What can we learn from South India's fertility transition?
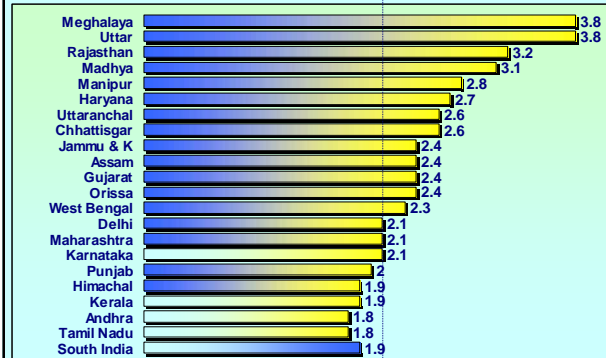
CZ Guilmoto, LPED-IRD-CICRED
IIPS, 12 December 2006

- Recent fertility trends in India and in Asia
- Fertility variations in India: statistical models and spatial analysis
- Tracing fertility decline in South India
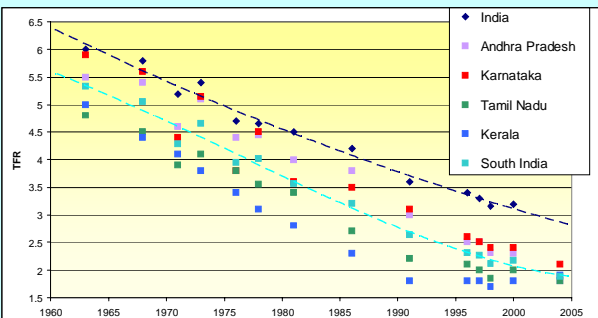- Recent progress of fertility decline across Indian states

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Fertility trends

- Fertility today
- Fertility trends over 40 years
- Fertility in Asian countries

State-level fertility
*provisional NFHS-3 results (2005-06)*

State	TFR
Meghalaya	3.8
Uttar	3.8
Rajasthan	3.2
Madhya	3.1
Manipur	2.8
Haryana	2.7
Uttaranchal	2.6
Chhattisgar	2.6
Jammu & K	2.4
Assam	2.4
Gujarat	2.4
Orissa	2.4
West Bengal	2.3
Delhi	2.1
Maharashtra	2.1
Karnataka	2.1
Punjab	2
Himachal	1.9
Kerala	1.9
Andhra	1.8
Tamil Nadu	1.8
South India	1.9

Fertility in South Indian states and India, 1960-2005

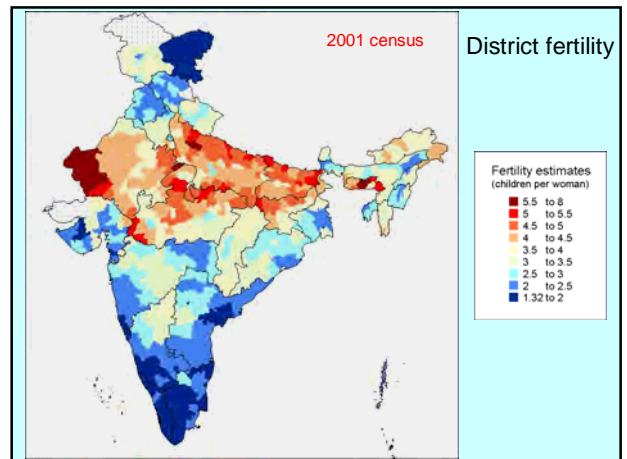*Sources: Estimates from Rele (1987), SRS, NFHS-3*

- **Fertility in South India and Asian countries, 1960-2005**
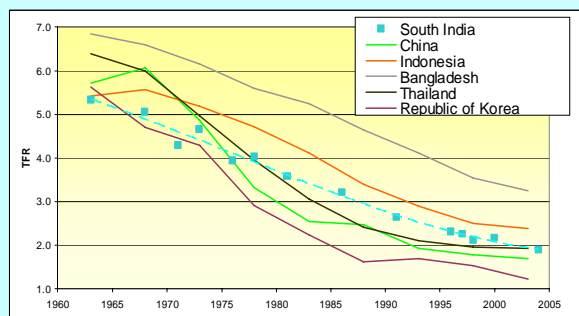
Sources: Estimates from Rele (1987), SRS, NFHS-3, United Nations.

Contours and determinants of Indian fertility

- Modeling fertility
- Spatial autocorrelation and hot spots
- Fertility trend maps

2001 census

District fertility

Fertility estimates
(children per woman)
- 5.5 to 8
- 5 to 5.5
- 4.5 to 5
- 4 to 4.5
- 3.5 to 4
- 3 to 3.5
- 2.5 to 3
- 2 to 2.5
- 1.32 to 2

Modeling fertility variations

- Fertility estimates for 576 districts
- Social and economic indicators available for 2001 (literacy, urbanization, etc.)
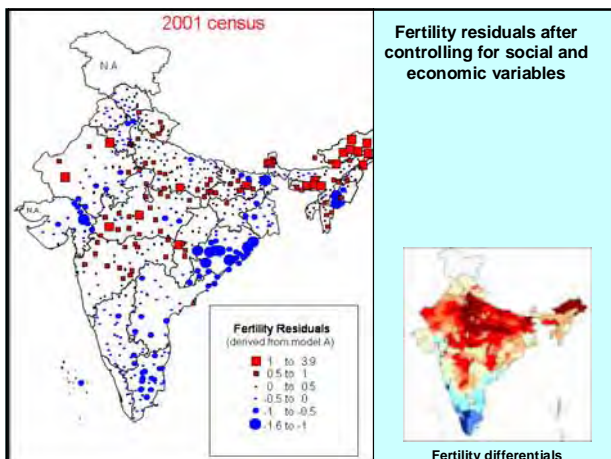- Ordinary least-square regression and its residuals

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Determinants of district fertility differentials in 2001

Geographical residuals →

District-level fertility	Model B
Explanatory variable	Coefficient
Male Literacy	-0.014***
Urbanisation	-0.307***
Muslims	0.015***
Christians	0.014***
Female children (sex ratio)	-1.731***
Female literacy (sex ratio)	-2.751***
Child survival	-4.095***
North-central India (Bimaru)	0.787***
South India	-0.505***
Constant	11.301***
N	576
r²	0.902

Significance levels: *** = 1%; **= 5%; *=10%.

2001 census

Fertility residuals after controlling for social and economic variables

Fertility Residuals
(derived from model A)
- 1 to 3.9
- 0.5 to 1
- 0 to 0.5
- -0.5 to 0
- -1 to -0.5
- -1.6 to -1

Fertility differentials

Spatial patterns

- Spatial autocorrelation of fertility
- Hot spots
- Trends over time

Spatial autocorrelation
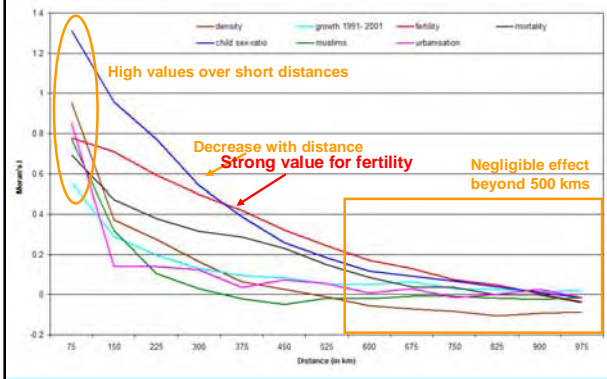
Moran's I for z (z_i at district i)

$$I = \frac{\sum\limits_{i,j} W_{ij}(z_i - \bar{z}).(z_j - \bar{z})}{n} / \sigma^2(z)$$

where $\bar{z} = $ mean and $\sigma = $ standard deviation
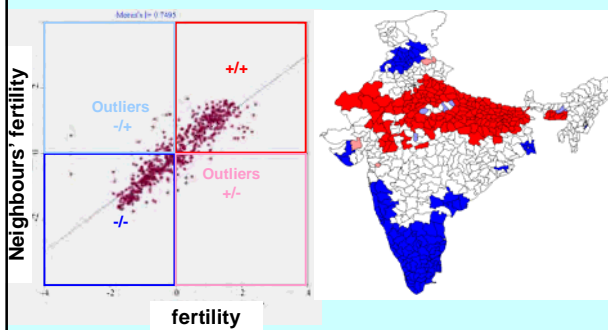
$W_{ij} = $ contiguity matrix between districts i and j

$n = $ number of pairs of observations

Spatial autocorrelation of district variables, 2001

High values over short distances

Decrease with distance
Strong value for fertility

Negligible effect beyond 500 kms

Hot spots and outliers

Neighbours' fertility
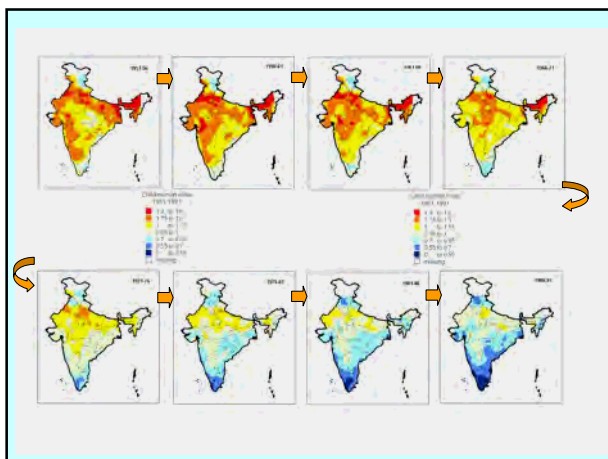
Moran's I = 0.7495

Outliers
-/+

+/+

Outliers
+/-

-/-

fertility

Mapping fertility change in 1951-91

- District fertility estimated using *Child-woman index* derived from census age data
- Five-year estimates for 1951-55 to 1986-91
- Fertility values have been mapped (kriging interpolation and contouring)

- High fertility is red and low fertility is blue
- No estimate possible for 1991-2001


1951-55

1956-61

1961-65

1966-70

1971-75

1976-80

1981-85

1986-90

| 1951-55 | |
1956-61	
1961-65	
1966-70	
1971-75	
1976-80	
1981-85	
1986-90	

1951-55
1956-61
1961-65
1966-70
1971-75
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1981-85
1986-90

1951-55
1956-61
1961-65
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1951-55
1956-61
1961-65
1966-70
1971-75
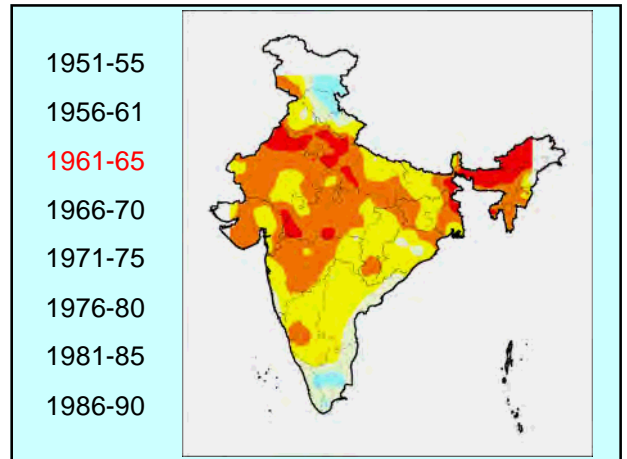1976-80
1981-85
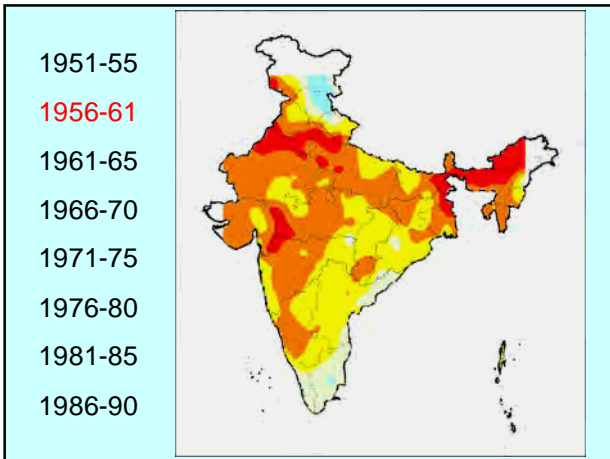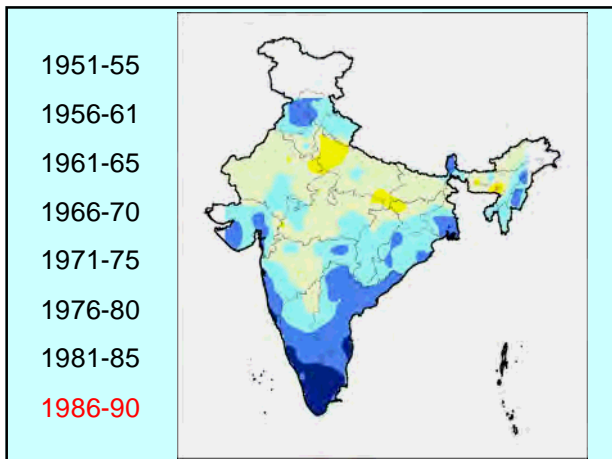1986-90

1951-55
1956-61
1961-65
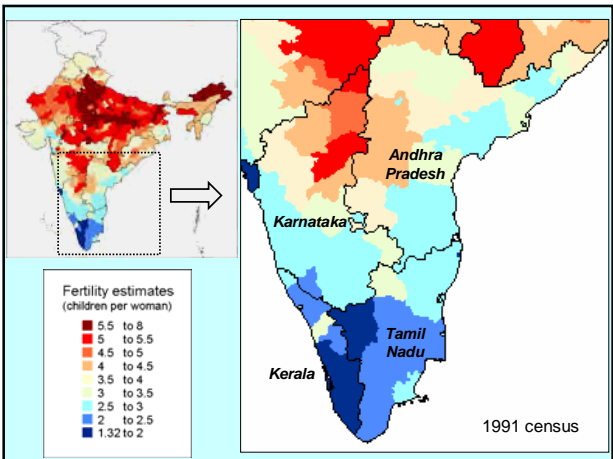1966-70
1971-75
1976-80
1981-85
1986-90
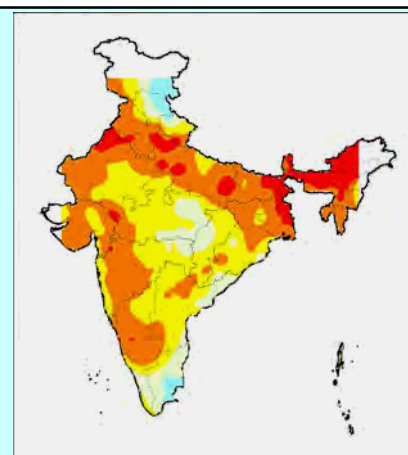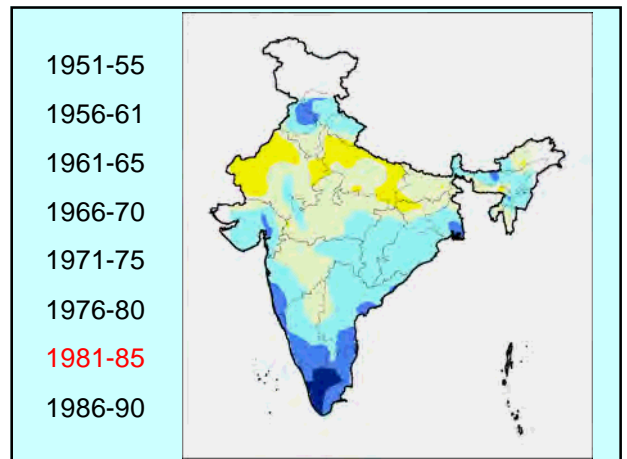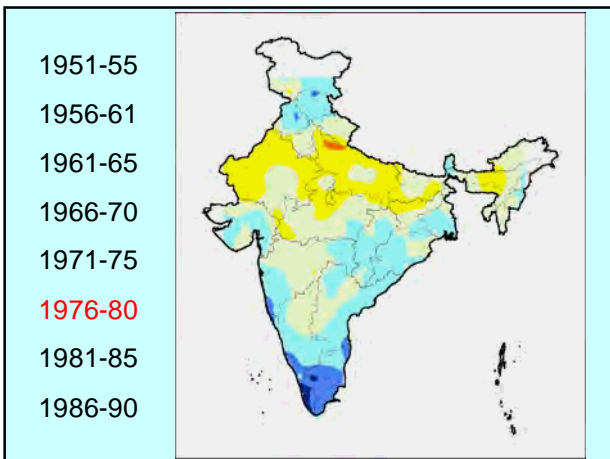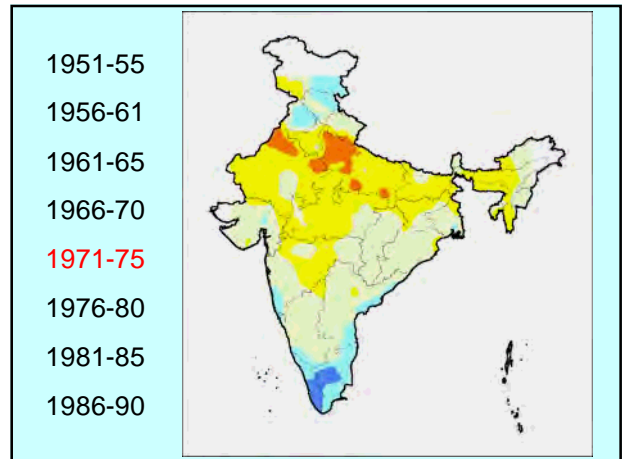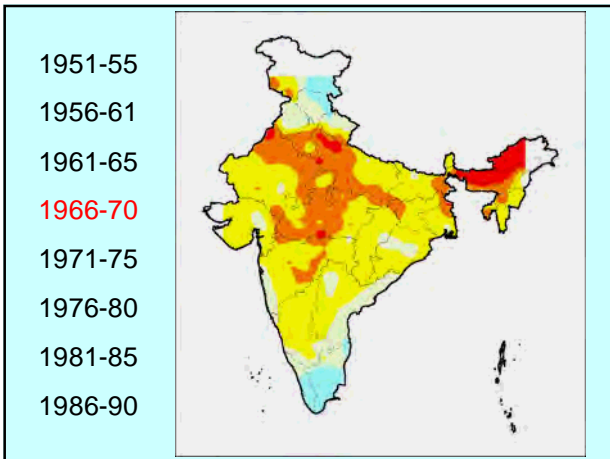
Fertility in South India

- Geographical variations within South India and within states
- Rural fertility differentials
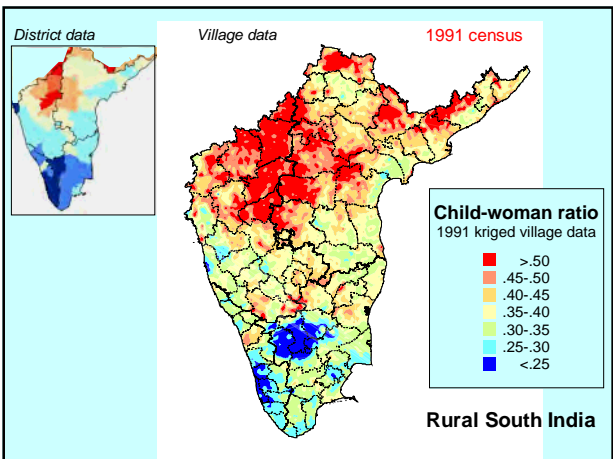- Trends since 1951
- Forerunners in Kerala and Tamil Nadu

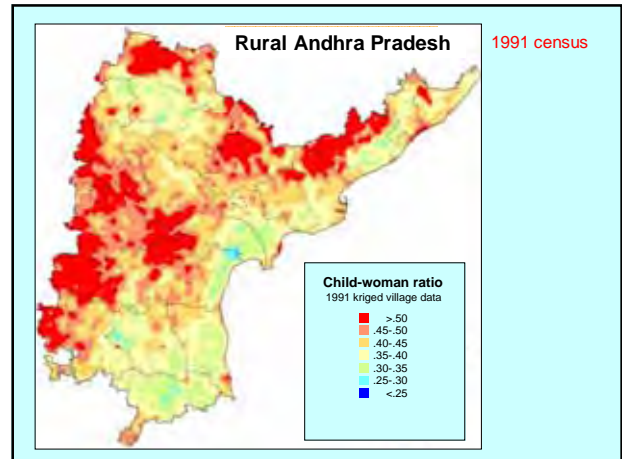## Decomposition of fertility variations in South India

- District-level fertility
- Are local fertility variations random within districts ?

Fertility estimates
(children per woman)

5.5 to 8
5 to 5.5
4.5 to 5
4 to 4.5
3.5 to 4
3 to 3.5
2.5 to 3
2 to 2.5
1.32 to 2

Andhra Pradesh
Karnataka
Tamil Nadu
Kerala

1991 census

Fertility micro-differentials in rural South India

- 75,000 village data aggregated in spatial clusters
- Child-woman ratio used as proxy for fertility

- Urban values not included

District data   Village data   1991 census

Child-woman ratio
1991 kriged village data

>.50
.45-.50
.40-.45
.35-.40
.30-.35
.25-.30
<.25

Rural South India

5

1991 census

Child-woman ratio
1991 kriged village data

- >.50
- .45-.50
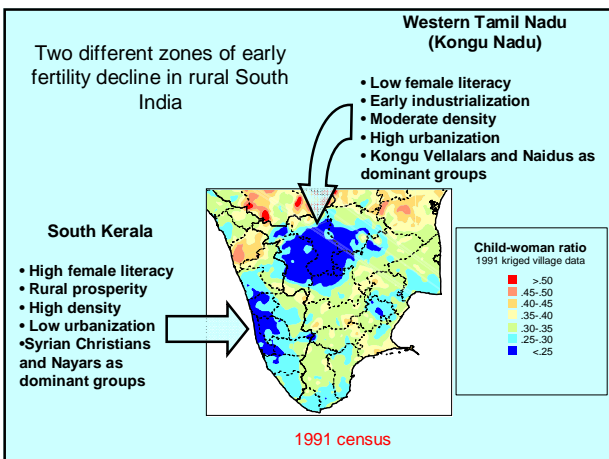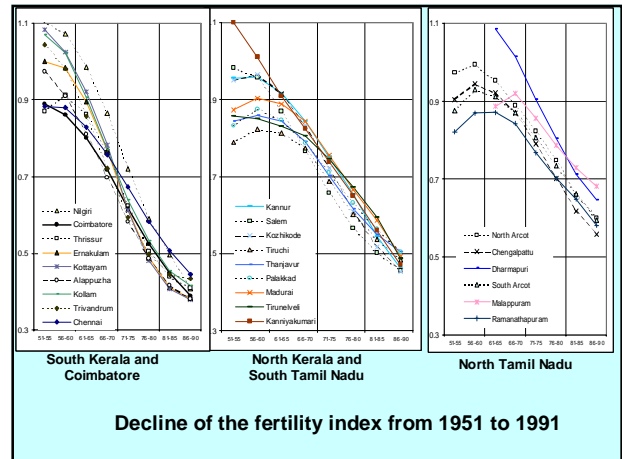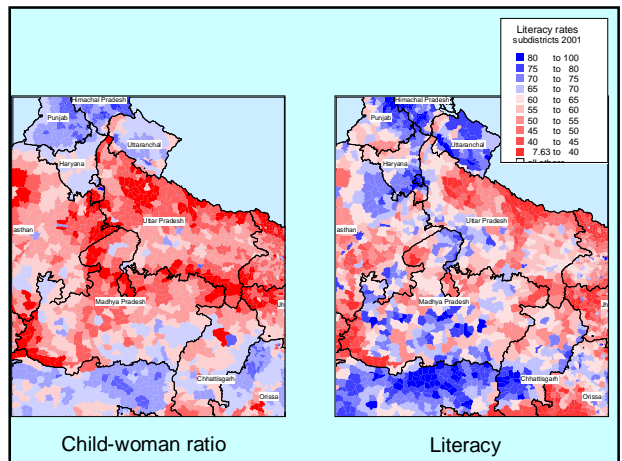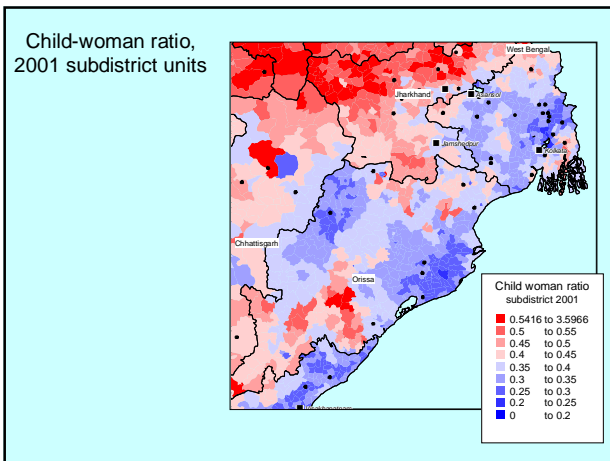- .40-.45
- .35-.40
- .30-.35
- .25-.30
- <.25

Rural Kerala and Tamil Nadu

Rural Andhra Pradesh

1991 census

Child-woman ratio
1991 kriged village data

- >.50
- .45-.50
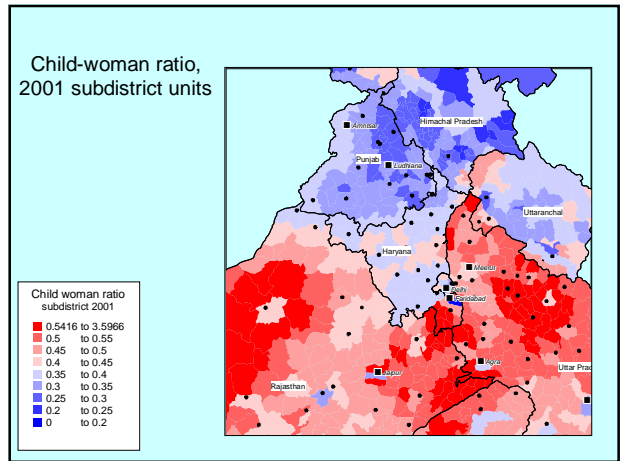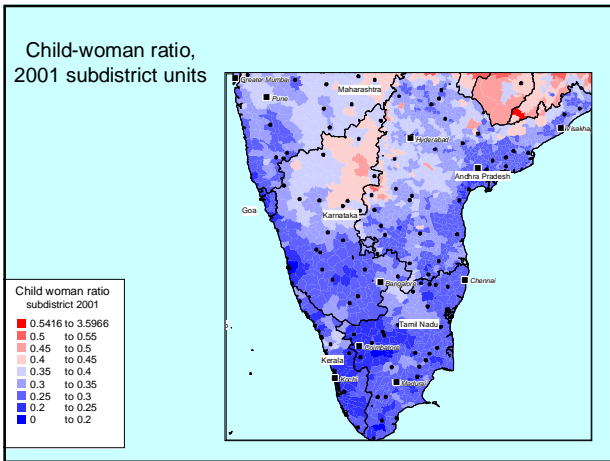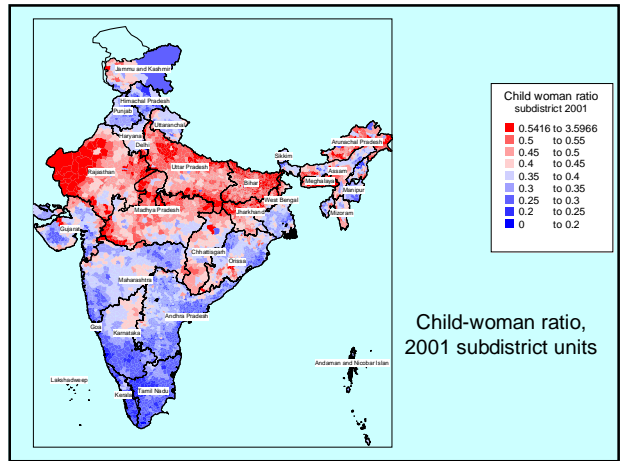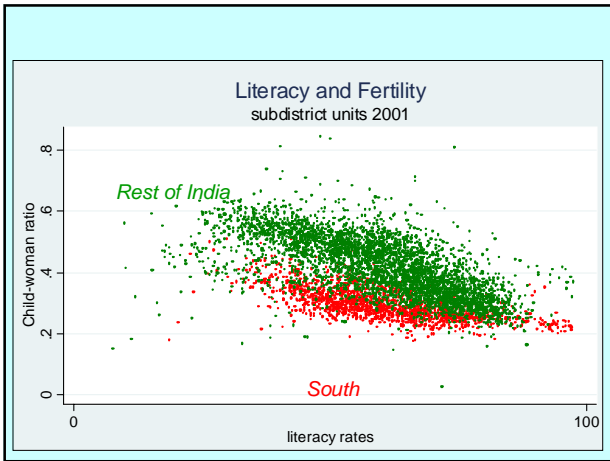- .40-.45
- .35-.40
- .30-.35
- .25-.30
- <.25
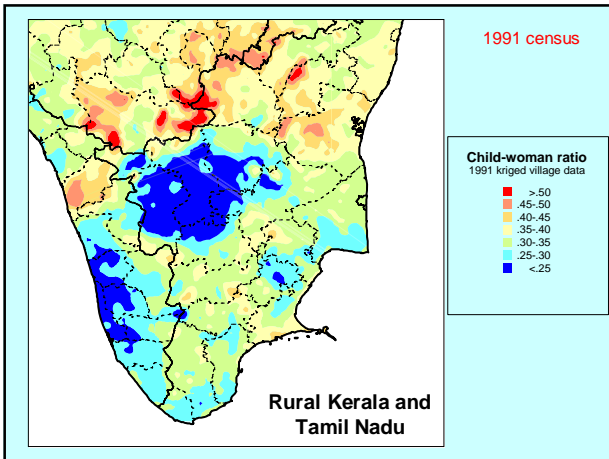
Early fertility trends in South India (1951-1991)

- Fertility estimates for South Indian districts
- Three groups of districts: early, medium and late decliners
- Early decliners centered around Kochi-Kottayam (South Kerala) and Coimbatore (Western Tamil Nadu)

South Kerala and Coimbatore — Nilgiri, Coimbatore, Thrissur, Ernakulam, Kottayam, Alappuzha, Kollam, Trivandrum, Chennai

North Kerala and South Tamil Nadu — Kannur, Salem, Kozhikode, Tiruchi, Thanjavur, Palakkad, Madurai, Tirunelveli, Kanniyakumari

North Tamil Nadu — North Arcot, Chengalpattu, Dharmapuri, South Arcot, Malappuram, Ramanathapuram

Decline of the fertility index from 1951 to 1991

Two different zones of early fertility decline in rural South India

Western Tamil Nadu (Kongu Nadu)

- Low female literacy
- Early industrialization
- Moderate density
- High urbanization
- Kongu Vellalars and Naidus as dominant groups

South Kerala

- High female literacy
- Rural prosperity
- High density
- Low urbanization
- Syrian Christians and Nayars as dominant groups

Child-woman ratio
1991 kriged village data

- >.50
- .45-.50
- .40-.45
- .35-.40
- .30-.35
- .25-.30
- <.25

1991 census

Geographical exploration in 2001

- Child-woman ratio (0-6/Fem7+) below the district levels (tehsils, taluks, mandals, etc.)
- Literacy and fertility: South vs. the rest
- Regional maps
- Barriers, corridors and hot spots

Literacy and Fertility
subdistrict units 2001

Child-woman ratio,
2001 subdistrict units

Child-woman ratio,
2001 subdistrict units

Child-woman ratio,
2001 subdistrict units

Child-woman ratio,
2001 subdistrict units

Child-woman ratio

Literacy

Conclusions

- Fertility decline is a historical process that has deeply refashioned the Indian demographic landscape at both regional and local levels
- District fertility variations in India are closely associated to social and economic factors, though the nature of the causative link is somewhat unstable.
- The impact of regional policy efforts appears blurred as fertility levels cut across state boundaries.

- Fertility decline includes an independent geographical component that can be traced to the inception of fertility decline from the 1950s and the crucial role played by pioneer groups
- This spatial dimension points to the existence of significant self-sustaining diffusion mechanisms: behavioral change spreads gradually across adjacent social groups or cultural regions

Thank you