

Gender Disparity in Literacy in Koch Bihar District: A Spatio-Temporal Perspective

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Abstract

Gender disparity is the difference in treatment, opportunities and resources between people based solely on their gender. This study examines how the geography of gender disparity in literacy changed in Koch Bihar district, West Bengal, over the Census period 1991-2011. It combines a district-level three-census series (1991, 2001 and 2011) with a verified two-census panel for the twelve rural Community Development (CD) blocks (2001 and 2011). Gender inequality is measured using the modified Sopher Disparity Index, supported by the literacy gap and changes in female literacy. At district level, male literacy increased from 57.35% in 1991 to 80.71% in 2011, while female literacy rose more rapidly from 33.31% to 68.49%. Consequently, the Sopher index declined from 0.304 to 0.114. Across the twelve rural blocks, the mean index fell from 0.244 in 2001 to 0.138 in 2011, a reduction of 43.4%. Every block converged, but the relative geography of disadvantage remained persistent: Mathabhanga-I and Mekhliganj retained the highest 2011 disparities (both 0.160), whereas Cooch Behar-II and Dinhata-II recorded the lowest (both 0.119). The results reveal a dual process of universal improvement and durable spatial hierarchy. The paper argues that district-wide literacy progress should therefore be complemented by block-sensitive interventions focused on female retention, secondary-school accessibility and adult literacy.

Keywords: female literacy; gender disparity; Sopher index; Koch Bihar; West Bengal

1. Introduction

Literacy is both a basic capability and a gateway to wider social participation. It affects access to formal education, public information, paid work, health knowledge, financial services and political voice. A district average, however, can conceal the geographical concentration of educational disadvantage. This limitation is especially important in predominantly rural districts, where the distance to institutions, the density of settlements, riverine barriers, agrarian work cycles and socially differentiated household decisions can produce sharply uneven outcomes within a relatively small area.

Gender is central to this geography. In rural India, the schooling of girls has historically been shaped by household resource constraints, domestic work, mobility and safety concerns, marriage expectations and unequal perceptions of the economic return to education. Drèze and Kingdon (2001) showed that girls' school participation responds not only to household circumstances but also to village development, school quality and public programmes. Kambhampati and Pal (2001), using rural West Bengal data,

found that parental education - particularly maternal literacy - substantially influences daughters' schooling. Kingdon (2002) further demonstrated that gender gaps cannot be reduced to a single cause; they emerge through the interaction of household preferences, enrolment decisions and attainment conditional on enrolment.

Koch Bihar provides a revealing setting for a fine-grained analysis. The district occupies an alluvial borderland in north-eastern West Bengal and contains twelve rural CD blocks distributed across five subdivisions. Its literacy transition has been substantial: total literacy rose from 45.78% in 1991 to 74.78% in 2011. However, the trajectory of female literacy and the extent of convergence differed across its rural blocks. A geographical analysis is therefore necessary to determine whether aggregate progress translated into spatially balanced gender equality.

This paper adds to the discussion in three ways. First, it separates level from disparity: a block may have a low male-female gap because both sexes have low literacy, while another may have a similar gap at a much higher educational level. Second, it uses Sopher's disparity measure, modified by Kundu and Rao, to make the comparison sensitive to the relative position of male and female rates. Third, it distinguishes absolute convergence from spatial persistence. The study thus asks not only whether gender disparity declined, but also whether the identity of relatively advantaged and disadvantaged blocks changed.

2. Literature Review and Research Gap

The capability approach views education as constitutive of freedom rather than merely an input into earnings (Sen, 1999). Within this perspective, female literacy has intrinsic value and also affects household agency, intergenerational learning and access to public institutions. National studies consistently demonstrate that educational inequality is spatially patterned. Katiyar (2016) mapped substantial inter-state variation in India and stressed that female literacy gains do not automatically eliminate gender disparity. Recent district-scale work likewise shows that a spatial unit with improving average literacy may retain internal clusters of female disadvantage (Sakshi & Bano, 2023).

For West Bengal, research has highlighted the intersection of gender, rurality and social composition—Kambhampati and Pal (2001) connected girls' schooling to intergenerational educational conditions within rural households. Biswas (2022) used the modified Sopher index to compare literacy and enrolment inequalities between social groups, demonstrating the usefulness of a bounded relative measure. These studies indicate that gender disparity should be analyzed together with the local social and institutional environment rather than treated as a purely demographic residual.

At the district level, Maji and Sarkar (2017) examined ten indicators of primary education in Bankura, including school facilities, enrolment and dropout. Their work shows why literacy alone cannot describe local educational conditions. In a study of Belagavi, Manjunatha and Hurakadli (2017) compared gender differences in literacy across administrative units using a modified Sopher index. These studies offer useful methods, but the present paper concentrates on changes in the position of the twelve rural CD blocks of Koch Bihar between 2001 and 2011.

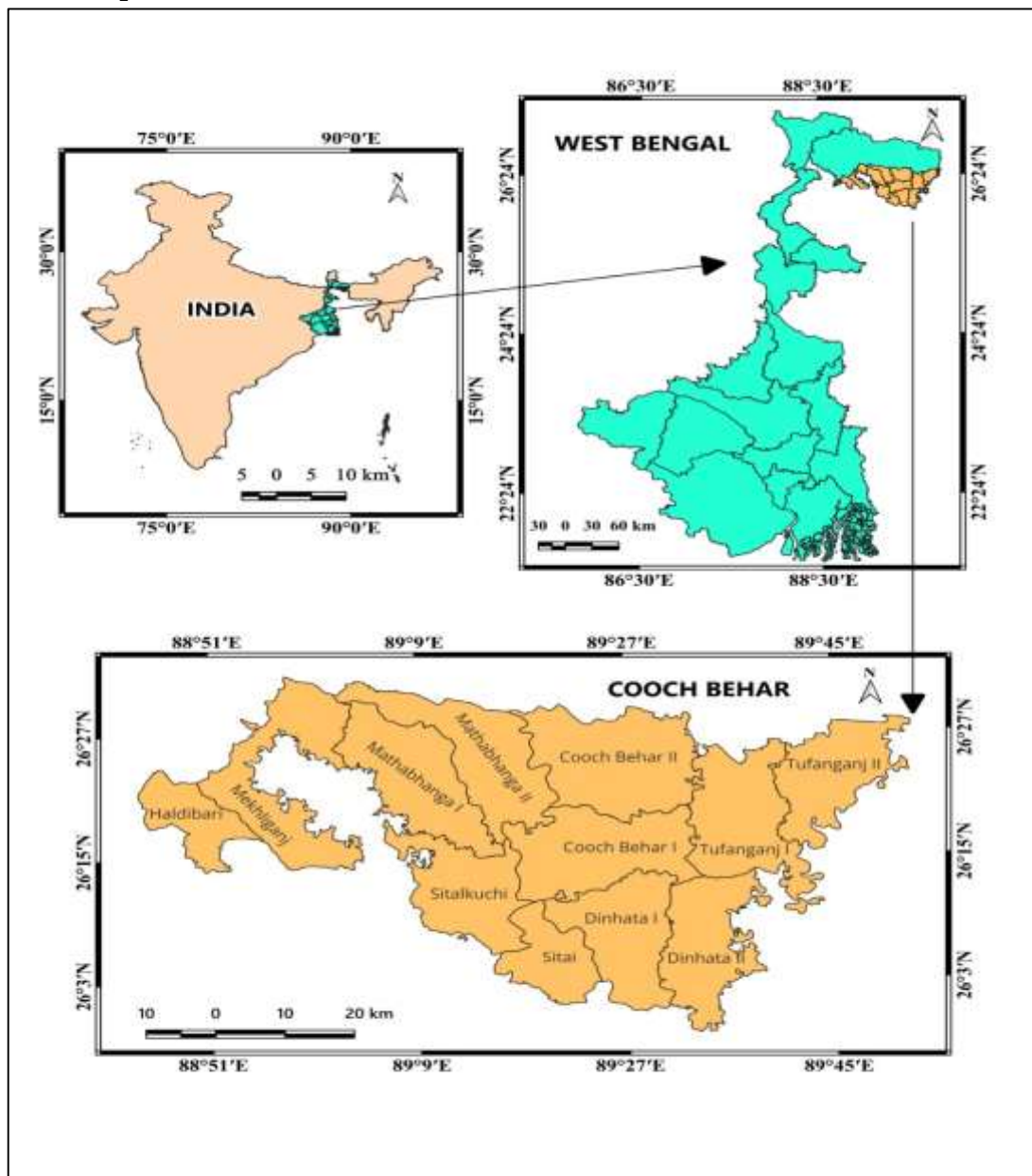
Research specific to Koch Bihar remains limited in scale or time. Das (2017) examined rural-urban and male-female differences at the subdivision level for 2011 and found relatively high gender disparity in Mekhliganj and Mathabhanga. Other studies have reported block-wise literacy patterns, but often focus on one social category, one census year or a simple percentage-point gap. The gap addressed here is a consistent comparison of all twelve rural CD blocks through a relative disparity measure, embedded in

the longer 1991-2011 district transition. The paper also treats the persistence of block rankings as analytically important: rapid convergence can coexist with a durable map of relative disadvantage.

3. Study Area

Koch Bihar district lies in the north-eastern part of West Bengal, adjoining Assam and sharing an international border with Bangladesh. The district covers approximately 3,387 square kilometres and had a population of 2,819,086 in 2011, of whom about 89.7% lived in rural areas (District Administration Cooch Behar, 2026; Office of the Registrar General & Census Commissioner, India [ORGI], 2014a). The terrain is predominantly flat and alluvial, crossed by rivers and drainage channels descending from the Himalayan foothills. Seasonal flooding, dispersed settlement and variations in road access have implications for the everyday reach of educational institutions.

Map 1: Location and Administrative Divisions of Koch Bihar District



The operative spatial units are Haldibari, Mekhliganj, Mathabhanga-I, Mathabhanga-II, Cooch Behar-I, Cooch Behar-II, Tufanganj-I, Tufanganj-II, Dinhata-I, Dinhata-II, Sitai and Sitalkuchi. Municipalities are excluded from the block panel so that the comparison represents the rural domain. Administratively, the blocks fall within five subdivisions, but the analysis retains each block as a separate observation because the distribution of literacy within a subdivision is not necessarily uniform.

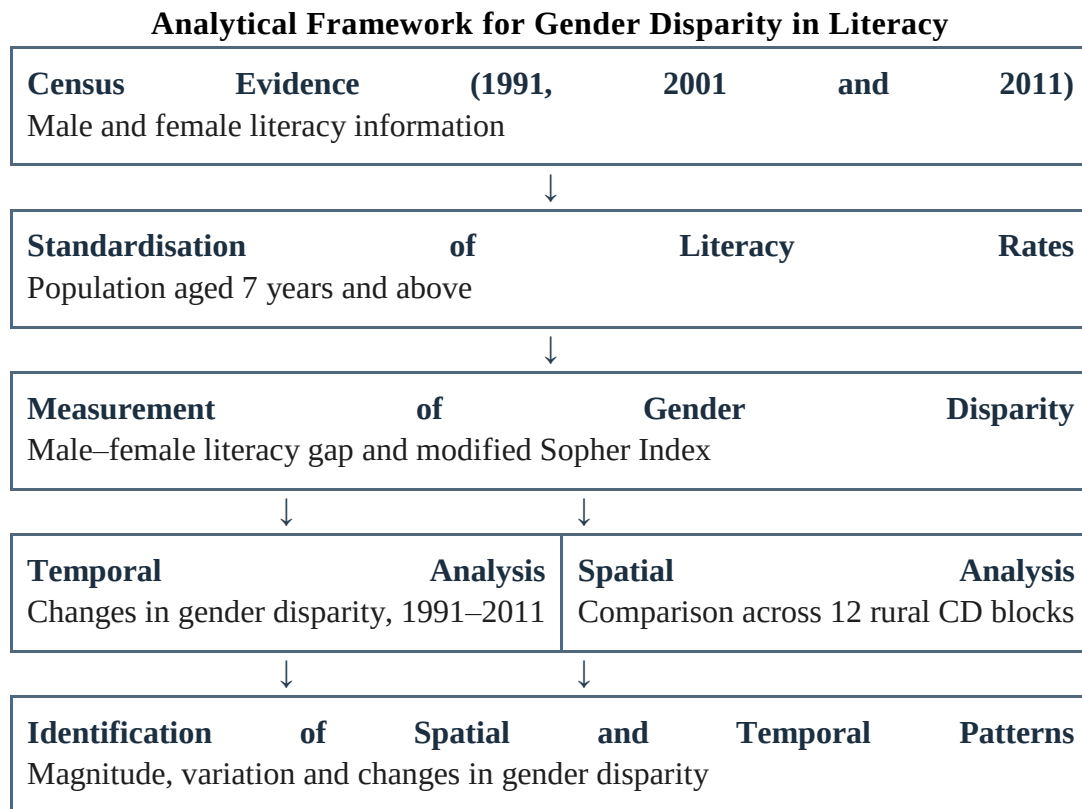


Figure 1: Analytical Framework for the Analysis of Spatial and Temporal Variation in Gender Disparity in Literacy

4. Objectives and Hypotheses

The study has two objectives:

1. to trace the district-level transition in male and female literacy between 1991 and 2011.
2. to examine block-wise variation in female literacy and gender disparity across the twelve rural CD blocks.

Two hypotheses guide the analysis. H1: male-female literacy disparity declined between successive censuses at district level and between 2001 and 2011 in every rural CD block. H2: Despite absolute decline, the relative block-wise geography of gender disparity remained persistent over the decade.

5. Data and Methodology

5.1 Database and temporal comparability

The analysis uses secondary data from the District Census Handbooks and Primary Census Abstracts for Koch Bihar. The district series covers 1991, 2001 and 2011. The block panel uses sex-specific effective literacy rates for 2001 and 2011 compiled from DCHB tables for the twelve rural CD blocks. The 2011

block-wise literacy counts are presented in Table 3 within the results section. Effective literacy is the percentage literate among persons aged seven years and above.

A crucial comparability rule is followed. A digitally verifiable and harmonised 1991 male-female rate table for the present twelve rural CD blocks was not available in the accessible Census series. The 1991 Census is therefore used as the verified district baseline, while the complete block-level panel begins in 2001. No block-level 1991 values are interpolated, back-cast or inferred. This two-scale design preserves the requested 1991-2011 temporal perspective without presenting estimates as Census observations.

5.2 Measurement

Three indicators are used. The absolute gender gap is male literacy minus female literacy, expressed in percentage. Female literacy gain is the 2011 female rate minus the 2001 female rate. The principal indicator is the modified Sopher Disparity Index (Sopher, 1974; Kundu & Rao, 1986):

$$D = \log_{10}(M/F) + \log_{10}[(200 - F)/(200 - M)], M \geq F$$

where D is the disparity index, M is the male literacy rate and F is the female literacy rate. A value of zero represents parity; larger positive values indicate greater male advantage. The constant 200 is the Kundu-Rao modification, which avoids the instability that can occur as percentage values approach 100 and permits consistent comparison across different attainment levels.

5.3 Analytical strategy

The analysis proceeds at two scales. District values establish the long transition from 1991 to 2011. Block values reveal the internal geography from 2001 to 2011. For each block, the study calculates D in both years, absolute index reduction and percentage reduction. Inter-block dispersion is assessed through the mean, range and standard deviation of D. Spearman's rank correlation measures the persistence of block ordering between 2001 and 2011. Because Census figures describe the full enumerated population rather than a sample, emphasis is placed on effect size, direction and spatial pattern rather than null-hypothesis significance testing.

6. Results

6.1 District-level transition, 1991-2011

Table 1. District literacy and gender disparity, 1991-2011

Census year	Total (%)	Male (%)	Female (%)	Gap (pp)	Sopher D	F/M ratio
1991	45.78	57.35	33.31	24.04	0.304	0.581
2001	66.30	75.93	56.12	19.81	0.196	0.739
2011	74.78	80.71	68.49	12.22	0.114	0.849

Source: Census of India, 1991, 2001 and 2011; indices calculated from the reported literacy rates.

pp = percentage%.

The district experienced a pronounced literacy transition. Female literacy more than doubled, rising by 35.18% between 1991 and 2011, compared with a 23.36-% increase for males. The male-female gap narrowed from 24.04% in 1991 to 19.81 in 2001 and 12.22 in 2011. Sopher's index fell even more clearly, from 0.304 to 0.196 and then to 0.114. The total two-decade reduction was 62.6%. The fall in disparity was greater after 2001 despite the smaller absolute rise in overall literacy, because female literacy continued to increase much faster than male literacy.

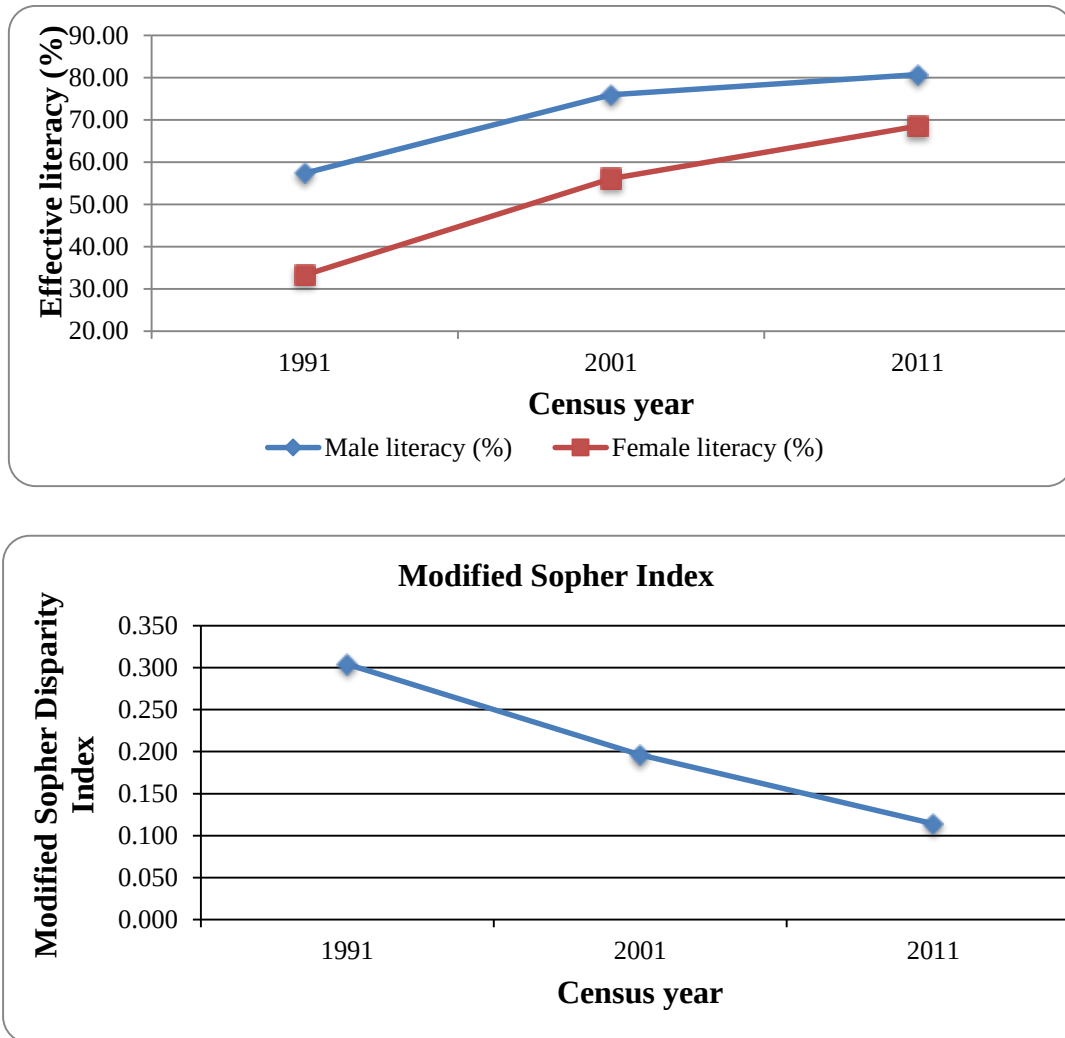


Figure 2. District literacy transition and decline in gender disparity

Source: Census of India, 1991–2011; disparity indices computed from the stated rates.

6.2 Block-wise literacy change

Table 2. Block-wise effective literacy rates and female gain, 2001-2011

Rural CD block	M 2001	F 2001	M 2011	F 2011	F gain (pp)	2011 gap
Cooch Behar-I	77.28	53.67	83.63	69.36	15.69	14.27
Cooch Behar-II	81.64	59.55	85.73	72.60	13.05	13.13
Dinhata-I	73.97	52.44	80.39	67.35	14.91	13.04
Dinhata-II	78.51	56.70	81.50	68.71	12.01	12.79
Haldibari	73.80	48.07	78.36	63.34	15.27	15.02
Mathabhanga-I	73.73	46.34	80.10	63.19	16.85	16.91
Mathabhanga-II	77.85	53.11	79.52	63.99	10.88	15.53

Rural CD block	M 2001	F 2001	M 2011	F 2011	F gain (pp)	2011 gap
Mekhliganj	73.78	47.69	78.25	61.57	13.88	16.68
Sitai	65.51	41.65	70.65	56.38	14.73	14.27
Sitalkuchi	69.19	43.94	77.84	62.11	18.17	15.73
Tufanganj-I	78.00	56.89	82.99	69.20	12.31	13.79
Tufanganj-II	76.40	53.36	82.02	67.79	14.43	14.23

Source: Census of India, District Census Handbook tables, 2001 and 2011; calculations from the rates presented. M = male; F = female.

Female literacy increased in all twelve blocks and did so more rapidly than male literacy. The unweighted block mean for women rose from 51.12 to 65.47%, a gain of 14.35%; the corresponding male mean rose by 5.11%. Sitalkuchi recorded the largest female gain (18.17%), followed by Mathabhanga-I (16.85), Cooch Behar-I (15.69) and Haldibari (15.27). Mathabhanga-II had the smallest gain (10.88), although even this exceeded its male gain by more than 9%.

The 2011 level remained uneven. Cooch Behar-II had the highest female literacy (72.60%), followed by Cooch Behar-I (69.36), Tufanganj-I (69.20%) and Dinhata-II (68.71%). Sitai remained lowest at 56.38%, while Mekhliganj (61.57%), Sitalkuchi (62.11%) and Mathabhanga-I (63.19%) also formed a lower tier. This pattern shows why change and level must be read together: Sitalkuchi improved fastest but remained below the block mean in 2011 because it began from a very low base.

Table 3 presents the 2011 rural CD block counts of literate and illiterate men and women. These counts provide the population context for the block-level discussion. They should not be used on their own to calculate effective literacy rates, since the illiterate totals include children younger than seven years.

Table 3. Literate and illiterate population by sex in the twelve rural CD blocks, 2011

Rural CD block	Male literate	Female literate	Total literate	Male illiterate	Female illiterate	Total illiterate
Cooch Behar-I	107,437	85,514	192,951	43,900	56,416	100,316
Cooch Behar-II	115,781	90,493	206,274	36,165	47,478	83,643
Dinhata-I	100,162	80,243	180,405	45,163	56,322	101,485
Dinhata-II	86,950	68,124	155,074	39,713	49,279	88,992
Haldibari	34,912	27,925	62,837	17,939	23,193	41,132
Mathabhanga-I	76,500	58,017	134,517	35,997	47,677	83,674
Mathabhanga-II	81,033	63,036	144,069	36,067	47,261	83,328
Mekhliganj	51,259	38,372	89,631	26,542	34,594	61,136

Rural CD block	Male literate	Female literate	Total literate	Male illiterate	Female illiterate	Total illiterate
Sitai	33,323	26,272	59,595	22,693	28,045	50,738
Sitalkuchi	62,693	49,879	112,572	31,584	41,197	72,781
Tufanganj-I	88,459	69,618	158,077	37,213	47,966	85,179
Tufanganj-II	67,883	53,338	121,221	25,548	34,477	60,025
Rural total	906,392	710,831	1,617,223	398,524	513,905	912,429

Source: Census of India 2011 rural block table; column totals are arithmetic sums of the displayed block counts.

6.3 Sopher disparity and block convergence

Table 4. Modified Sopher Disparity Index by rural CD block

Rural CD block	D 2001	D 2011	Reduction	Reduction (%)	2011 rank*
Cooch Behar-I	0.235	0.131	0.103	44.0	5
Cooch Behar-II	0.211	0.119	0.092	43.5	2
Dinhata-I	0.218	0.122	0.096	44.1	3
Dinhata-II	0.213	0.119	0.094	44.3	1
Haldibari	0.267	0.143	0.124	46.4	7
Mathabhanga-I	0.287	0.160	0.127	44.1	12
Mathabhanga-II	0.246	0.147	0.099	40.3	9
Mekhliganj	0.271	0.160	0.111	41.0	11
Sitai	0.268	0.143	0.124	46.4	8
Sitalkuchi	0.274	0.151	0.123	45.0	10
Tufanganj-I	0.206	0.127	0.079	38.3	4
Tufanganj-II	0.230	0.132	0.098	42.5	6
Block mean	0.244	0.138	0.106	43.4	-

Source: Calculated from Table 2. Rank 1 indicates the lowest disparity; rankings use values before rounding.

The values support the proposed decline in disparity. Sopher's D declined in every block. The block mean fell from 0.244 to 0.138, a reduction of 43.4%. The standard deviation decreased from 0.029 to

0.015 and the range narrowed from 0.081 to 0.041. Thus, the decade produced both gender convergence within blocks and a substantial compression of absolute inter-block differences.

Convergence was not spatially uniform. Mathabhanga-I registered the largest absolute reduction (0.127), closely followed by Haldibari and Sitai (0.124 each) and Sitalkuchi (0.123). Tufanganj-I showed the smallest reduction (0.079), largely because its 2001 disparity was already the lowest in the district. By 2011, Cooch Behar-II and Dinhata-II had the most favourable values (approximately 0.119), whereas Mathabhanga-I and Mekhliganj remained highest (approximately 0.160).

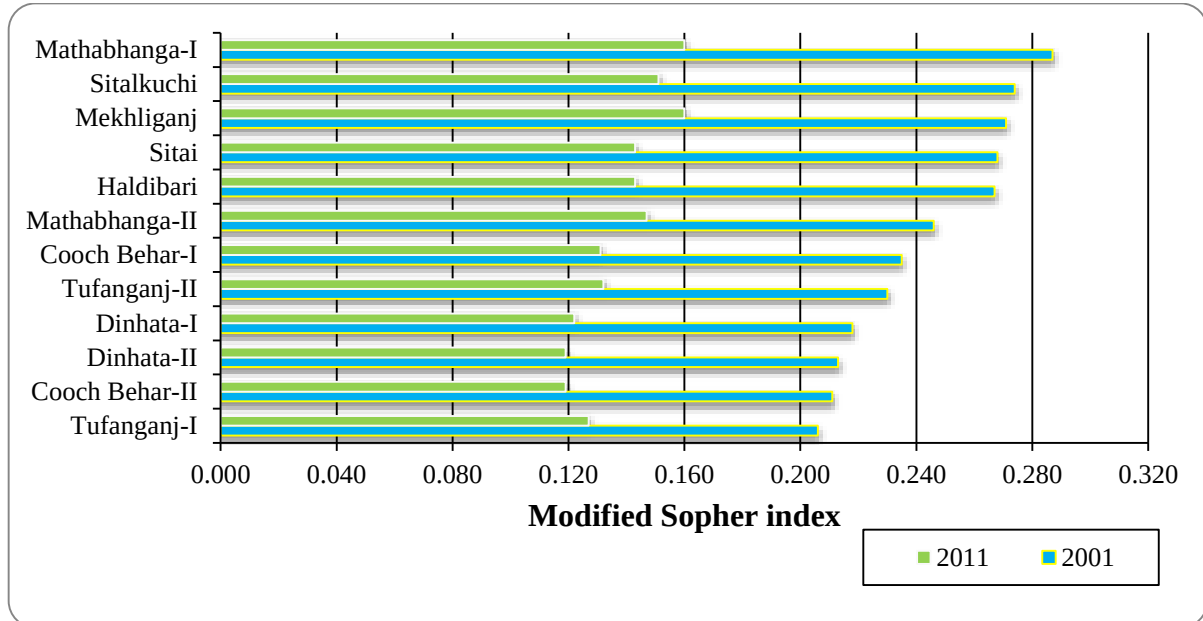
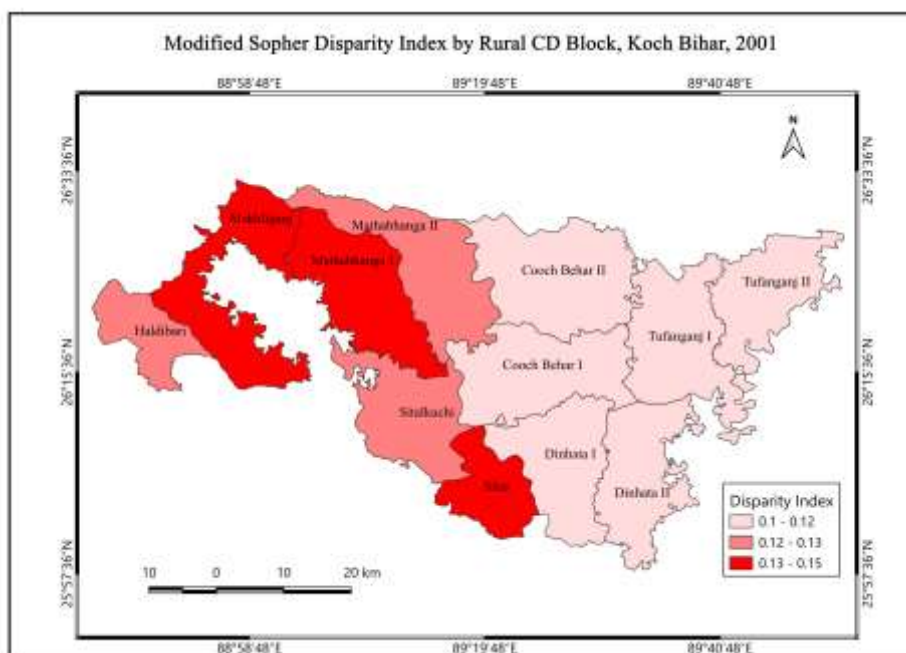


Figure 3. Decline in the Sopher Disparity Index across the twelve rural blocks

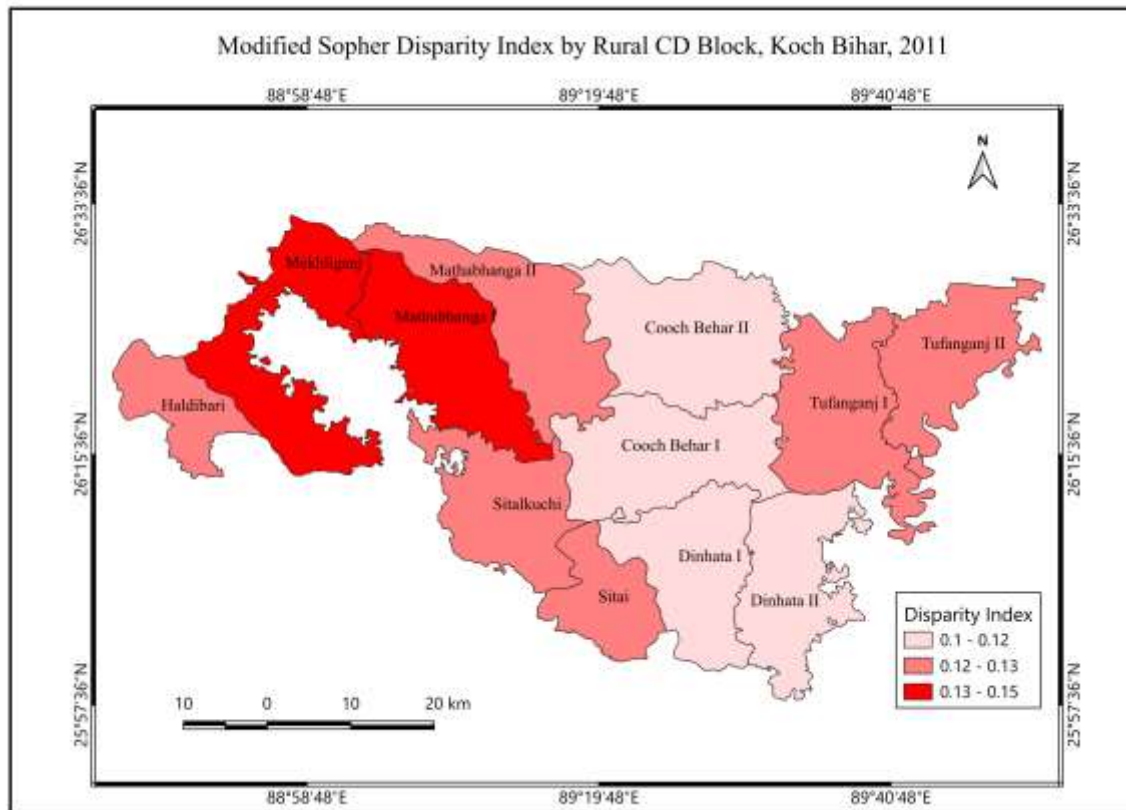
Source: Calculations from the block literacy rates reported in Table 2.

Map 2: Modified Sopher Disparity Index by Rural CD Block, 2001



Source: Prepared from Census of India 2001 block literacy rates; modified Sopher disparity index calculated by the author.

Map 3: Modified Sopher Disparity Index by Rural CD Block, 2011



Source: Prepared from Census of India 2011 block literacy rates; modified Sopher disparity index calculated by the author.

The two maps visually confirm the changing geography of disparity. In 2001, relatively higher disparity was concentrated in Mekhliganj, Mathabhanga-I, Haldibari, Sitalkuchi and Sitai, whereas lower disparity was observed in Cooch Behar-II, Dinhata-I, Dinhata-II and Tufanganj-I. By 2011, disparity had declined in every rural CD block, but higher values remained concentrated in Mekhliganj, Mathabhanga-I and Sitalkuchi. Thus, the spatial pattern shows clear convergence, although the relative geography of disadvantage did not disappear completely.

6.4 Convergence with spatial persistence

Blocks with greater initial disparity generally recorded larger absolute reductions. The correlation between D in 2001 and its subsequent reduction is $r = 0.939$, indicating strong catch-up from the most unequal starting positions. Nevertheless, the ordering of blocks remained highly stable: Spearman's rank correlation between the 2001 and 2011 disparity series is 0.916. The findings suggest that blocks with greater initial disparity made larger gains, although their relative positions changed little. In practical terms, the worst-performing blocks improved quickly, but most remained relatively disadvantaged when compared with their neighbours.

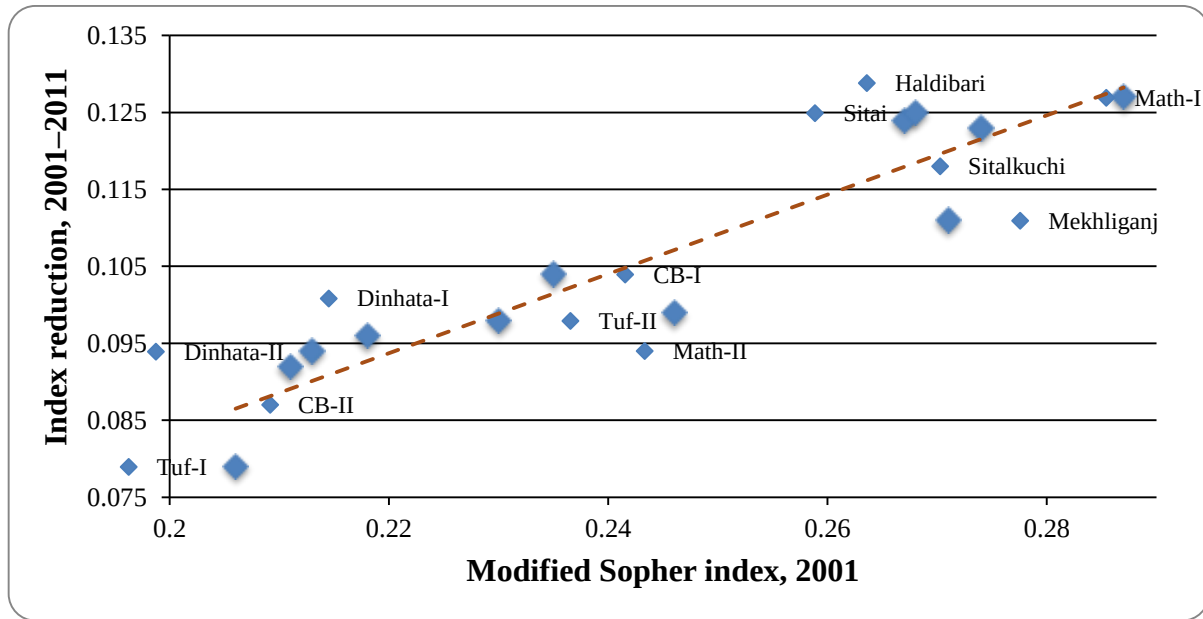


Figure 4. Initial disparity and subsequent convergence

Source: Calculations from Table 2. The dashed line shows the linear trend.

7. Discussion

The results reveal a two-sided literacy transition. On one side, the district made broad progress: female literacy increased in every rural block, the male-female gap narrowed, and Sopher's D fell sharply. On the other, progress followed an inherited geography. Blocks located around Cooch Behar and along the more institutionally connected Cooch Behar-Dinhata-Tufanganj axis generally occupied favourable positions. At the same time, parts of the Mekhliganj-Mathabhanga-Sitalkuchi belt retained higher relative disparity. The pattern is consistent with Das's (2017) finding of greater gender inequality in the Mekhliganj and Mathabhanga subdivisions.

The comparison also shows the Sopher index's analytical advantage over the raw gap alone. In 2011, Sitai and Cooch Behar-I had the same percentage-point gap (14.27), yet their literacy levels differed markedly. Sitai's Sopher value was higher because a similar gap imposed a larger relative disadvantage at its lower level of female attainment. The index therefore helps distinguish numerical equality in gaps from substantive equality in educational position.

Several mechanisms may plausibly underpin the observed geography, although the Census data cannot establish cause and effect. First, access to secondary and higher-secondary schooling matters after basic primary access expands. Distance, transport reliability and perceived safety can affect girls more strongly than boys. Second, agrarian poverty and seasonal labour can raise the opportunity cost of continued schooling, especially where girls combine study with domestic and care work. Third, household educational history is cumulative. The strong influence of parental, and particularly maternal, literacy identified by Kambhampati and Pal (2001) suggests that low-literacy blocks may reproduce disadvantage across generations unless adult and school-age interventions operate together.

Policy expansion during the period - including universal elementary education, school meals, scholarships and wider rural school provision - likely contributed to the faster rise of female literacy. However, the persistence of rankings cautions against interpreting universal programmes as spatially uniform in effect. The same scheme can produce different outcomes depending on institutional density,

teacher availability, local transport, settlement dispersion and household demand. The evidence supports a place-sensitive understanding of educational policy: coverage must be complemented by attention to the specific barriers that shape continuity from enrolment to literacy and higher attainment.

8. Policy Implications

The findings point to four priorities. First, Mathabhanga-I and Mekhliganj should receive the highest disparity-sensitive attention because they retained the largest Sopher values in 2011. Sitai requires a different but equally urgent response: its disparity was moderate by district standards, yet its female literacy level remained the lowest. Second, planning should focus on transitions beyond primary school through accessible upper-primary and secondary institutions, safe transport, and targeted support for adolescent girls. Third, link adult women's literacy and community learning with school policy so it directly addresses intergenerational disadvantage. Fourth, block-level monitoring should report female literacy, completion and dropout alongside average literacy; otherwise, rapid total improvement may conceal continued gender inequality.

Within each block, gram panchayat and village-level diagnostics are the next logical step. A block classified as relatively favourable may still contain remote low-literacy pockets, while a lagging block may include local success clusters. Future district planning should therefore combine Census indicators with school-location data, transport accessibility, social composition and household survey evidence. Such integration would convert a descriptive literacy map into a practical targeting framework.

9. Limitations

Three limitations qualify the conclusions. First, the 1991 analysis is district-level because a harmonised sex-specific table for the present twelve rural CD blocks could not be verified; the block panel consequently covers 2001-2011. Second, literacy is a threshold measure and does not capture years of schooling, learning quality or educational completion. Third, Census aggregates cannot establish the causal effect of religion, caste, income, infrastructure or governance. The suggested mechanisms should be tested through household-level data and GIS-based accessibility measures. These limitations do not invalidate the observed convergence, but they define the scale at which the results can be interpreted.

10. Conclusion

Between 1991 and 2011, Koch Bihar moved from low literacy and severe gender inequality toward a substantially more inclusive educational profile. At district level, the modified Sopher index fell from 0.304 to 0.114. Within the rural block system, every CD block registered declining disparity between 2001 and 2011, and female literacy gains consistently exceeded male gains. The transition was therefore both broad and gender-progressive.

However, convergence did not erase geography. Mathabhanga-I and Mekhliganj remained the most unequal blocks in 2011, while Sitai combined the lowest female literacy level with continuing disparity. Cooch Behar-II and Dinhata-II occupied the most favourable positions. The strong stability of block rankings shows that relative disadvantage can persist even when all places improve. The main policy conclusion is consequently clear: district-level progress must be followed by block-specific and eventually village-specific action. Literacy expansion has narrowed the gender divide, but spatially targeted support is required to complete the transition from improvement to parity.

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