

Multi-scale and multi-sensor analysis of urban cluster development and agricultural land loss in India

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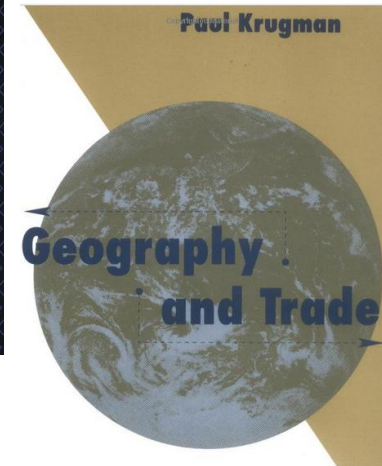
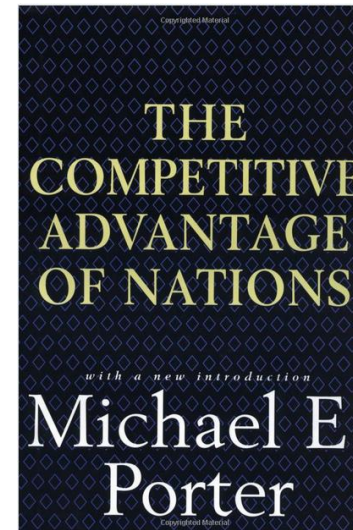


YALE UNIVERSITY
School of Forestry
& Environmental Studies

Our project goal is to quantify
and understand the
growth of ***urban clusters***

Clusters have become a key topic in economic, innovation, and globalization debates

“By agglomerating in close geographical proximity, firms can receive increasing returns from a trinity of **agglomeration economies**: a local pool of skilled labour, local supplier linkages, and local knowledge spillovers.”



Journal of Urban Economics **48**, 158–184 (2000)

doi:10.1006/juec.1999.2161, available online at <http://www.idealibrary.com> on **IDEAL**[®]

An Economic Theory of Regional Clusters¹

Paul Belleflamme

Urban Studies, Vol. 41, Nos 5/6, 959–969, May 2004

 Carfax Publishing
Taylor & Francis Group

Introduction: Clusters in Urban and Regional Development

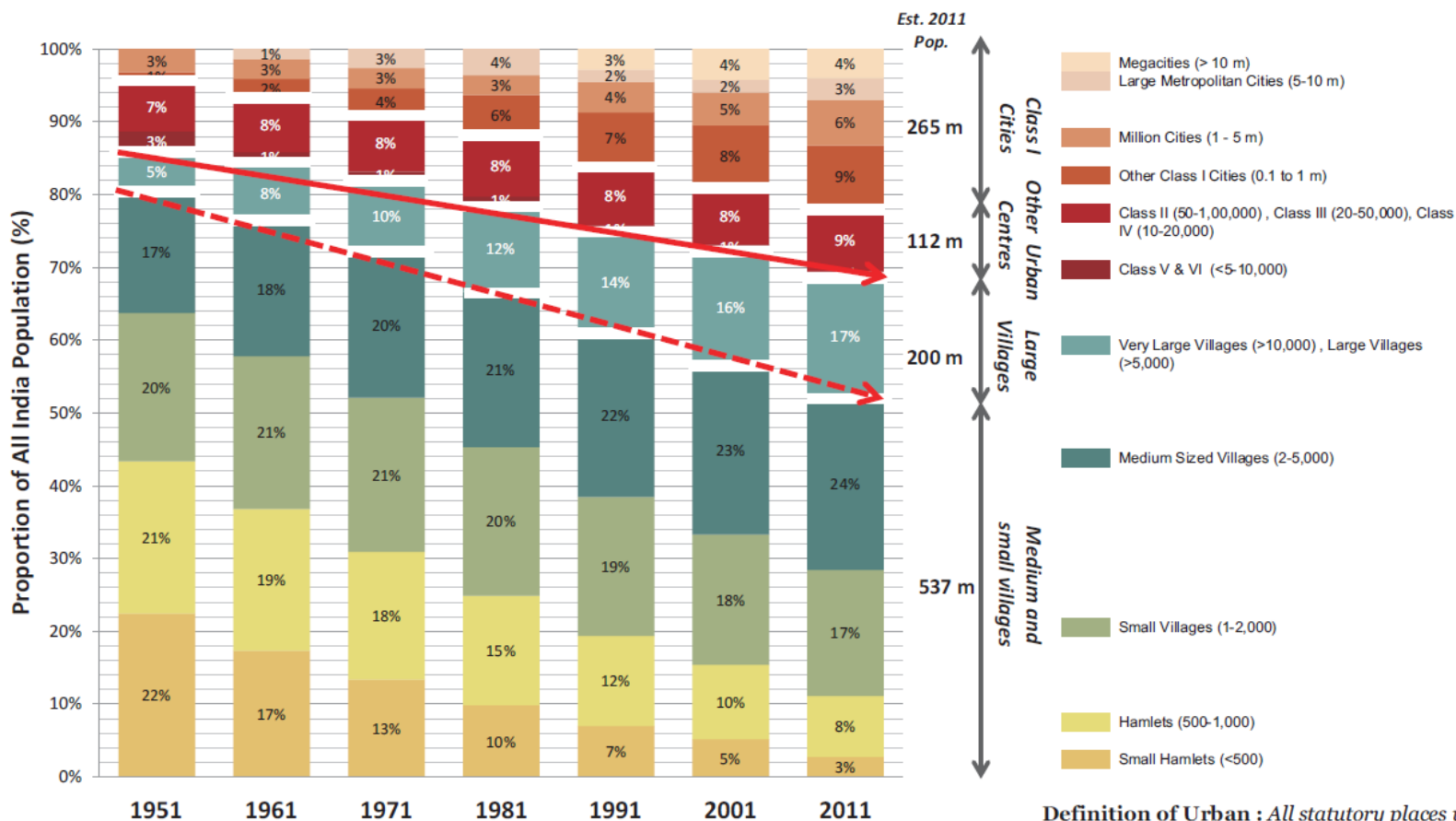
Andy Cumbers and Danny MacKinnon

**Why focus on urban clusters in
India?**

Point 1: Urbanization throughout India

Distribution of India's Population by Settlement Size (Urban & Rural): 1951 - 2011

Depending on the definition of urban , more settlements shift from the rural into the urban category.



All India: Number of Settlements (1971-2011)

| | 1991 | 2001 | 2011 |
|-------|---------|----------|---------|
| Urban | 3,351 | 5,161 | 7,935 |
| Rural | 634,321 | 6,38,588 | 640,867 |

Definition of Urban : All statutory places with a municipality, corporation, cantonment board or notified town area committee. A place satisfying the following three criteria simultaneously: a minimum population of 5,000; at least 75 per cent of male working population engaged in non-agricultural pursuits; and a density of population of at least 400 per sq. km.

Source: Census, 2011

Point 2: Drivers and patterns of urban expansion in India fundamentally different

| <i>Location</i> | <i>Average annual urban expansion growth rate</i> | <i>Approximate percent of urban land expansion attributed to</i> | |
|-----------------|---|--|-----------------------------------|
| | | <i>Population growth rate</i> | <i>GDP per capita growth rate</i> |
| China | 7.48 | 18 | 53 |
| India | 4.84 | 30 | 23 |
| Africa | 4.32 | 43 | Not significant |
| North America | 3.31 | 28 | 72 |
| Europe | 2.50 | 4 | 86 |

doi:10.1371/journal.pone.0023777.t002

Point 3: Non-local actors and global real markets shape local urban growth and form



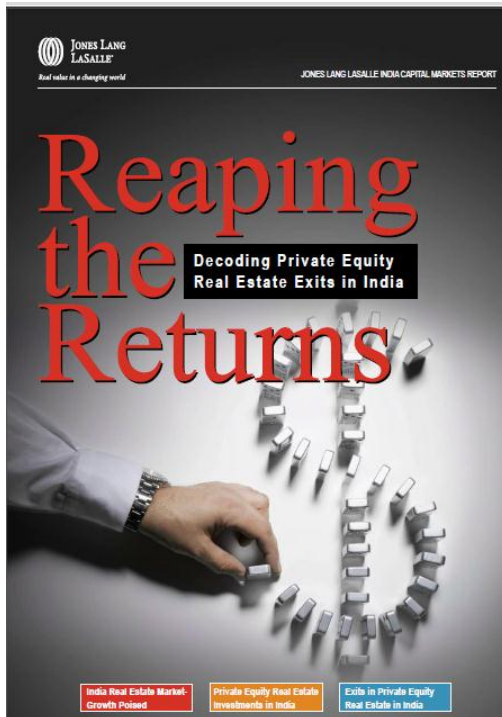
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1. Includes affiliate offices.
2. As of June 30, 2010.
3. Based on 2009 revenues versus Jones Lang LaSalle.

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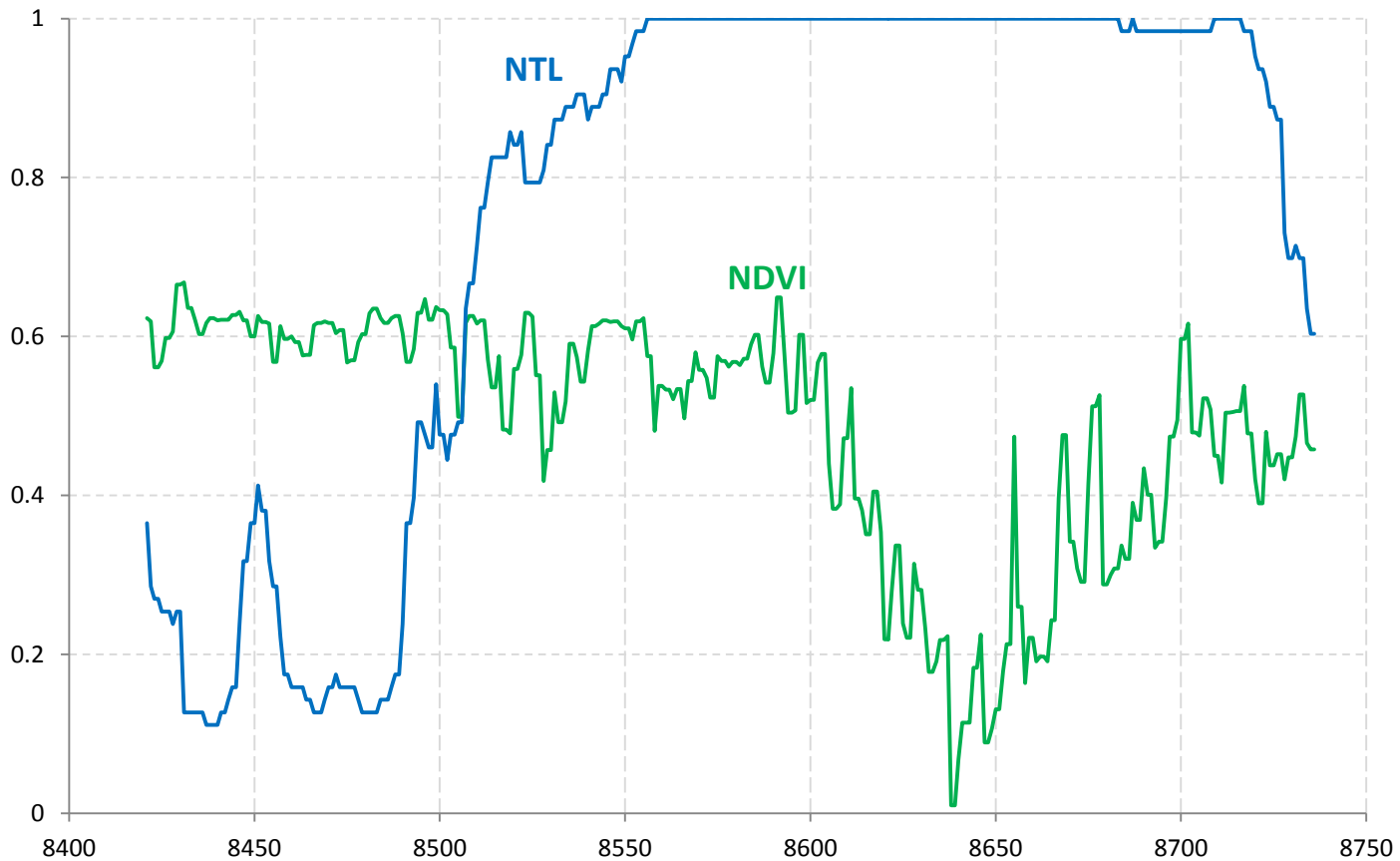


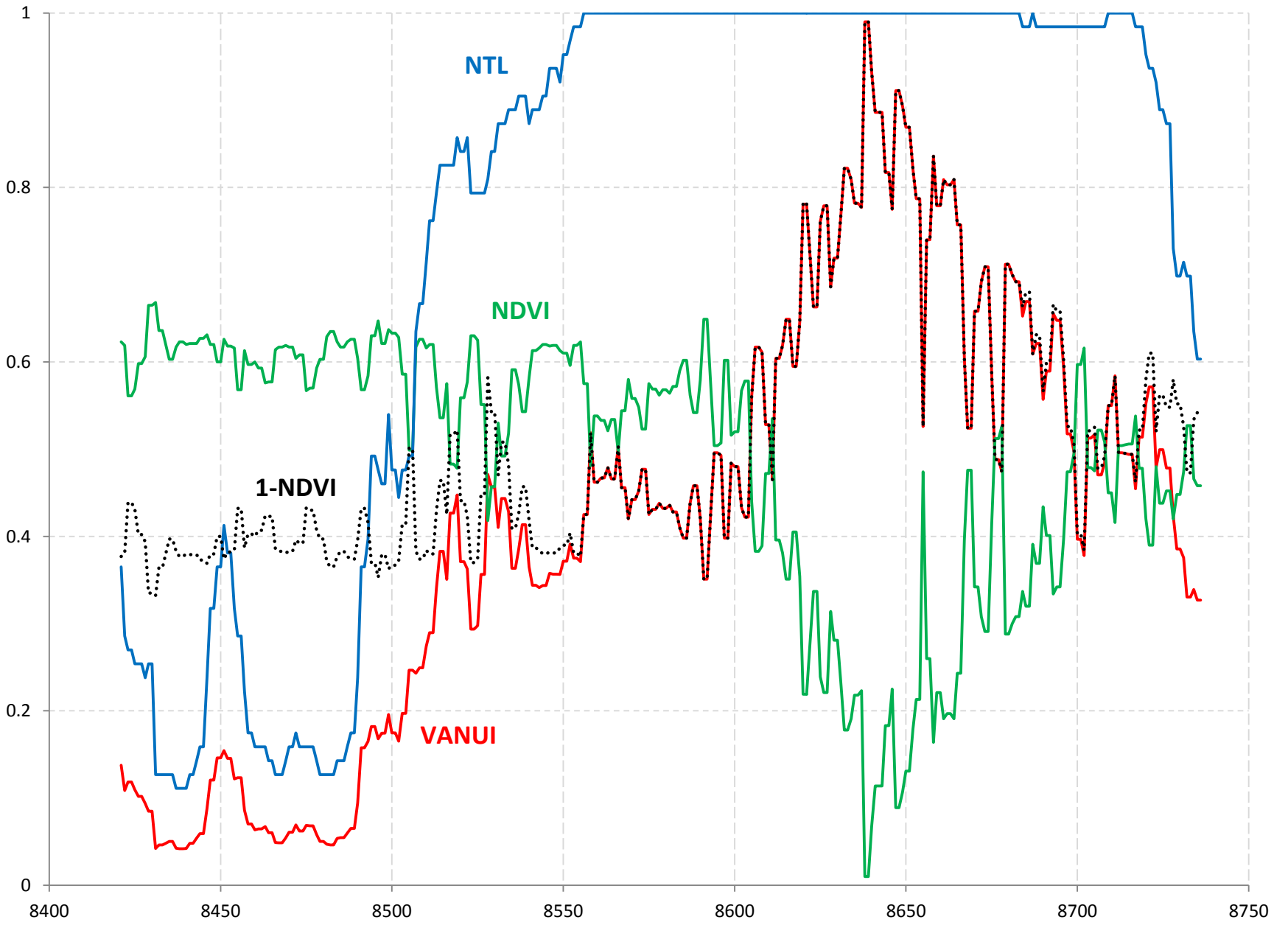
How do we identify urban clusters?

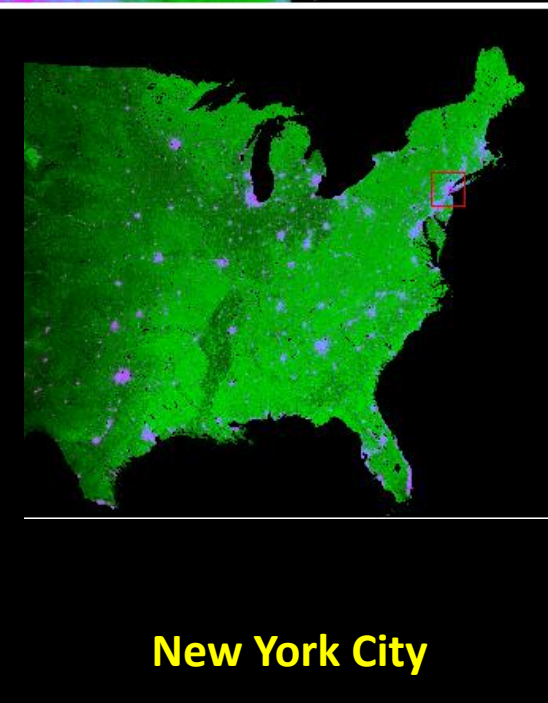
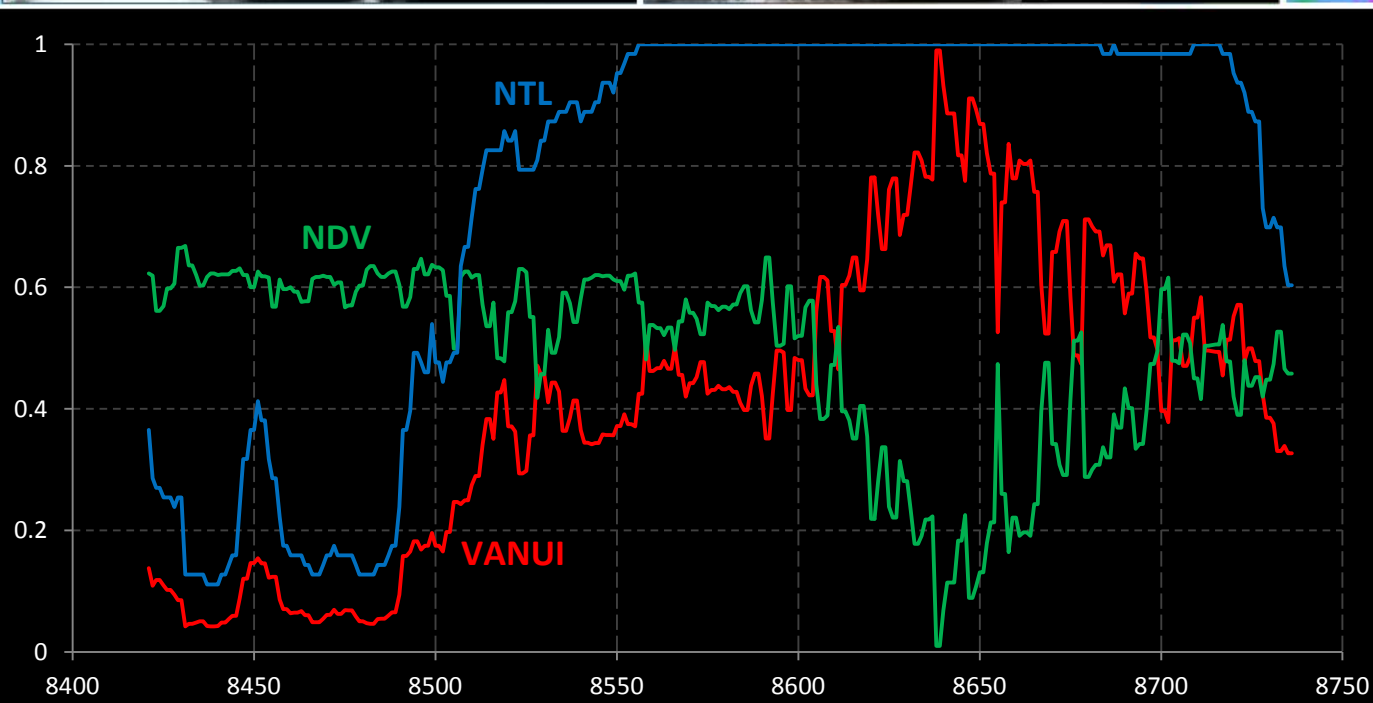
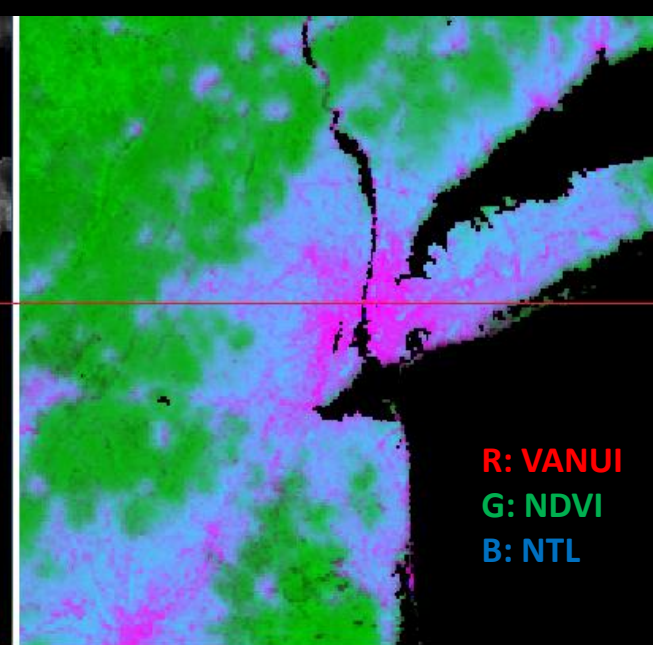
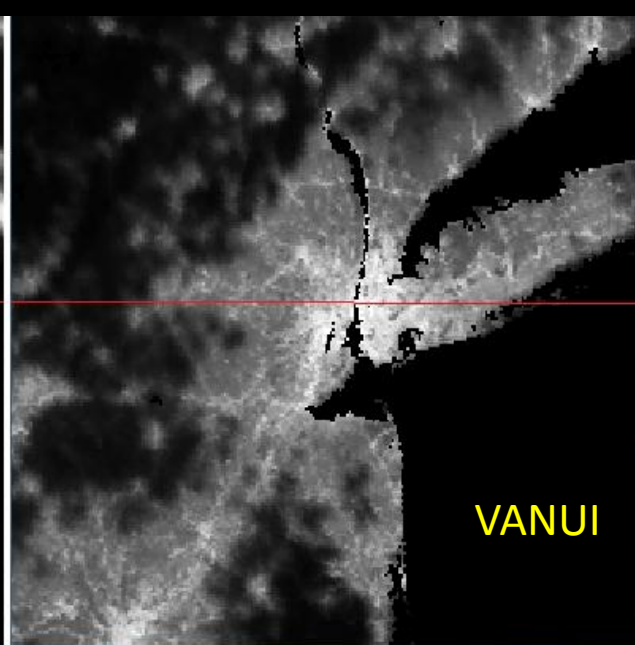
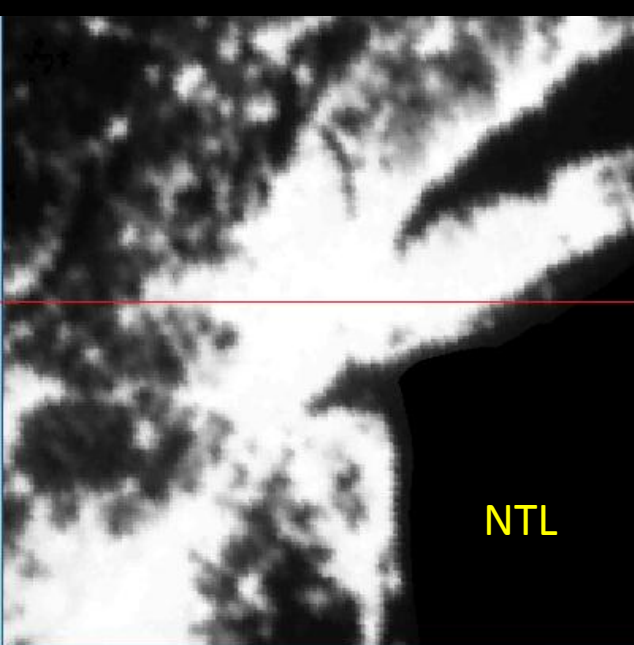
| Component 1: Detect and quantify growth of urban cluster hot spots | Component 2: Monitor land cover changes within urban cluster hot spots | Component 3: Understand the drivers of urban expansion and agricultural land loss |
|--|--|---|
| <ul style="list-style-type: none"> • MODIS+NTL indicator | <ul style="list-style-type: none"> • NTL + SPOT VGT | <ul style="list-style-type: none"> • Markets, commodity flows, and the growth of clusters in India |
| <ul style="list-style-type: none"> • MODIS+NTL time series | <ul style="list-style-type: none"> • MODIS 250m time series | <ul style="list-style-type: none"> • Infrastructure and educational factors in driving urban growth in India |
| <ul style="list-style-type: none"> • NTL + SPOT VGT | <ul style="list-style-type: none"> • Time series Landsat analysis | <ul style="list-style-type: none"> • Growth of the Delhi-Chandigarh cluster |
| <ul style="list-style-type: none"> • Discussions with public and private policy-shapers | | <ul style="list-style-type: none"> • Discussions with public and private policy-shapers |

How do we identify urban clusters *and* urban cluster hot spots?

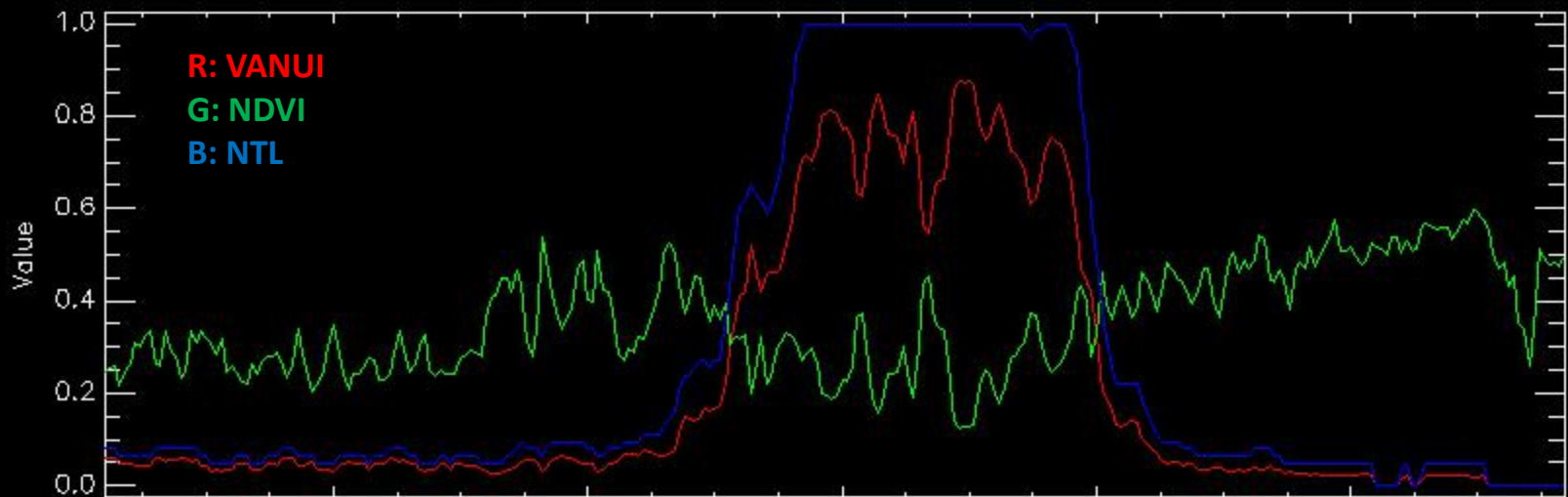
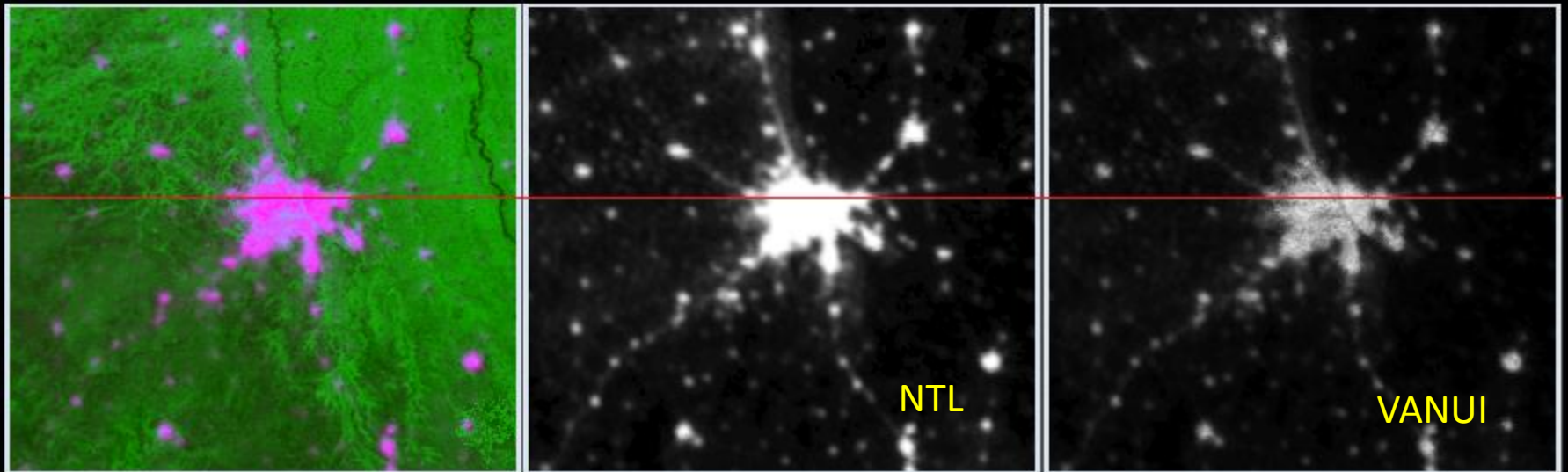
Vegetation Adjusted NTL Urban Index = $(1 - NDVI) * NTL$







New Delhi, India



LISA -- Local Indicators of Spatial Association

> Spatial autocorrelation: **Tobler's first law of geography**

$$I_i = \frac{Z_i}{m_2} \sum_j^N W_{ij} Z_j$$

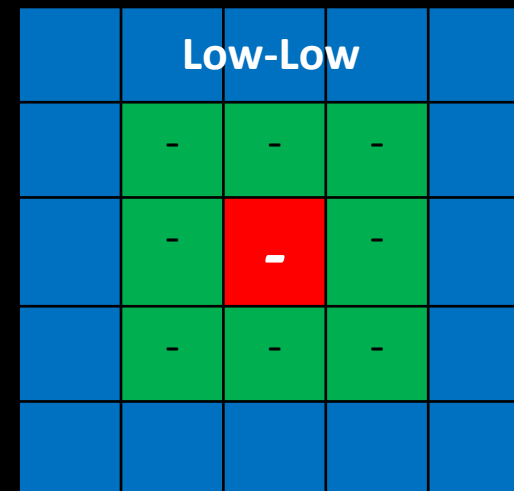
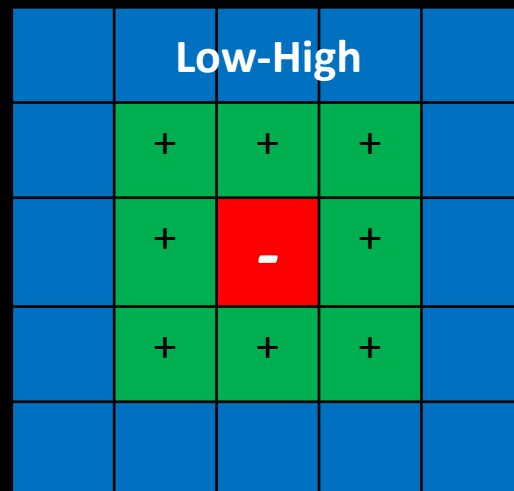
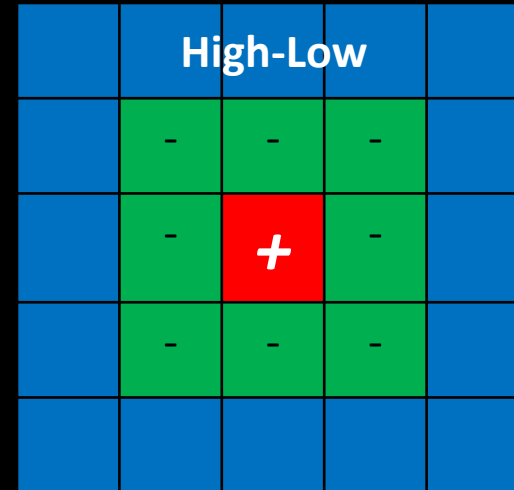
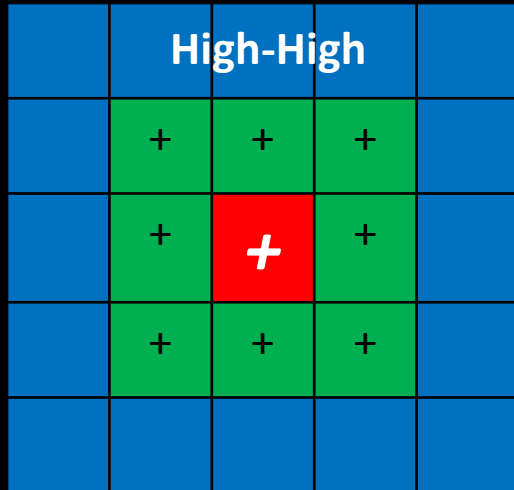
Z_i : distance from the global mean;
 W_{ij} : matrix of weight;

$$m_2 = \frac{\sum_i Z_i^2}{N}$$

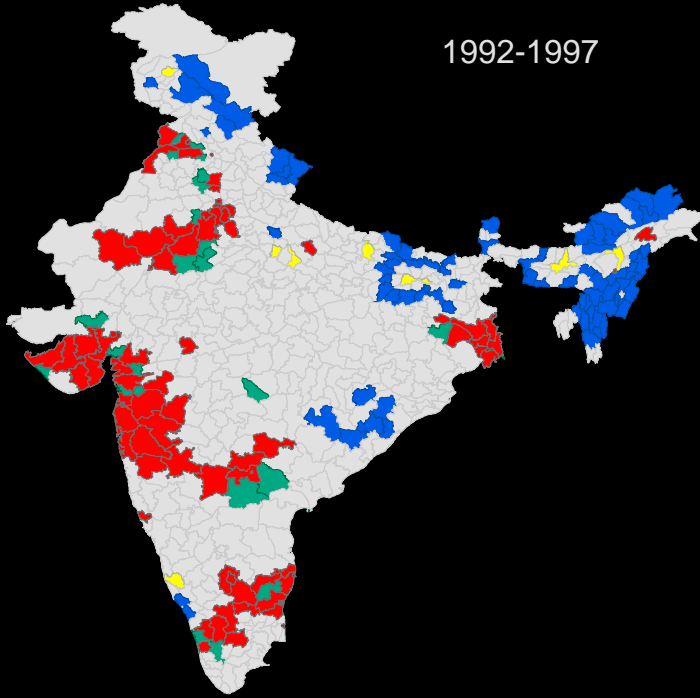
W_{ij}

| | | | | |
|---|---|-----------------|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | <i>i</i> | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 |

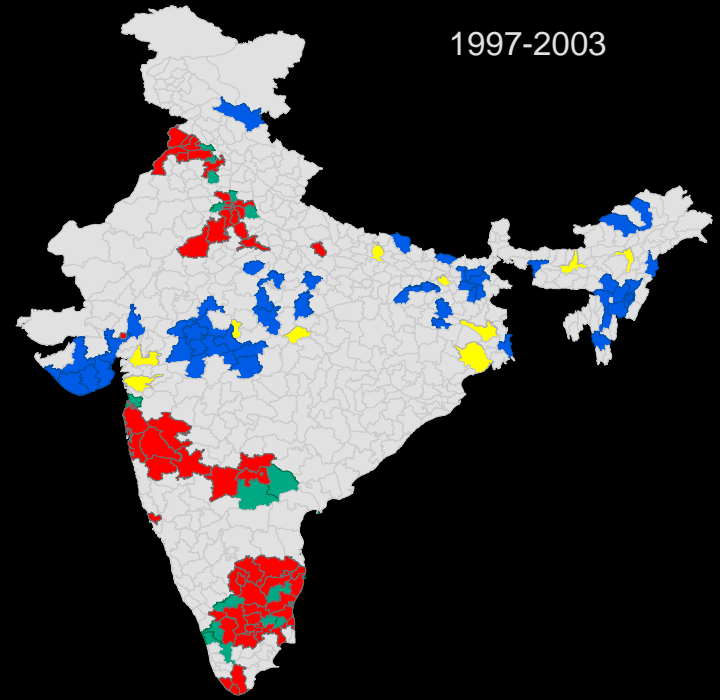
Types of Cluster Hotspots



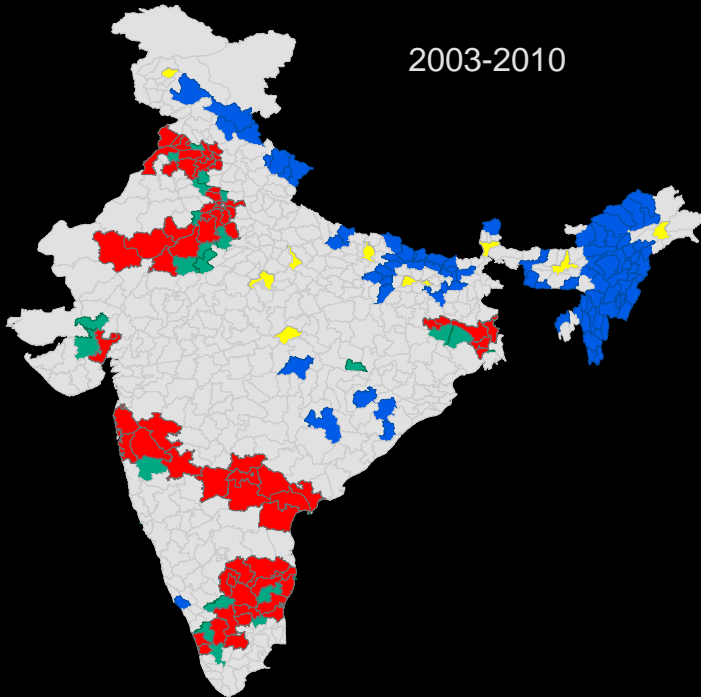
1992-1997



1997-2003



2003-2010



India urbanization hotspots



0 250 500 1,000 Kilometers

Variables currently compiled in India database

District-level Gross Domestic Product

- District -level Annual Gross and Net Domestic Product by Industry Sector
- 1999 – 2007 for 500 districts
- Source: Planning Commission of India

- Other supplementary data: state-level GDP by sector from 1993 to 2004
- India Statistical Yearbook

State Government Policy Variables

State-level Annual Capital Expenditure

- 1991 to 2011 , 29 states
- Expenditure on Education, Transportation, Urban Development, Rural Development, Agriculture, Industry, Housing, Water and Sanitation, Total Capital Expenditure
- Source: CEIC India Premium Database

Jawaharlal Nehru National Urban Renewal Mission

- Implementation policies, funding, identified cities
-

District-Level Population/Labor Variables

District-level Number of Workers (for two census years 1991 and 2001)

- Workers, main workers, cultivators, agricultural laborers, household industry workers, and non-workers
- Includes urban/rural

District-level Population Size

- Total population and Total rural/urban population
- For census years 1991 and 2001 for all the census districts
- Source: Census of India 1991 and 2001
- Census books and CD database
- Office of the Registrar General

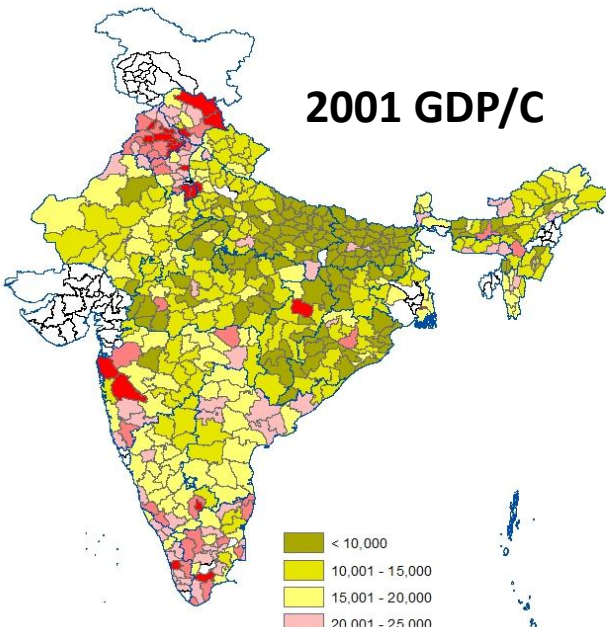
City-level population size

- Population and growth rates for census years from 1901 to 1991
- Source: United Nations Population Division

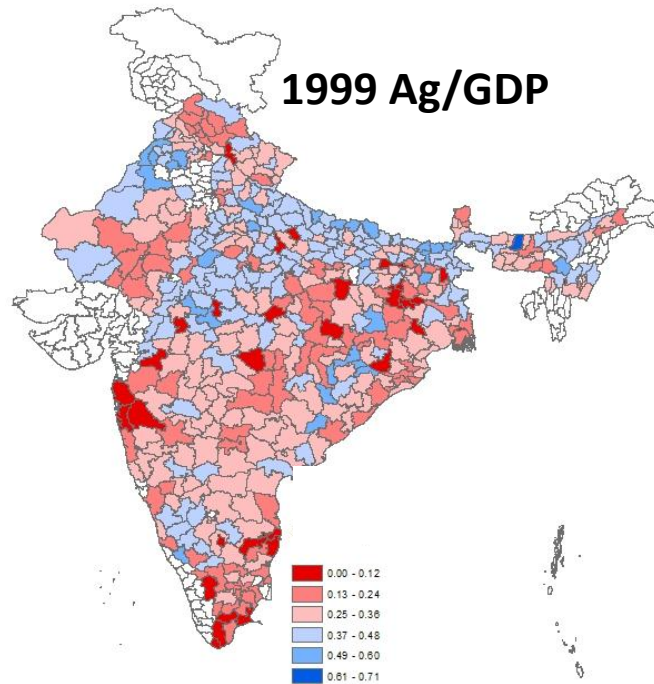
District-Level Geo/Biophysical Variables

- District-level average slope, elevation and coastal zone.
- Other biophysical characteristics (e.g., temperature, rainfall) are now being developed.

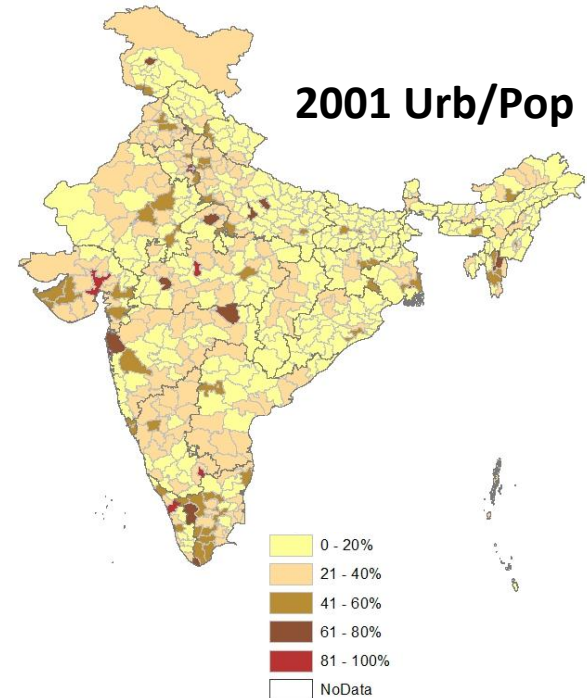
2001 GDP/C



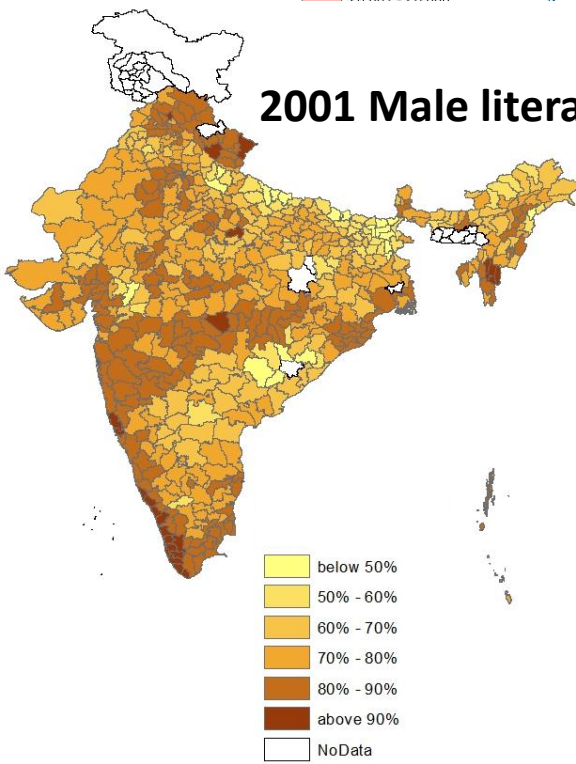
1999 Ag/GDP



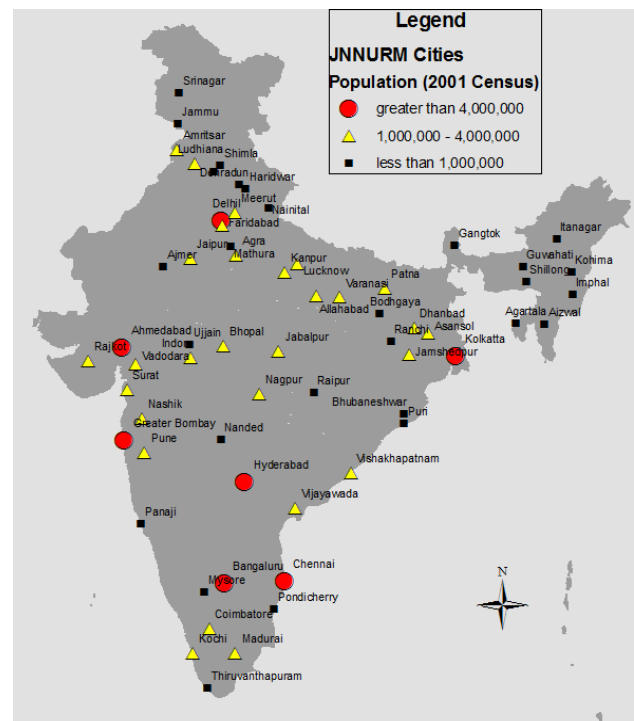
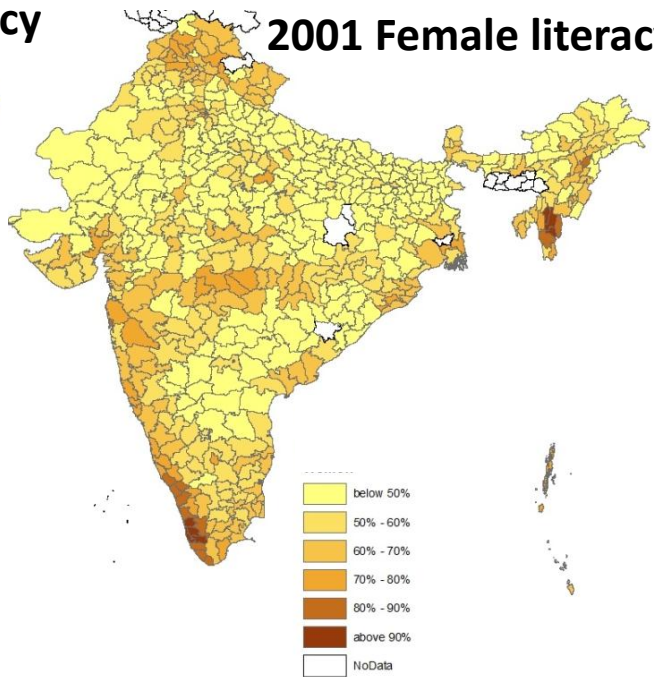
2001 Urb/Pop



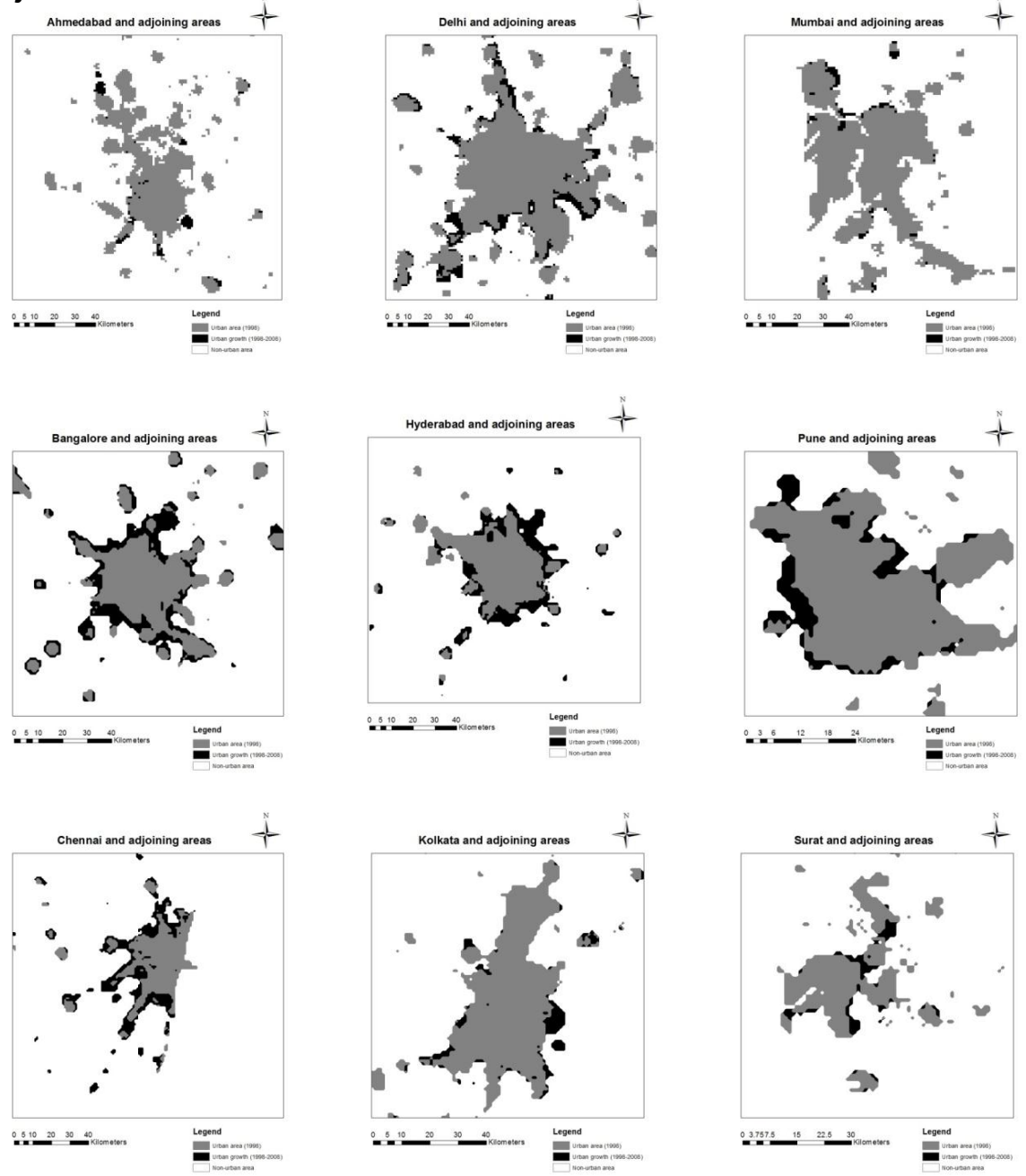
2001 Male literacy



2001 Female literacy

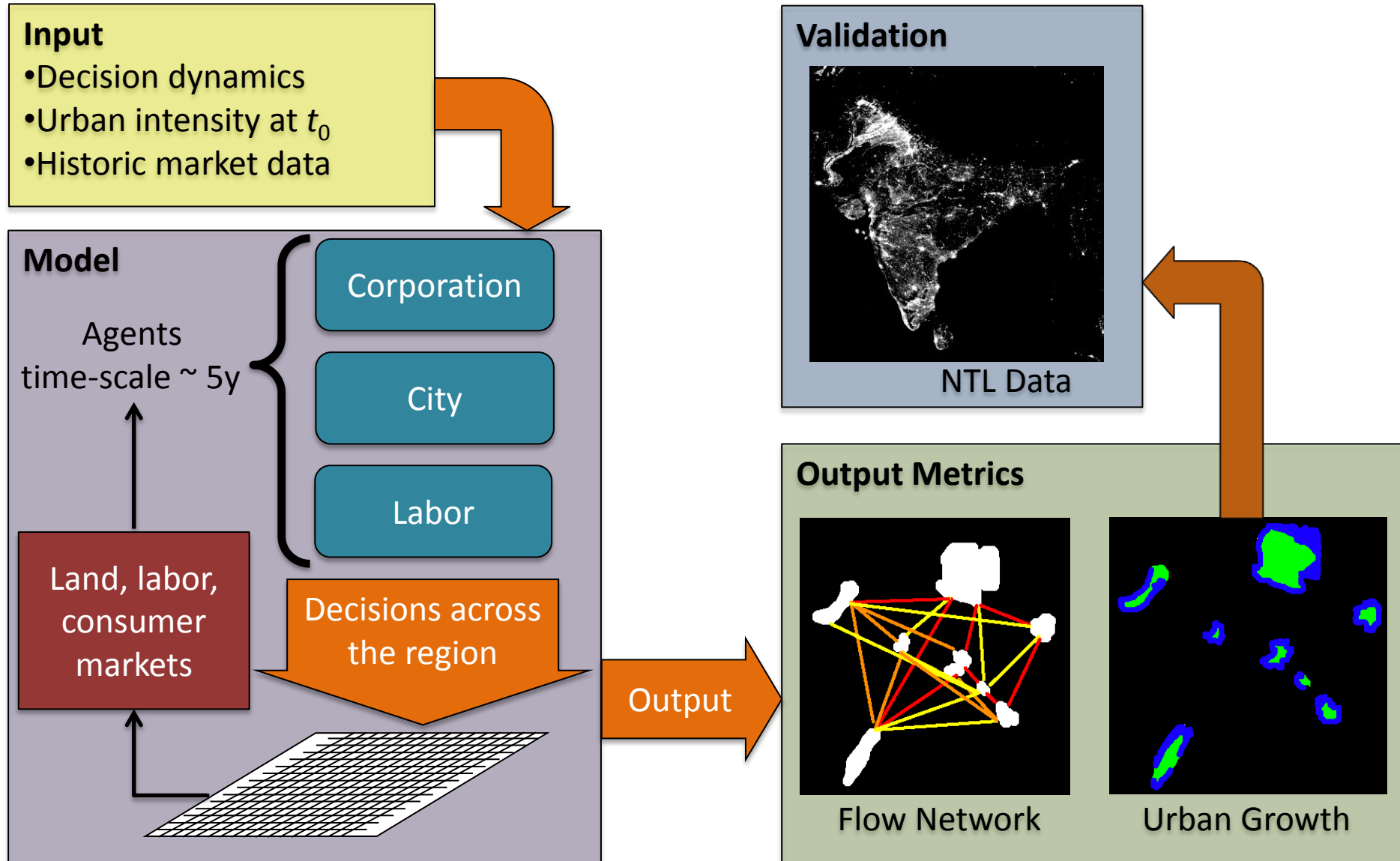


Growth in major cities from 1998 to 2008



ABM of Urban Clusters in India

Objective: How do market contexts affect how urban clusters develop?



Yale-India Urban Conference

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image courtesy m s gopal

Conference

- [Introduction](#)
- [Objectives](#)

India Urban Conference

The *India Urban Conference: Evidence and Experience* (IUC) covers the India segments of a series of international conferences on Urban India. The first conference was an academic conference on urban India in late April 2011 in New

Video updates



Year 2 Next Steps

- Continued database development
- Fieldwork in summer 2012
- Algorithm refinement
- Model building
- 8 papers in preparation or review

Research Team

