

MAPPING THE DISTRIBUTION AND EFFECTIVENESS OF THE TOTAL SANITATION CAMPAIGN

TAMIL NADU, INDIA | 2001-2011

BACKGROUND

The practice of open defecation is a primary cause of existing water-borne diseases (i.e. diarrhea) that claims the lives of many children under five. The use of improved sanitation methods, such as facilities where the feces cannot re-enter the environment, can be used to reduce open defecation. Worldwide, 1 billion people do not have access to a toilet; in India alone 814 million people do not have access to improved sanitation, and 626 million people practice open defecation posing major obstacles to appropriate health and safety measures (Patil et al., 2014). In response to this challenge, the Government of India launched the Total Sanitation Campaign (TSC) in 1999 with the goal of achieving universal rural sanitation coverage by 2012. This program intended to be community-led and demand-driven; however, due to poorly implemented interventions it ended up being government-led and supply-led leading to failed outcomes (Hueso & Bell, 2013). In order to understand the true impact of the campaign on toilet coverage, uptake and effect on health, studies and analysis need to be conducted.

METHODOLOGY

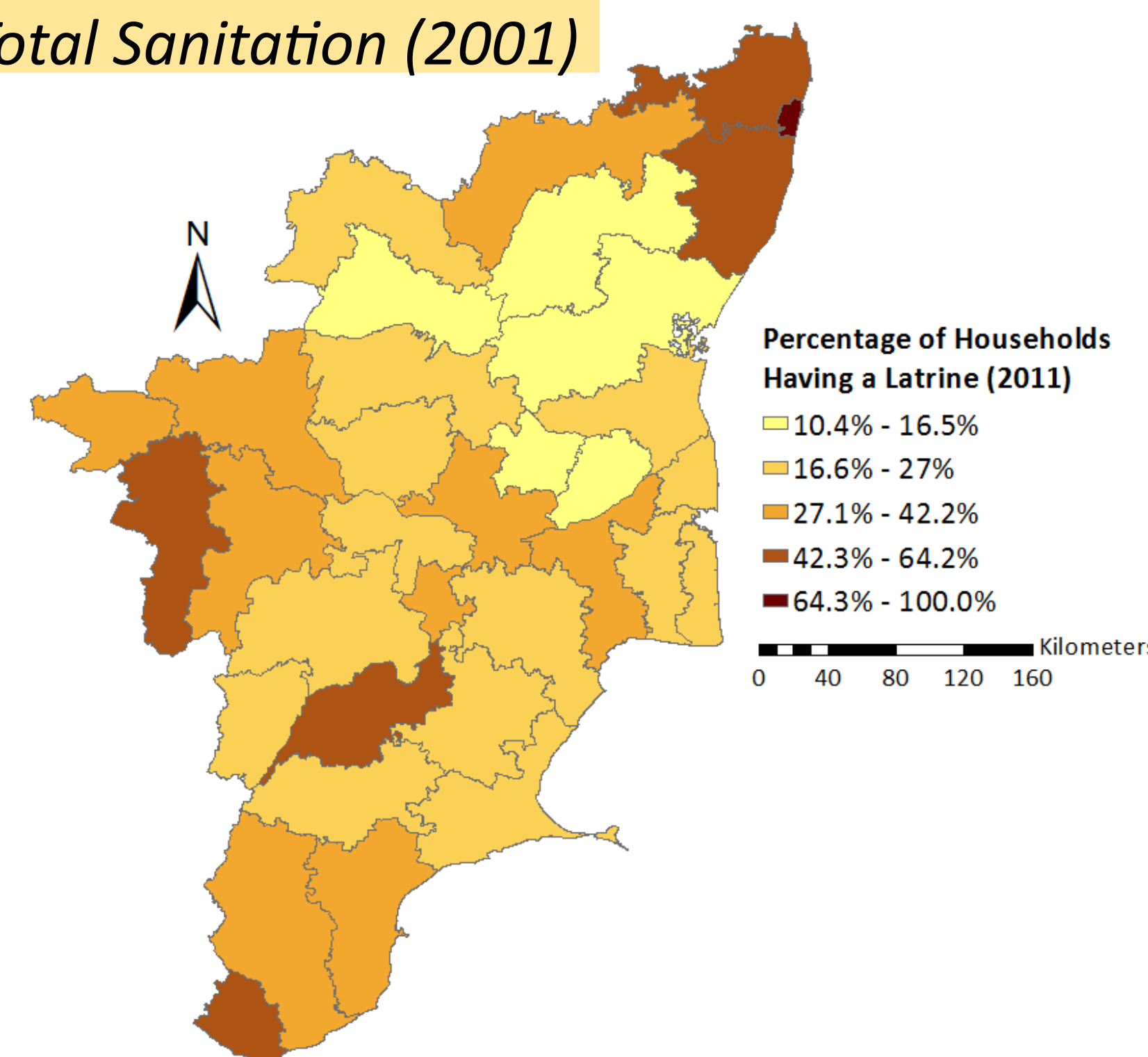
To evaluate the distribution of the Total Sanitation Campaign in Tamil Nadu, a cluster analysis was conducted using Global and Local Moran's I of the change in latrines. Global Moran's I demonstrates the presence of clustering, while local Moran's I presents the locations where clustering is occurring. A Differential Local Moran's I test was performed to evaluate whether more clustered change in latrine coverage occurred in rural or urban areas as a result of the government program. A regression analysis was then conducted to understand the factors contributing to the differences in latrine coverage, analyzing the impact of income, population density, and literacy rate on the change in latrine ownership between 2001 and 2011. In order to evaluate the effectiveness of the program, a second regression analysis was performed to examine the impact of latrine coverage on health outcomes, specifically diarrhea prevalence in children under five. The model attempts to control for extraneous factors including income, population density, and literacy rate.

RESULTS AND LIMITATIONS

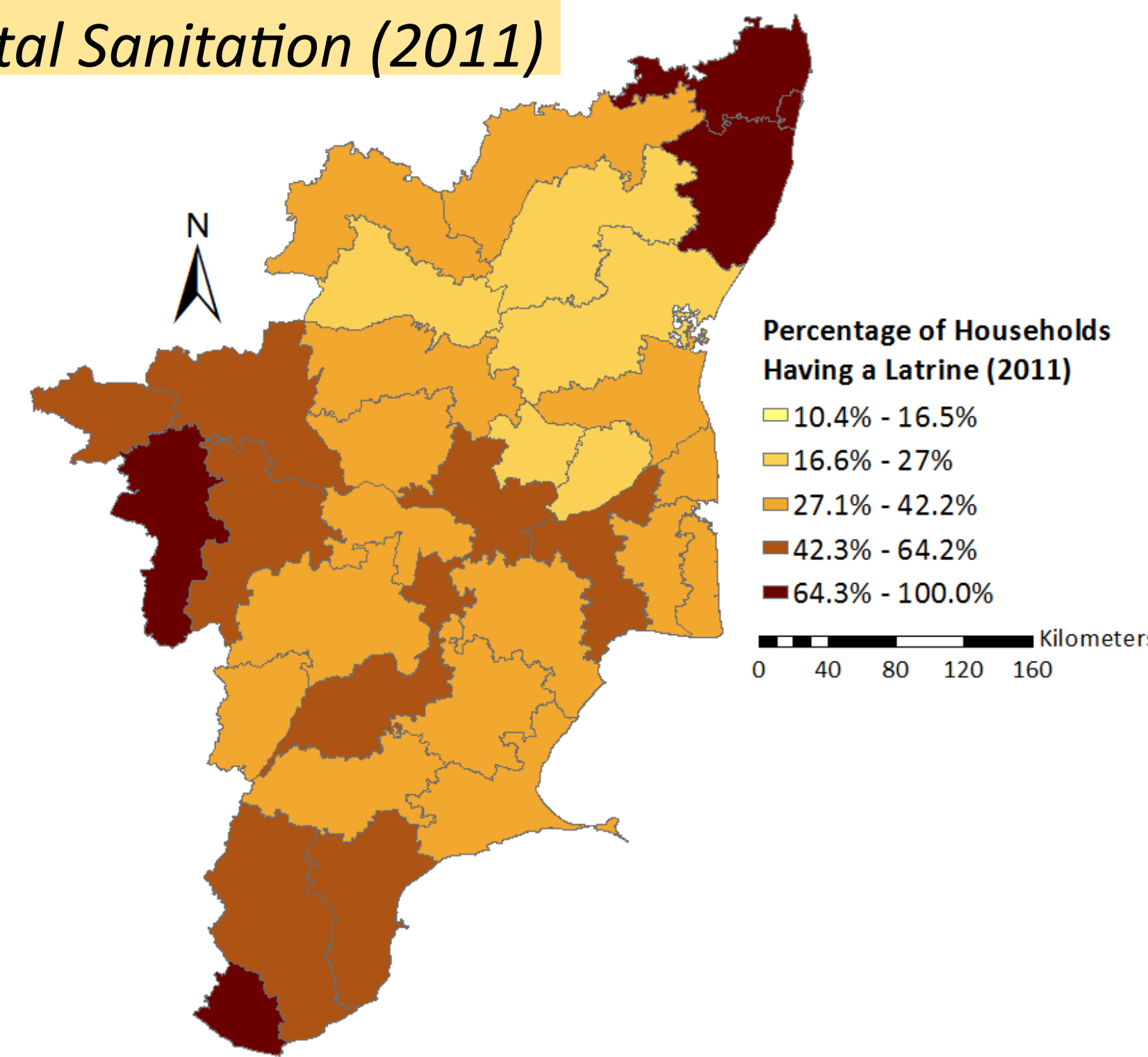
The resulting maps demonstrate the actual coverage of latrines in 2001 versus 2011, and the change in latrine ownership, distinguishing between total, rural, and urban change, with darker areas showing greater change. Clustering analysis exhibits clusters of high latrine change in southern Tamil Nadu (red), and Chennai is a low-high outlier (blue) since it began with a high level of latrine ownership prior to the campaign. Rural areas also exhibit clustering of high change (red) in the south, and low clustering (blue) in the northwest. The Differential Moran's I for rural areas is presented, as it had the greatest value demonstrating large yet unequal change in these areas. As the regression table to the right shows, per capita income, population density, and literacy rate are all significant factors in determining the change in latrine ownership during this time period. Limitations of this analysis include lack of data at a smaller spatial unit smaller (i.e. block group level), leading to a limited sample size.

DISTRIBUTION OF TOTAL SANITATION CAMPAIGN

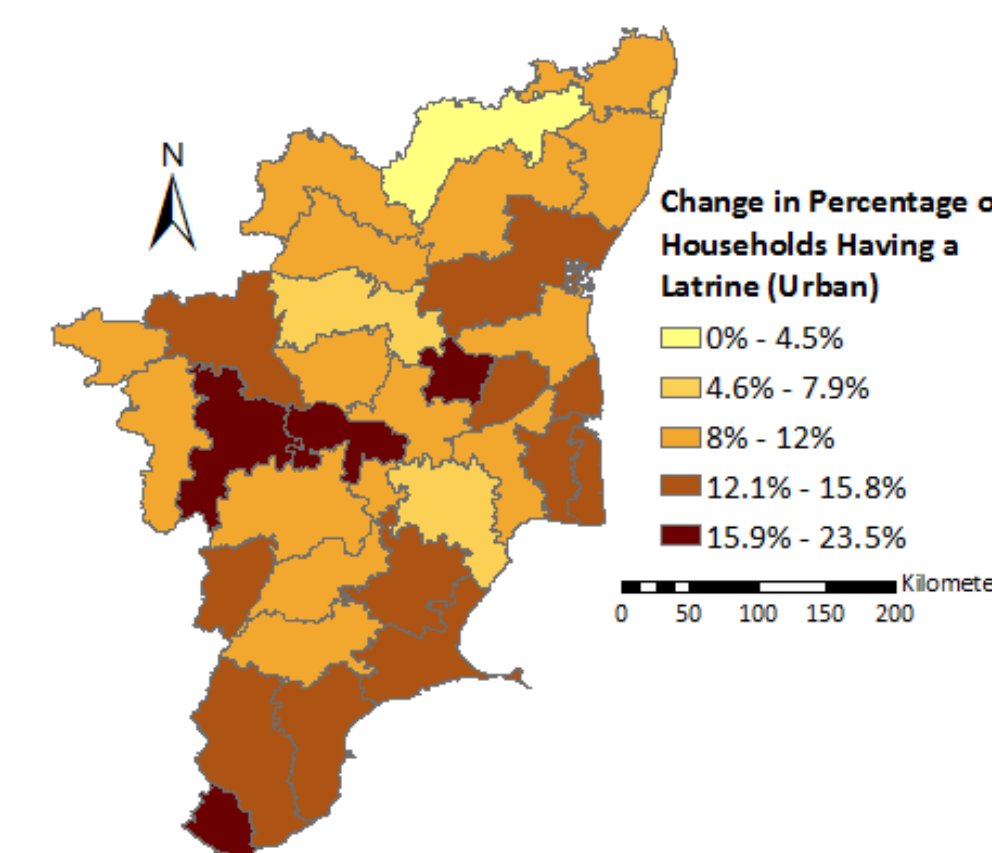
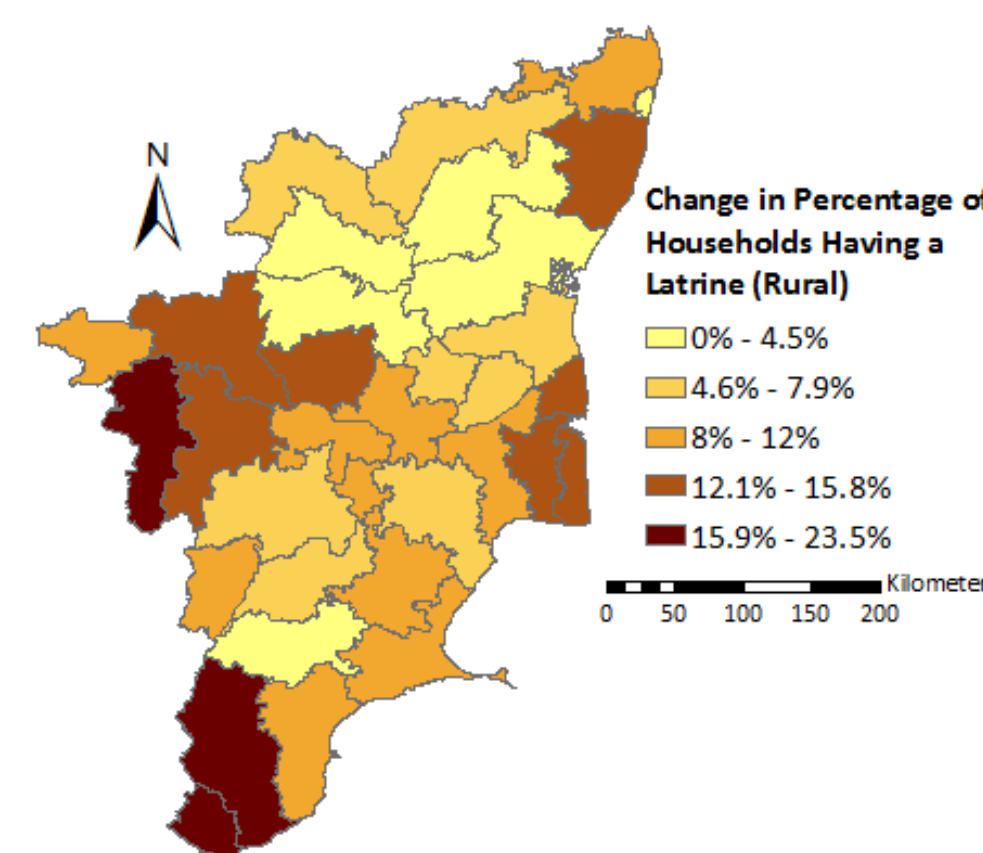
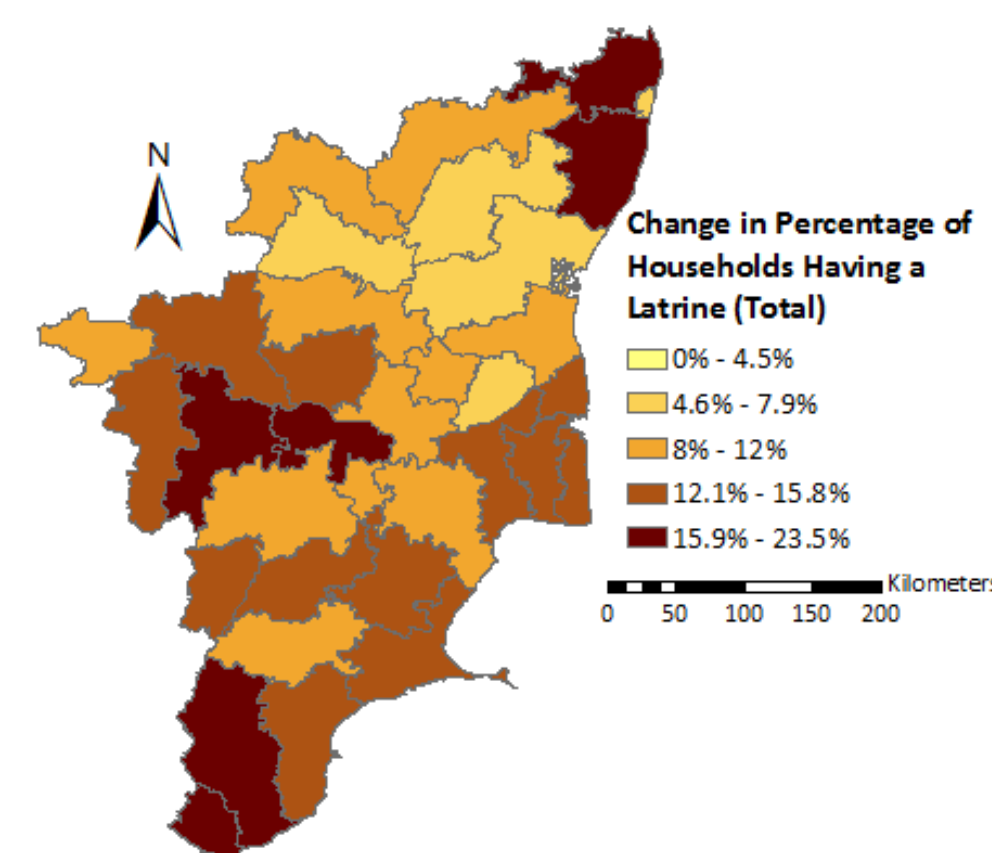
Total Sanitation (2001)



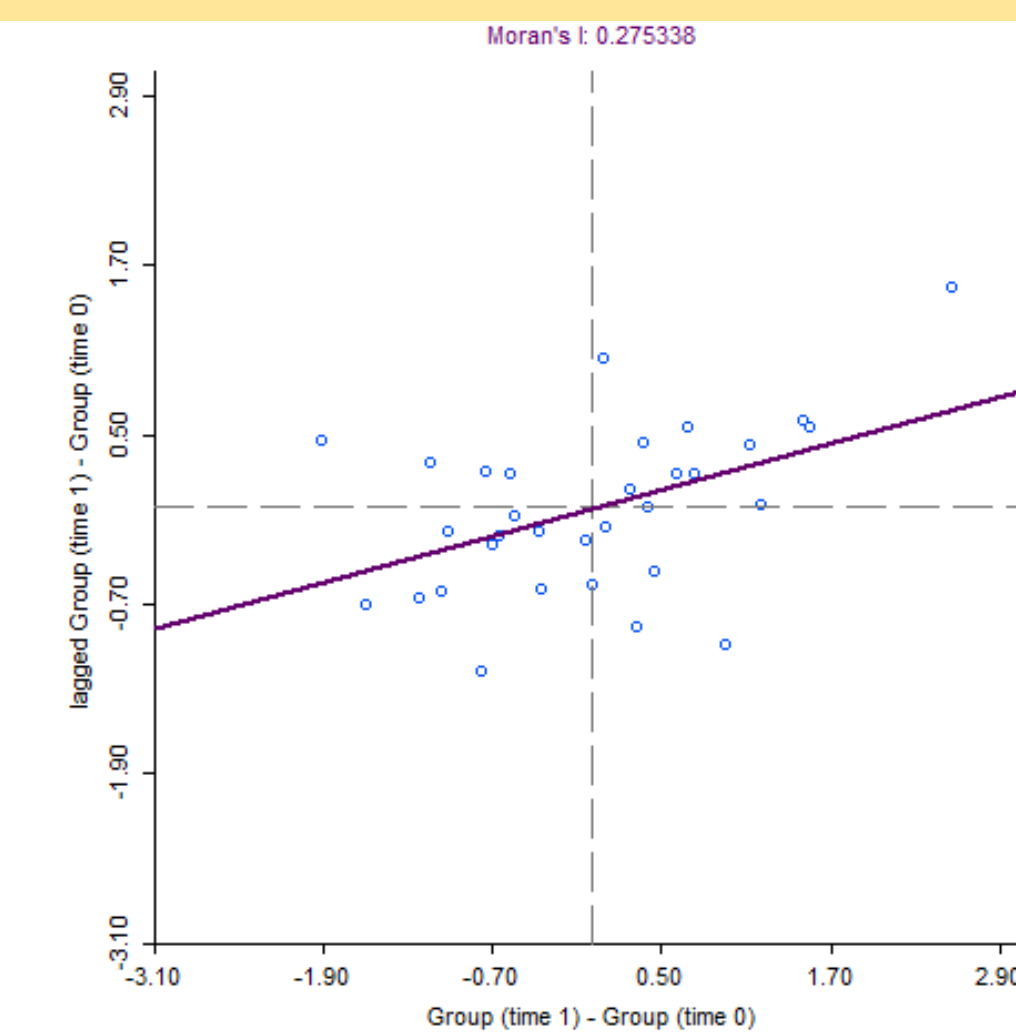
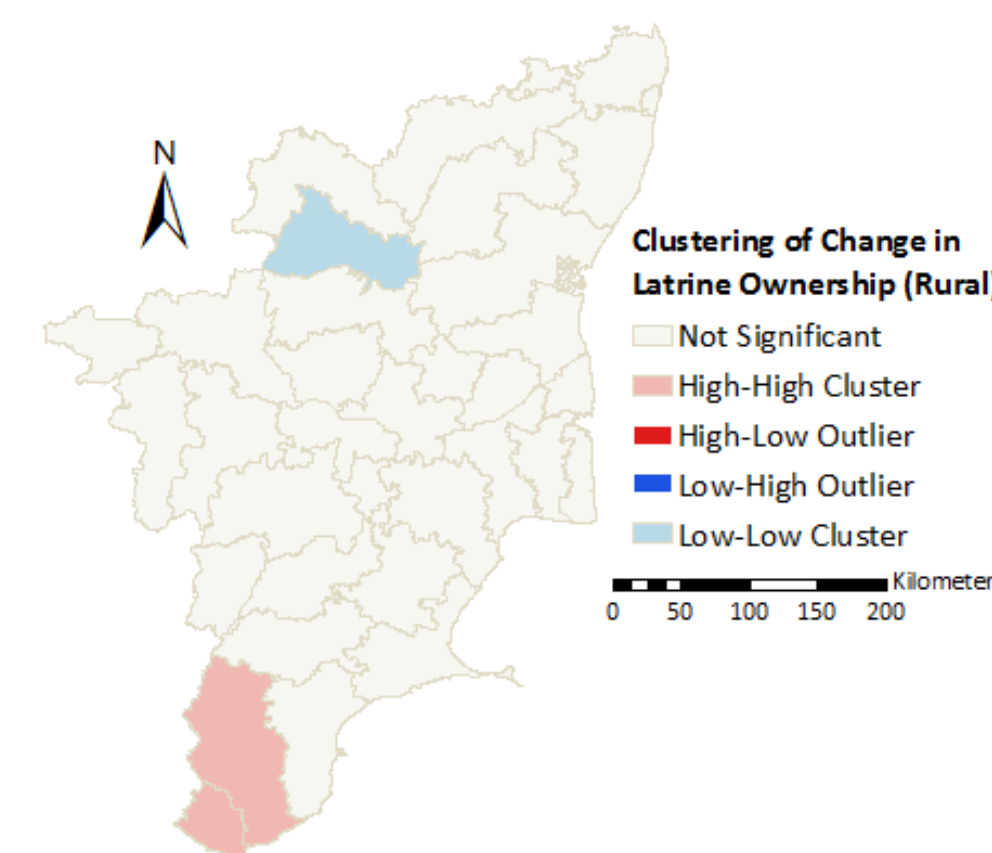
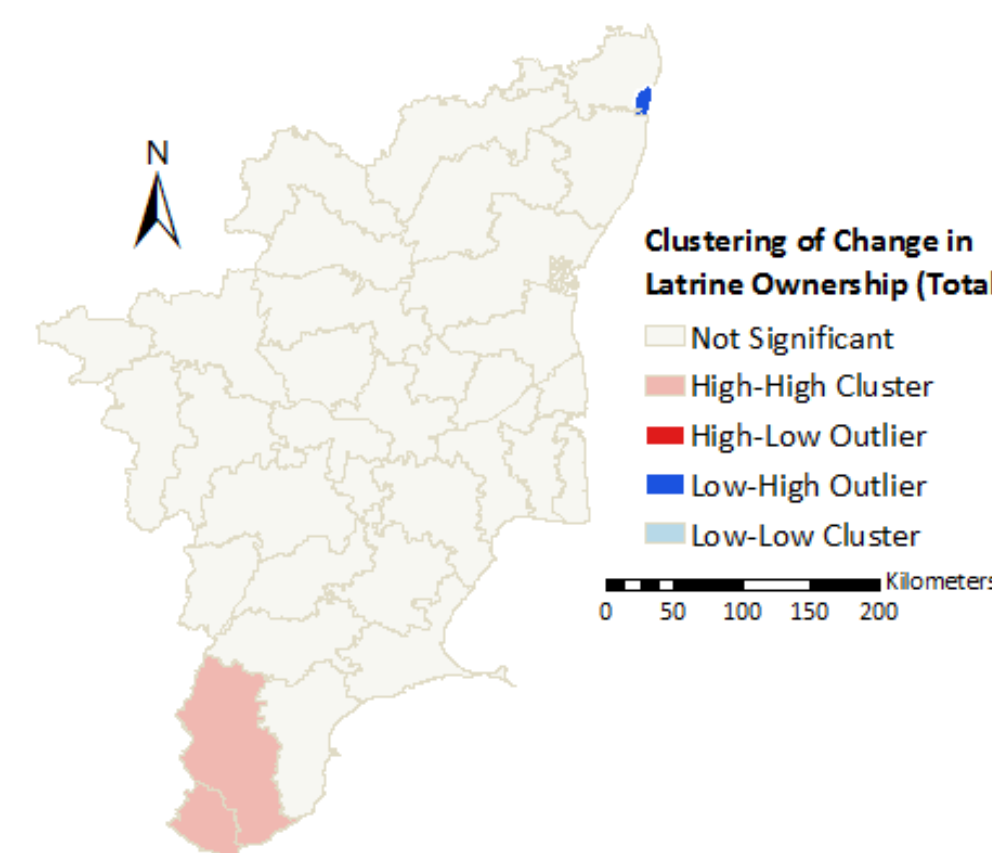
Total Sanitation (2011)



Change in Latrine Ownership (2001-2011)



Clustering of Change in Latrine Ownership (2001-2011)



Regression Analyzing Factors Contributing to Sanitation Coverage (2001-2011)

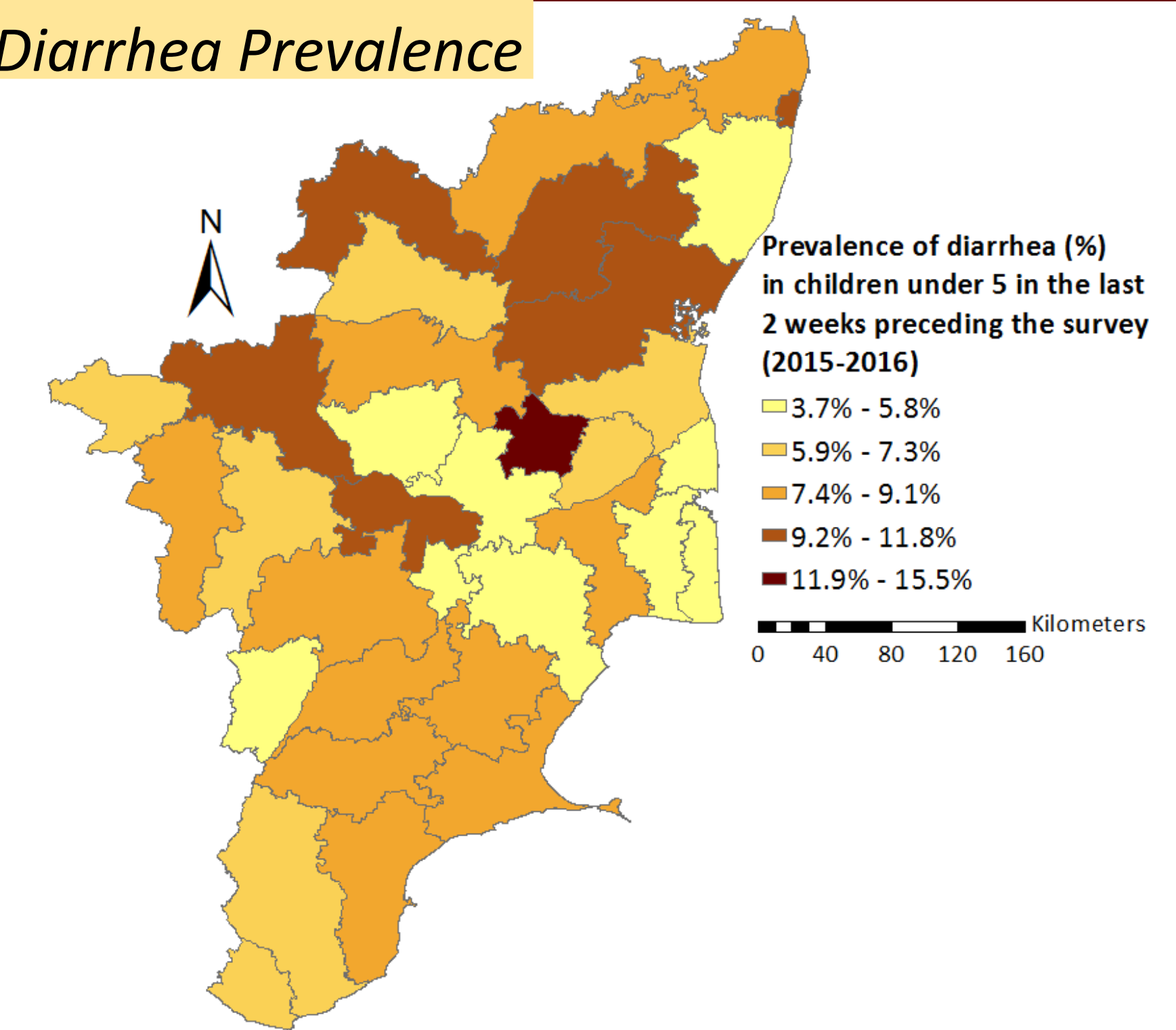
$$\text{Change_in_Latrine_Ownership} = \beta_0 + \beta_1 \text{Per_Capita_Income} + \beta_2 \text{Population_Density} + \beta_3 \text{Literacy_Rate}$$

Dependent Variable	Coefficient	Probability	Significance
Constant	-22.4609	0.0154	Yes, at 5% level
Per Capita Income (2011)	-0.0004	0.0027	Yes, at 1% level
Population Density (2011)	0.3723	0.0038	Yes, at 1% level
Literacy Rate (2011)	0.0001	0.0076	Yes, at 1% level

Adjusted R-Squared	0.5043
Independent Variable	Change in Latrine Ownership (2001-2011)

EFFECT OF TOTAL SANITATION CAMPAIGN

Diarrhea Prevalence



Regression Analyzing Latrine Ownership on Health Outcomes

Independent Variable	Prevalence of diarrhea (%) in the last 2 weeks preceding the survey (2015-2016)		
Dependent Variable	Coefficient	Probability	Significance
Latrine Ownership	-0.0225	0.3466	No
Population Density	0.0001	0.2414	No
Literacy Rate	-0.1215	0.0952	Yes, at 10% level
Per Capita Income	-0.0000332	0.2164	No

In this regression table, latrine ownership has the expected negative correlation with diarrhea prevalence, however, it is not significant. This demonstrates that latrine coverage does not necessarily indicate improvement in health, therefore, demand-driven, as opposed to supply-led, initiatives towards sanitation are essential. Limitations of this regression include lack of health data over time and issues of multicollinearity among dependent variables.

SOURCES

Cartography by Bhavna Sivasubramanian
 May 9, 2017
 GIS 102 Advanced Geographical Information Systems, Spring 2017

Data Sources: Census of India 2011; National Family Health Survey (NFHS) 2015-2016

References:

- Hueso, A., & Bell, B. (2013). An untold story of policy failure: the Total Sanitation Campaign in India. *Water Policy*, 15(6), 1001-1017.
- Patil, S. R., Arnold, B. F., Salvatore, A. L., Briceno, B., Ganguly, S., Colford Jr, J. M., & Gertler, P. J. (2014). The effect of India's total sanitation campaign on defecation behaviors and child health in rural Madhya Pradesh: a cluster randomized controlled trial. *PLoS Med*, 11(8), e1001709.
- Clasen, T., Boisson, S., Routray, P., Torondel, B., Bell, M., Cumming, O., ... & Ray, S. (2014). Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: a cluster-randomised trial. *The Lancet Global Health*, 2(11), e645-e653.

Coordinate System and Projection: WGS 1984 UTM Zone 44N; Transverse Mercator