	1.8	21.4	23.4	-2	29.4	26.8	2.6	9.5	8	1.5
19.5	20.2	-0.7	25.1	38.9	-13.8	31.5	29	2.5	13	11.1	1.9

Overall (2011)	Overall (2001)	% Change	SC (2011)	SC (2001)	% Change	ST (2011)	ST (2001)	% Change	Muslim (2011)	Muslim (2001)	% Change
27.7	25.5	2.2	33.9	36.9	-3	38.2	30.4	7.8	19.8	14.2	5.6
25.8	25.8	0.0	34	39.1	-5.1	40.3	41	-0.7	13.7	12.3	1.4
32.6	34.8	-2.2	37.2	42.5	-5.3	46.1	42.4	3.7	28.8	29.7	-0.9
18.3	27.9	-9.6	25.4	29.6	-4.2	28.8	53.3	-24.5	12	17.8	-5.8
20.3			28.3			32.9			14.5		

Notes

Notes

The Centre for Health Policy (CHP) at the Asian Development Research Institute (ADRI) has been set up with support from the Bill & Melinda Gates Foundation to strengthen the health sector in Bihar with a multidimensional and multi-disciplinary approach. Its aim is to engage in rigorous analysis of the health system and inform policy makers to fine-tune interventions for even stronger outcomes.

- Research and Analytical Studies

  It constitutes the core of CHP's activities. The areas of research include health infrastructure and delivery with emphasis on equity, health outcomes such as IMR, MMR, TFR and its predictors, health financing, private-public partnerships, regulatory framework and its implementation, and other issues which might emerge.

- Informing Policymakers on Strengthening the Existing Health System

  CHP aims to be the trusted partner of the state Government in providing evidence-based inputs in making the health system stronger, resilient and equitable.

- Sustainable Health Solutions

  CHP recognizes the need for establishing a strong health system which will be self-sustaining. It means immunity to natural disasters/calamities, financial uncertainties and other unanticipated factors. These pillars may be interrelated; CHP will provide a framework of synergy among actors working on these pillars.

- Collaboration

  CHP engages in collaboration with an extensive network of academic and policy research institutions both in India and abroad in health and the broader social sciences.