The Opportunity for Sustainable Habitat Development in India

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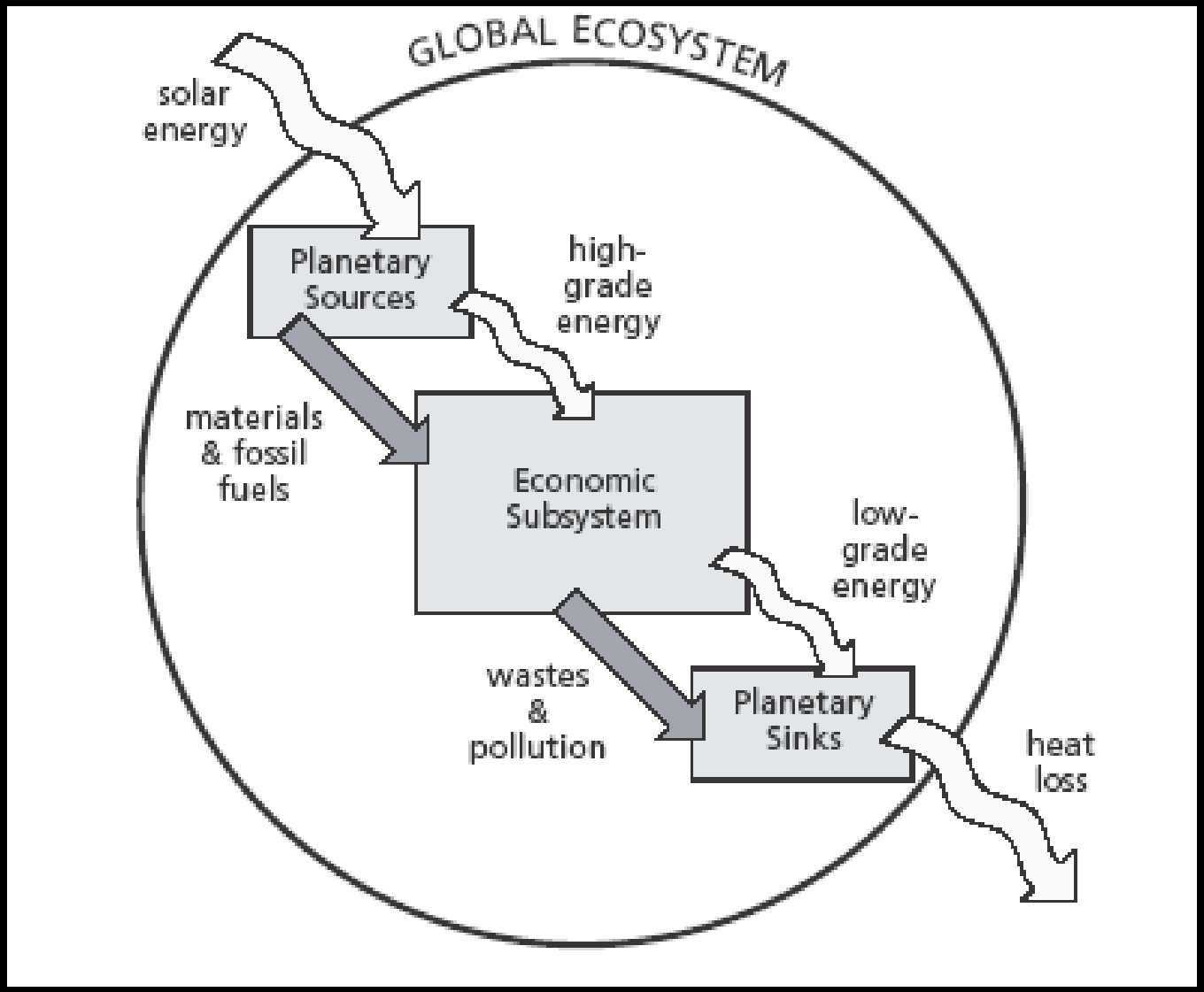
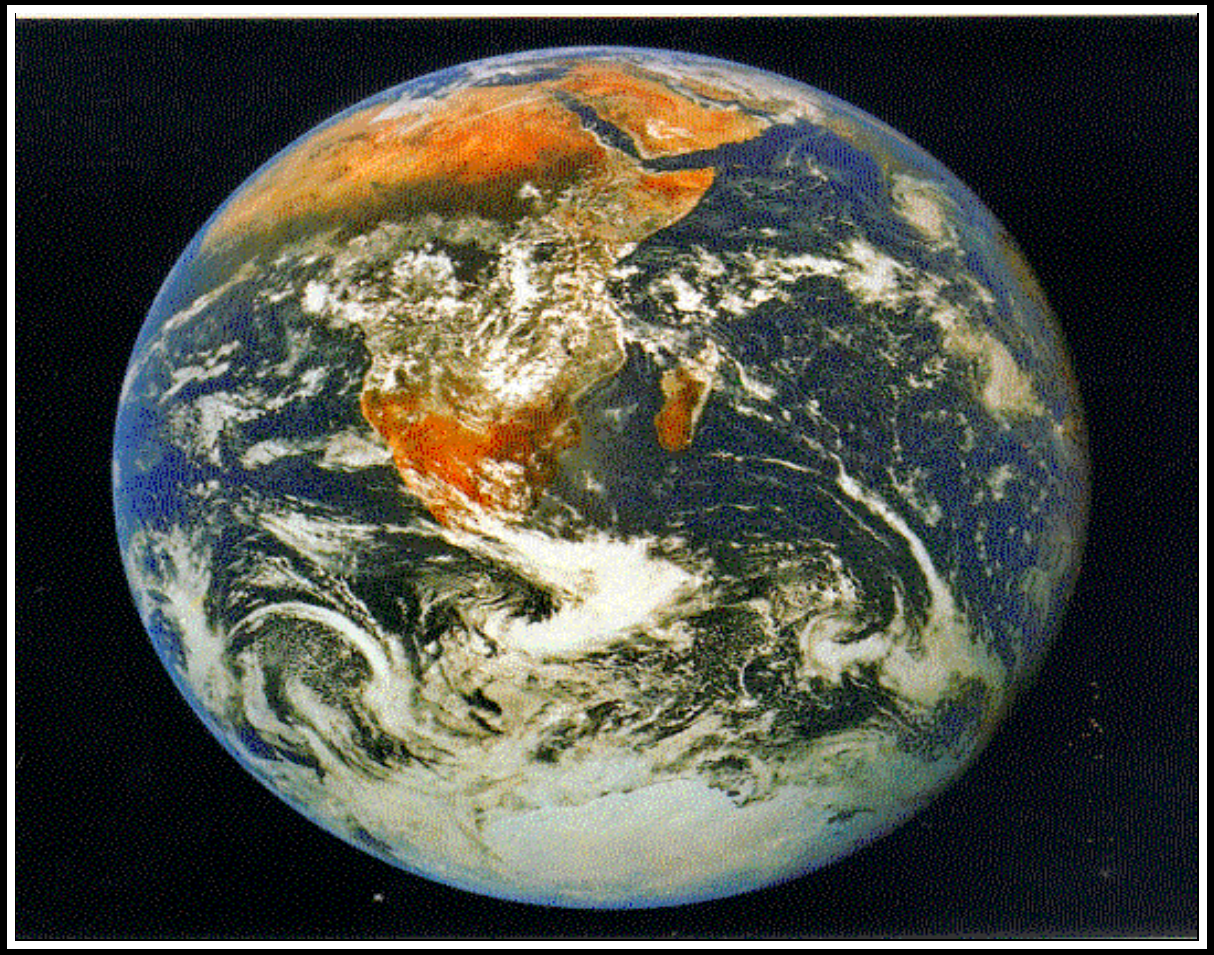
The Global context: 2000-2100

This earth-system is largely closed (Daly et. al., 1972)





There is Only One Earth and its in a small corner of the known Universe (Gagarin, Armstrong et. al. 1960s)

The Challenge of the 21st century Sustainability Transition

Present consumption requires ~2.0 worlds

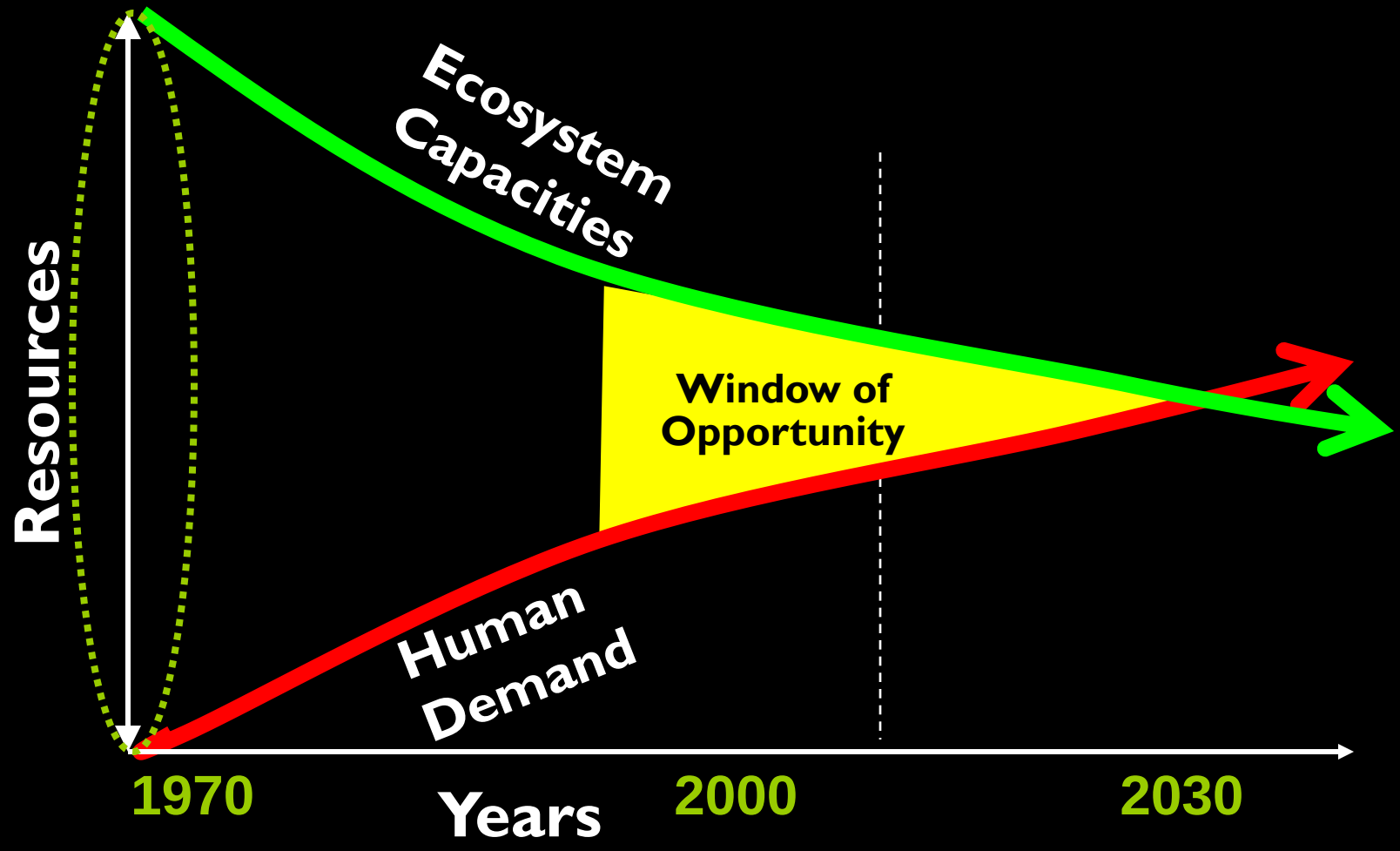
21st century Population growth needs **1.5+ worlds**

Available only One World

Ending poverty at present throughput **~2.0 worlds**

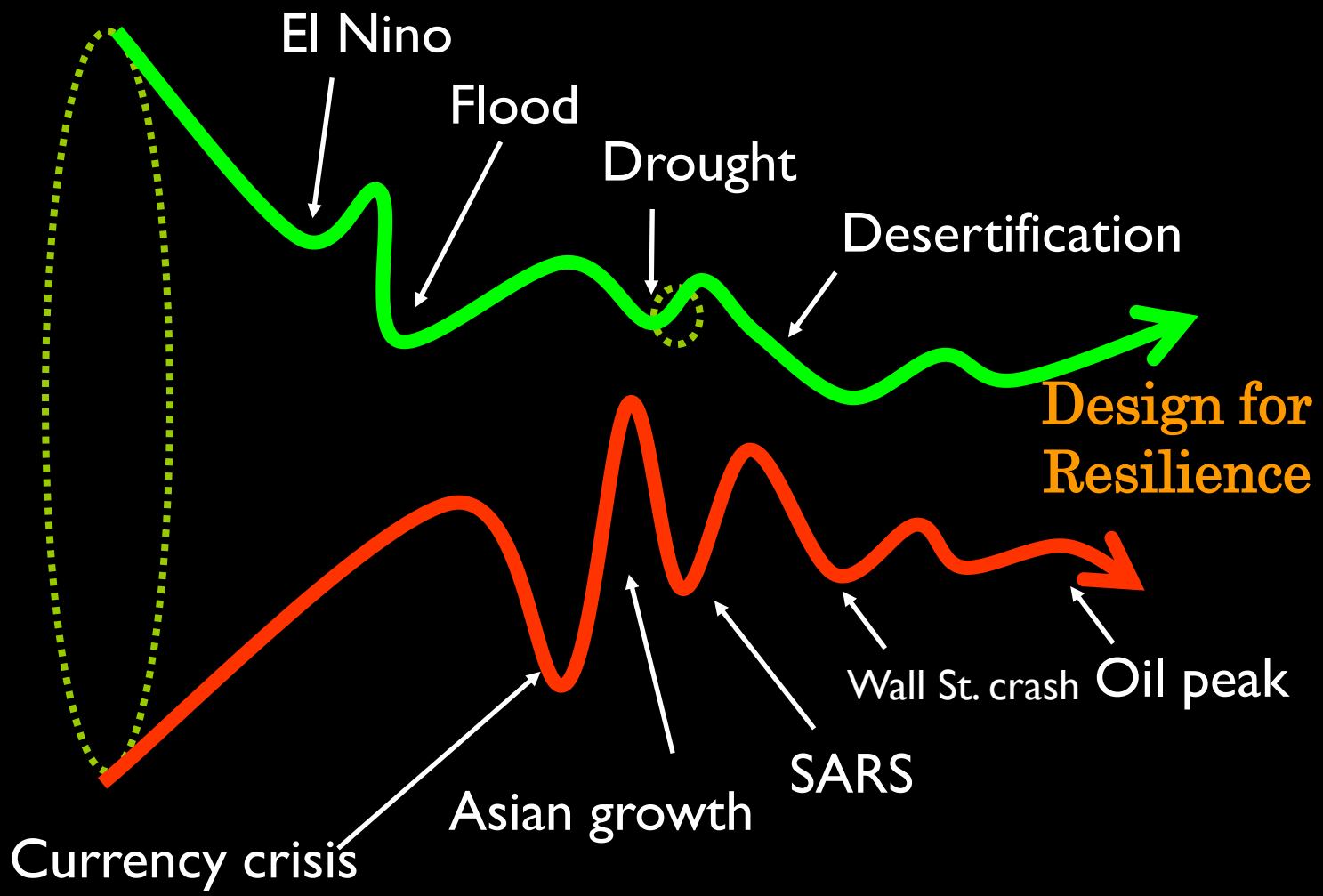
The Sustainability traverse will be largely played out in Chinese & Indian cities

A Narrowing Global Window of Opportunity



A narrowing ‘window of opportunity’ beyond which irreversible changes will take place

Reality is more complex: punctuated by multiple Shocks



We need to design our economic and urban systems for both performance & resilience

Sustainable Habitat: Key 'Governing' Equations

- Entropy *aka* Second Law of Thermodynamics
  - Closed Systems - Earth

$$\frac{dS}{dt} = \dot{S}_i \text{ with } \dot{S}_i \geq 0$$

  - Open Systems – Habitats

$$\frac{dS}{dt} = \frac{\dot{Q}}{T} + \dot{S} + \dot{S}_i \text{ with } \dot{S}_i \geq 0$$

- Exergy or available energy

$$B = Q(1 - \frac{T_o}{T_{source}})$$

- Gibbs, Massieu-Planck, Boltzmann's 'negentropy 'equations

$$J = S_{\max} - S = -\Phi = -k \ln Z$$

- Shannon-Hartley theorem

$$C = B \log_2 \left(1 + \frac{S}{N}\right)$$

The Climate challenge: 2000-2100

Evidence of Dangerous Climate Change

- Cumulative mean global temperature impact
  - Total anthropogenic GHG emissions to 2008 — 0.8 °C
  - Thermal inertia — 0.6 °C
  - Albedo flip — 0.3 °C
  - Slow feedback impacts — 0.3 °C

  Impact of historical emissions & lag — **2.0 °C**

  (2 °C mean implies > 4 °C inland and over 6 °C at the poles)
  - Current emissions to 2030 — 0.4 °C
  - Addition emissions due to growth — 0.6 °C

  BAU Global mean temperature deviation — **3.0 °C**
- 3 to 5 m Sea Level Rise by 2100
  - Thermal expansion
  - Artic sea ice melt
  - Greenland icesheet loss
  - West Antartic icesheet loss
  - East Antartic icesheet loss
- Glacial melt

Himalayan Glacial melt (1921-2009)

A ‘naïve’ Climate Change Impact Equation

Atmospheric Greenhouse Gas Concentrations =

Historical GHG concentrations ← History, industrialisation, past-consumption & equity

+

[Population (1+ population growth rate) ← Economic and human development, poverty

x

GDP per capita (1 + GDP growth rate) ← Growth, investment, productivity, technology governance & equity

x

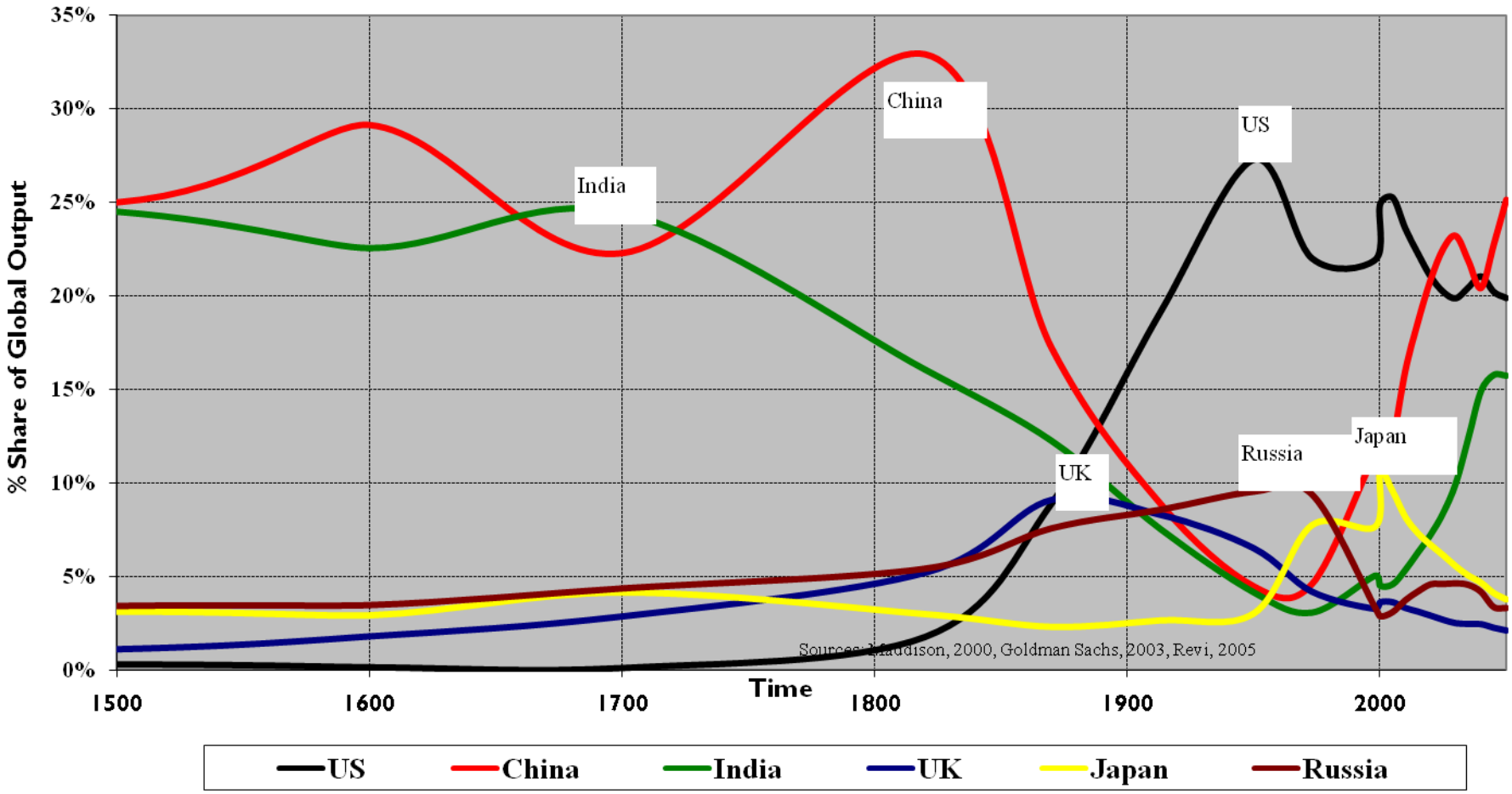
Energy per unit GDP output ← Investment, technology, efficiency, markets

x

Carbon emission / unit Energy] ← Investment, technology, ‘metabolic’ change, markets

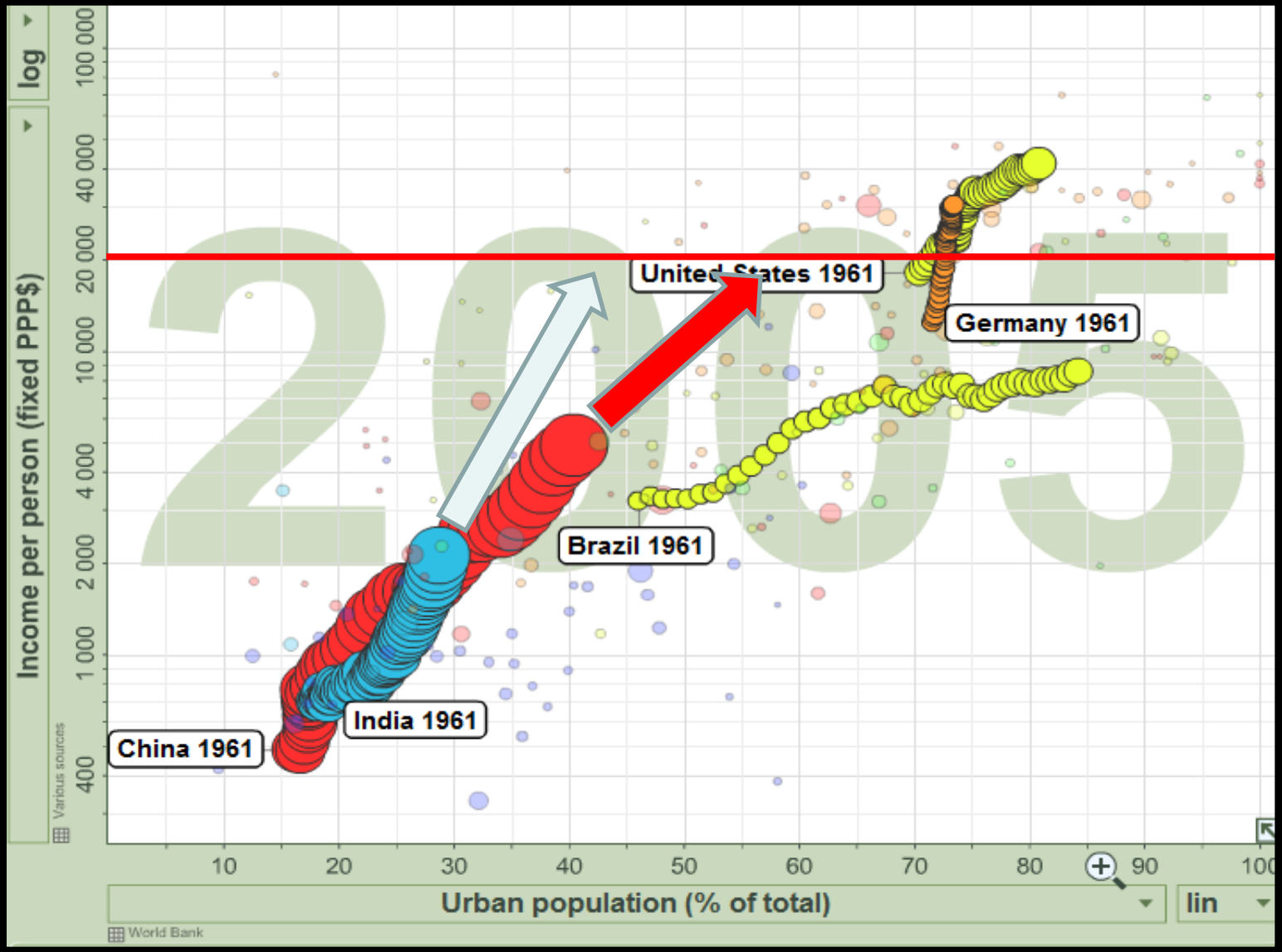
The built environment & the Energy-Climate debate

Relative National Share of Global Economic Output (1500 to 2050)

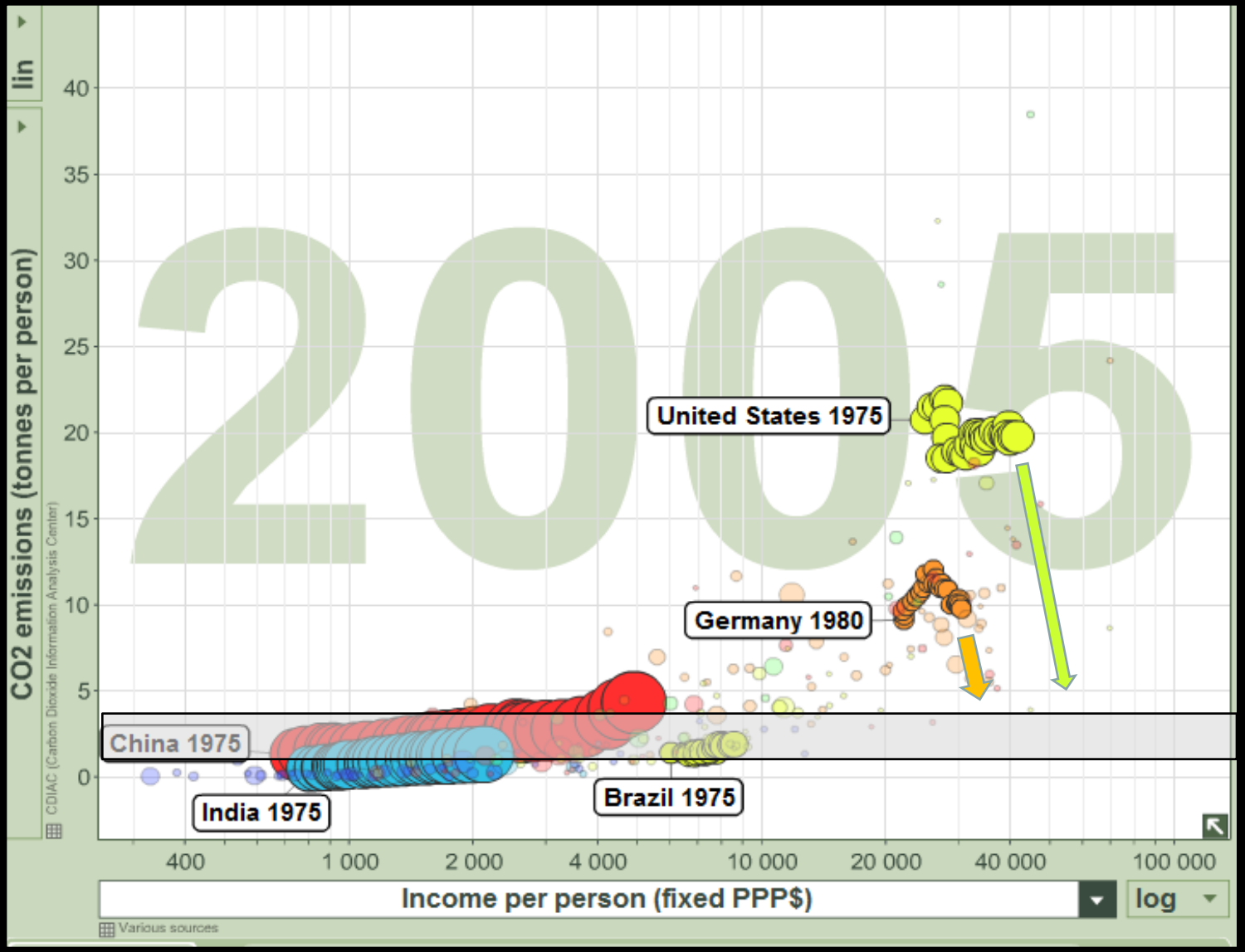


Asia returns to centre of the global economy after a gap of 250 years

Urbanisation: a key growth & economic development driver

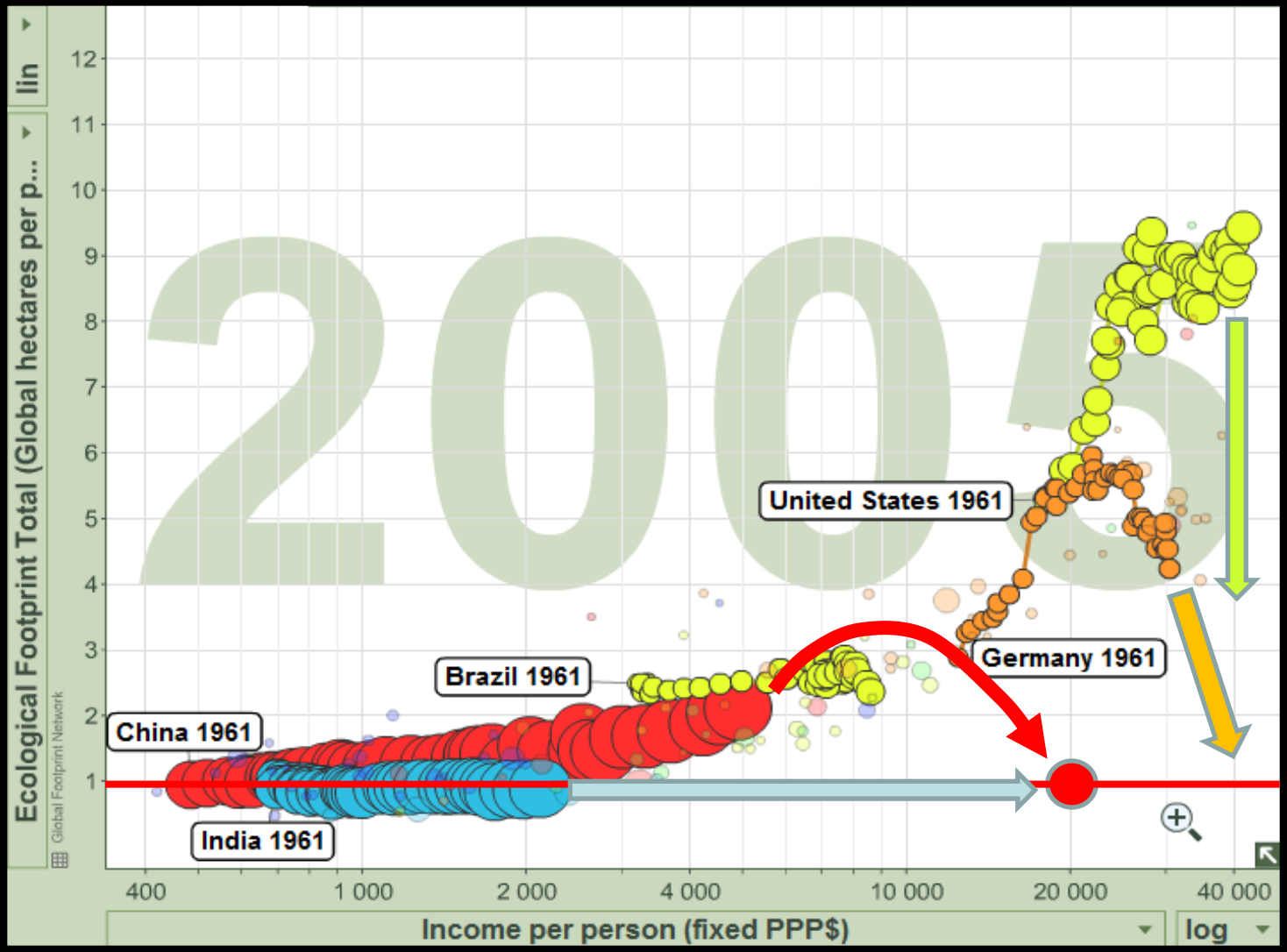


The battle for Carbon ‘space’ and growth potential

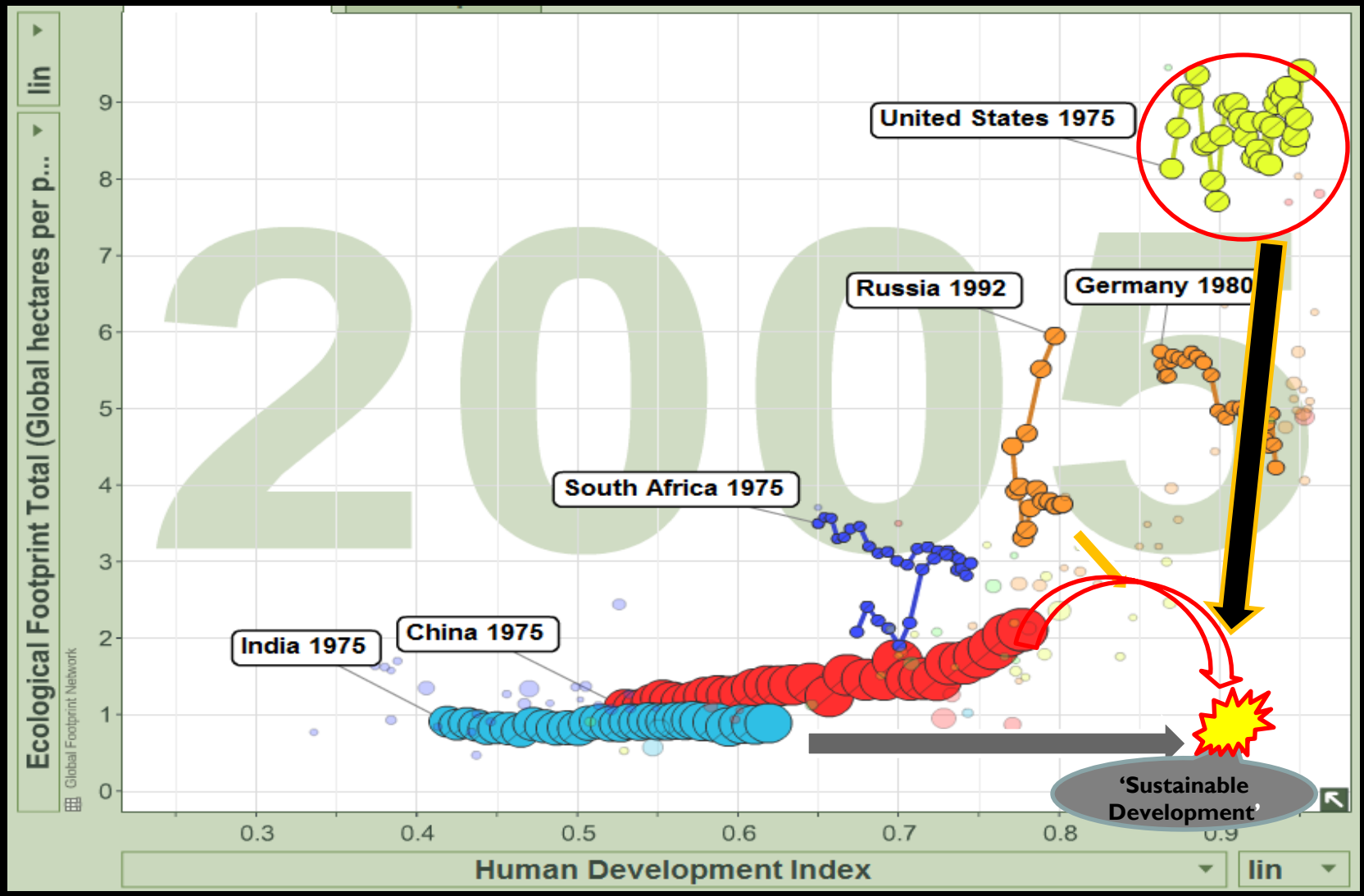


A possible reframing of India's Climate challenge/opportunity

The Great Transition: balancing growth & ecosystem health



Future History - Sustainability Transitions: 2005 →



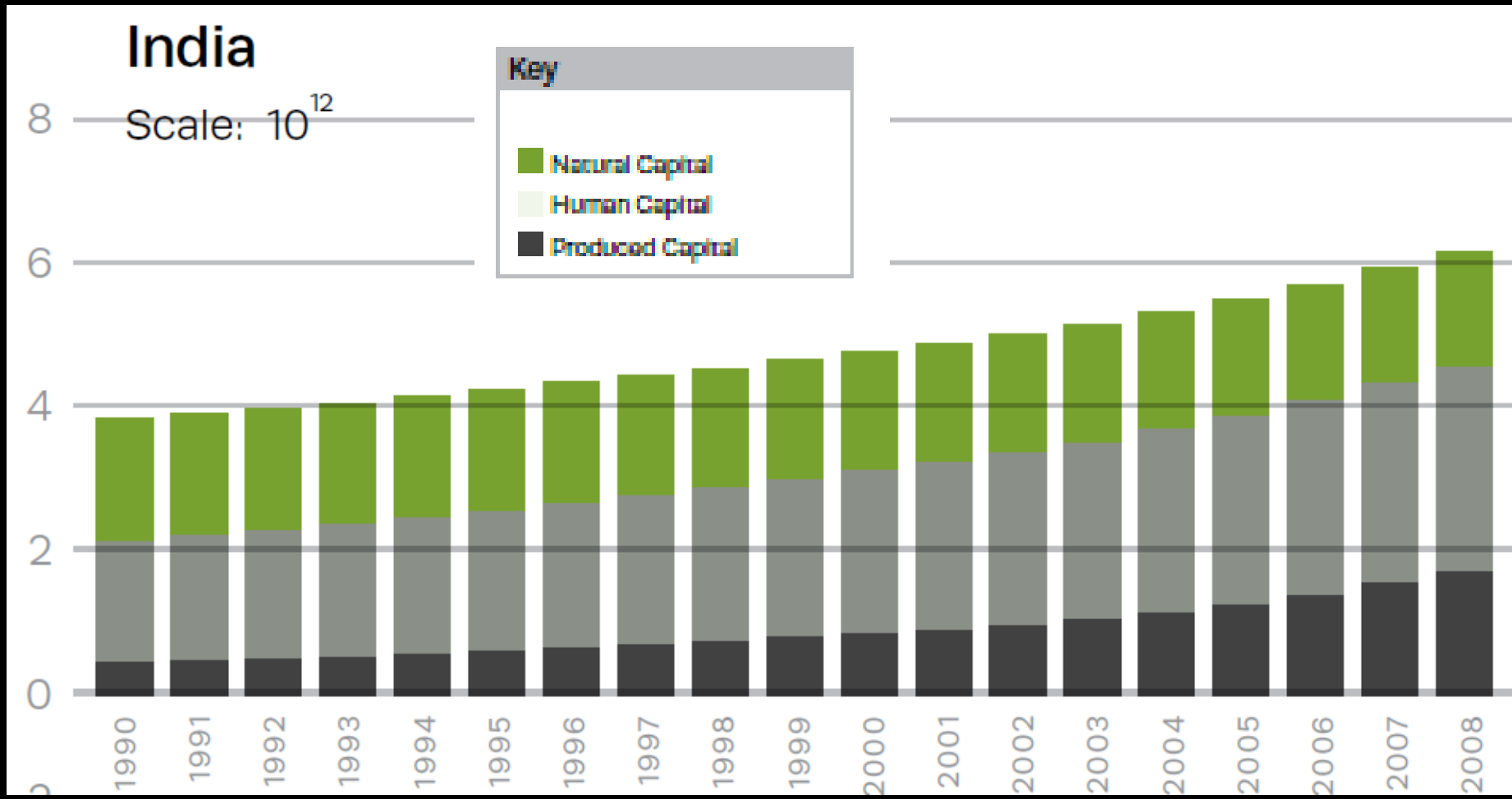
Can China traverse the environmental Kuznets curve Germany & USA converge without serious Human Development decline India 'tunnel through';
or will there be serious international 'resource' conflict?

The national context: 1970-2030

India: the opportunity of ten simultaneous Transitions

1. Demographic transition: population stabilisation & aging
2. Health transition: infectious + lifestyle disease burden
3. Education transition: elementary → secondary→ tertiary
4. Energy transition: oil + coal → gas + renewables
5. Environmental transition: 'brown' + 'grey' + 'green' agendas
6. Information transition: post →phone→ cell phone + www
7. Livelihoods transition: agrarian → green + knowledge jobs
8. Economic transition: primary + secondary → tertiary-led
9. Political transition: decentralised, youth and urban
10. Urban transition: rural → 'urban'

India: Inclusive Wealth trends (1990-2008)

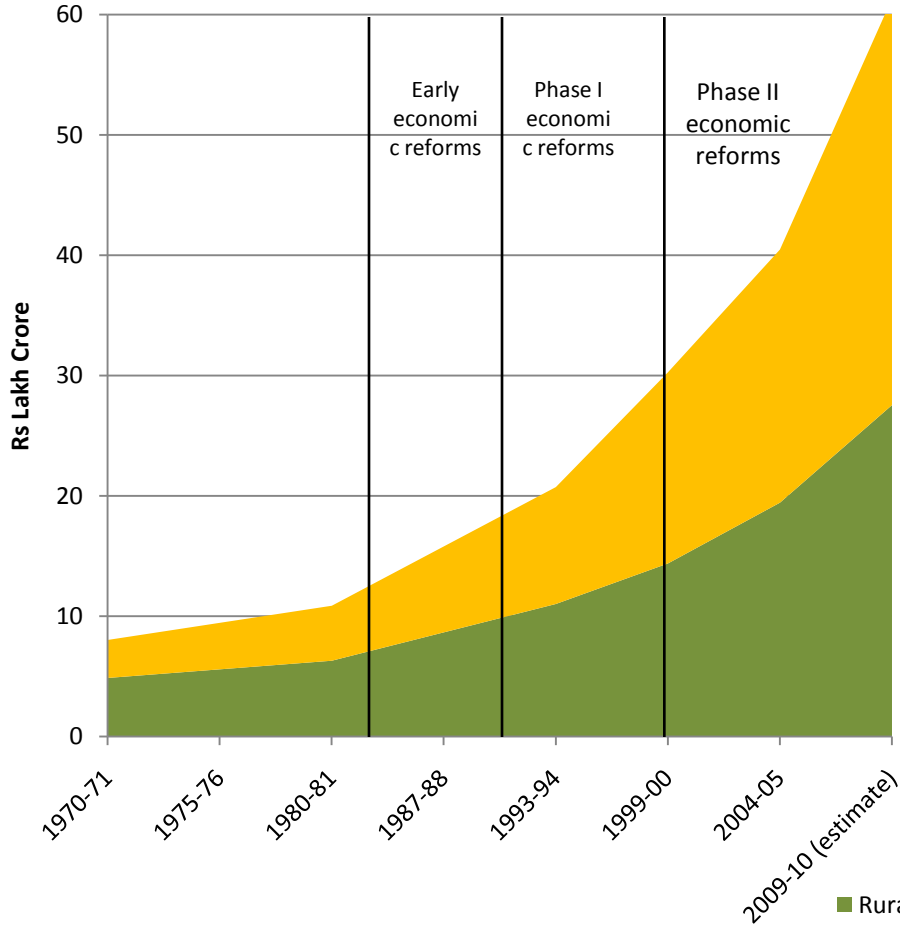


India's Inclusive Wealth base is about 4 times its GDP.

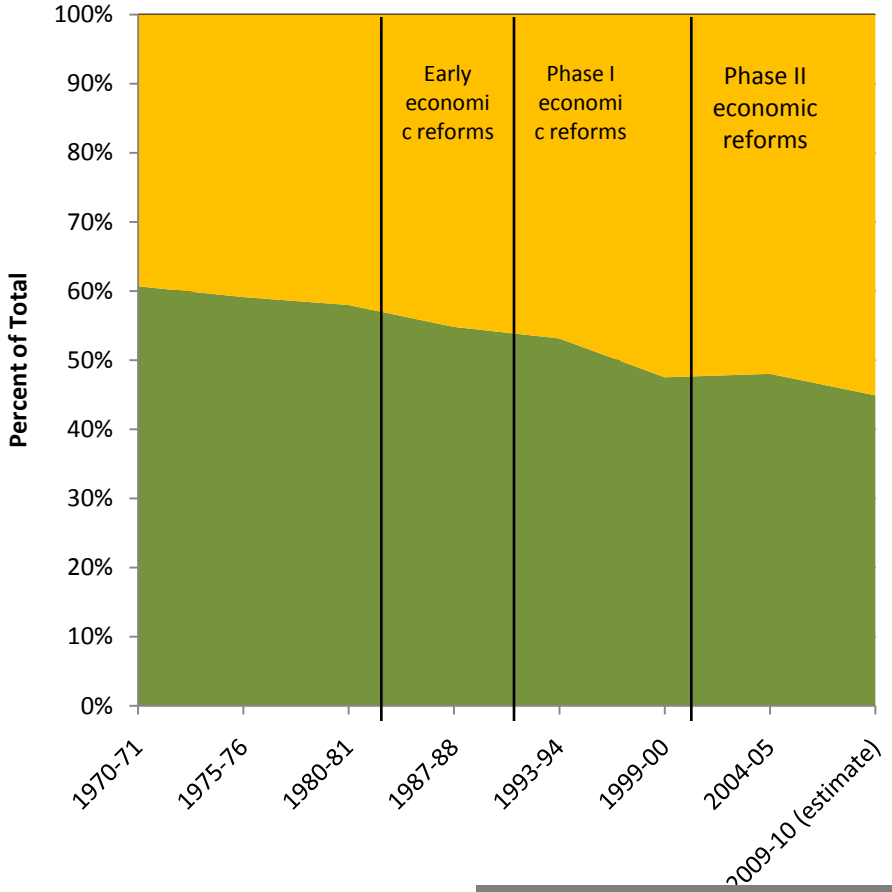
Of this, the largest component is 'human capital'

India: Rural-Urban GDP

Rural: Urban GDP share (1970-2009)



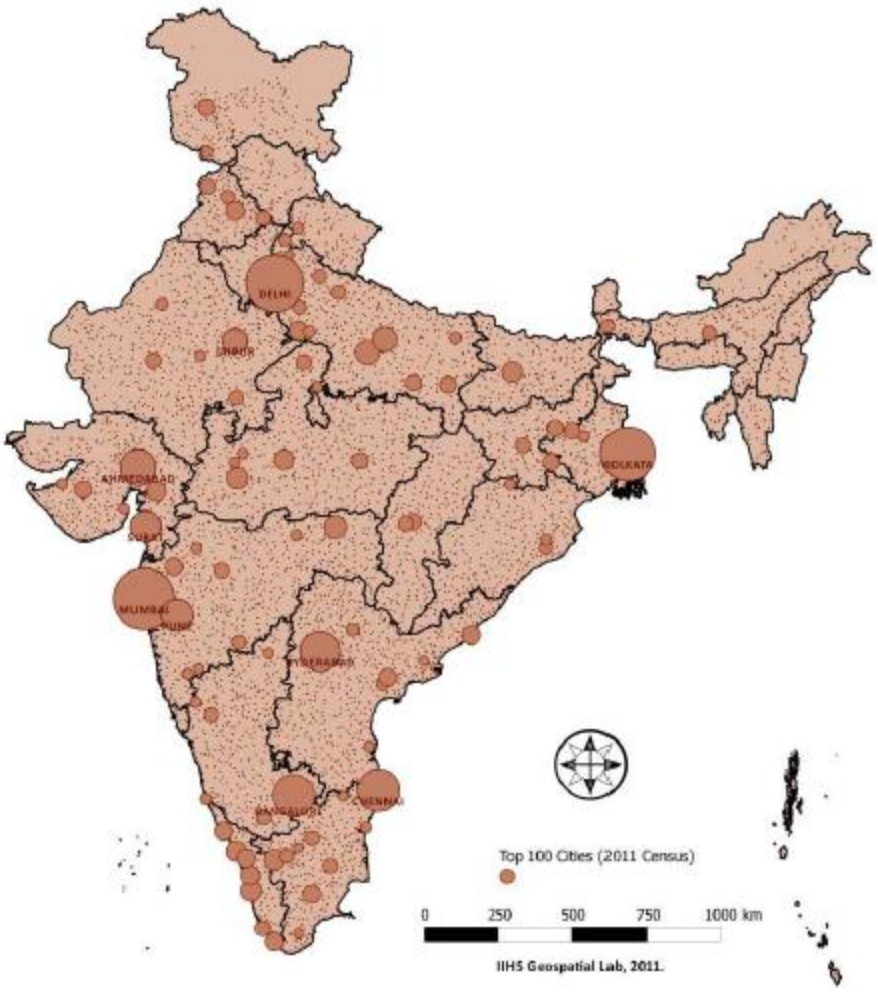
Rural: Urban GDP fraction (1970-2009)



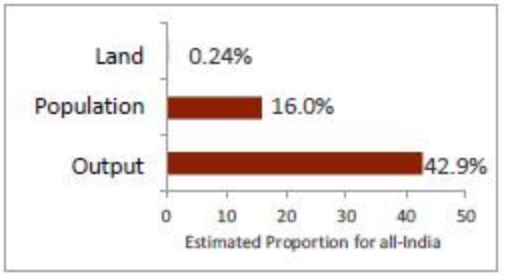
Source: National Accounts Statistics

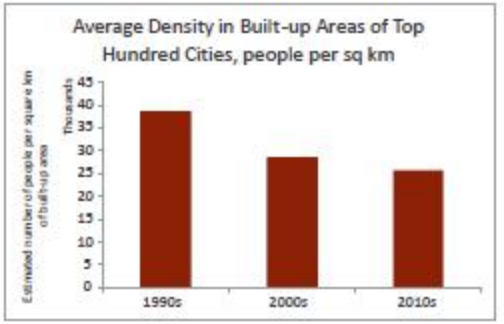
Close to 60% of India's GDP comes from Urban areas

India: Concentration of Economic Output (2009)



The top 100 largest cities are estimated to produce about 43% of the GDP, with 16% of the population and just 0.24% of the land area.

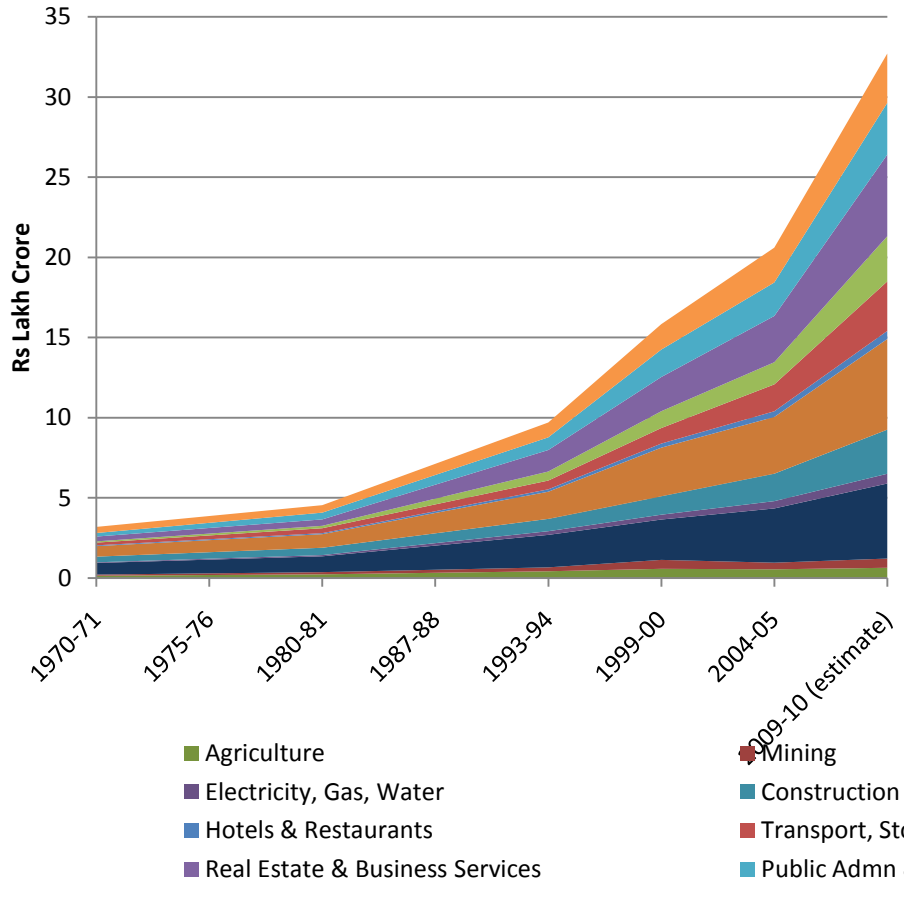




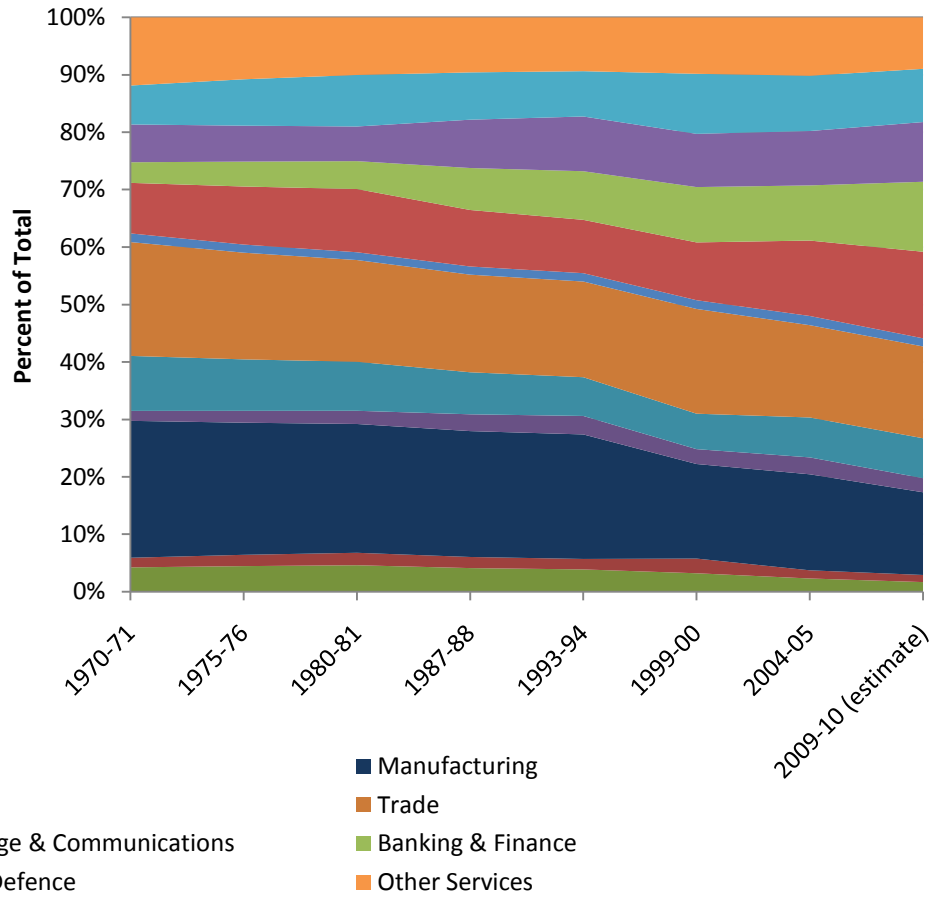
Source: IIHS Analysis 2011(built-up area); Census 2011 (population); Planning Commission 2011 (DPP Estimates 2005-06).
See endnotes for method of calculating urban output and built-up area.

India: Urban Sectoral GDP

Urban sectoral GDP growth (1970 – 2009)

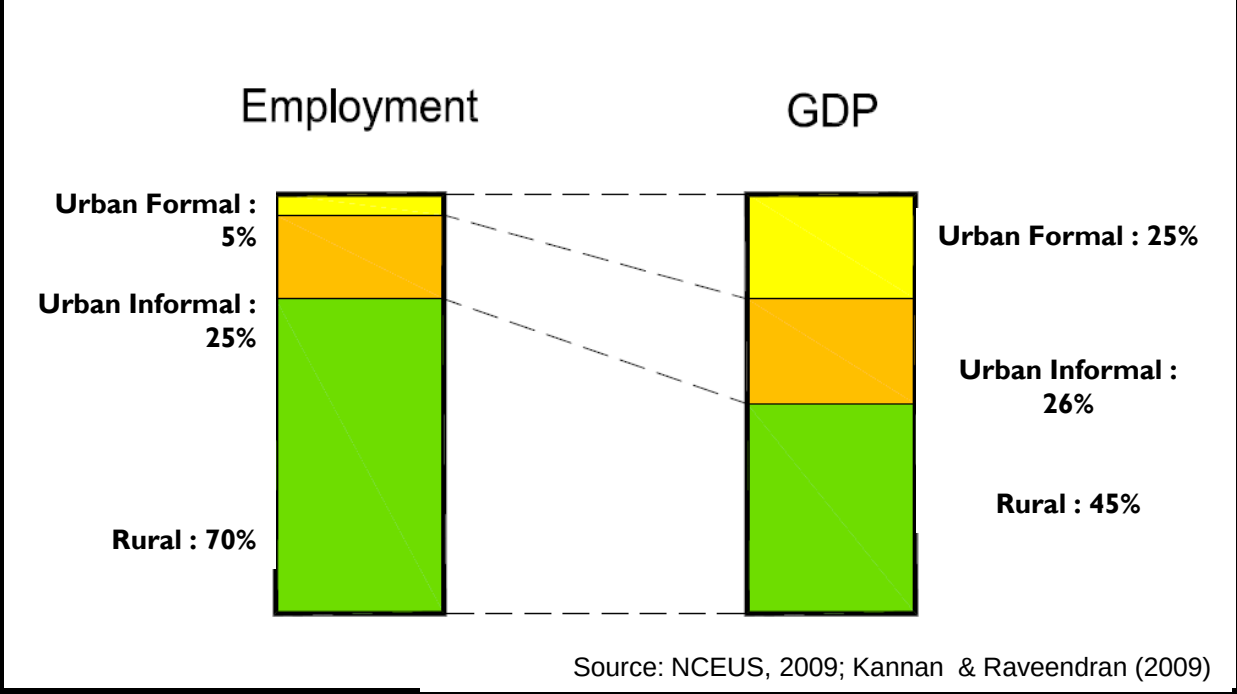


Urban sectoral GDP structure (1970 – 2009)



Decoupling of energy/carbon systems and the real economy have to be sector specific

India: GDP & Employment structure (2009)

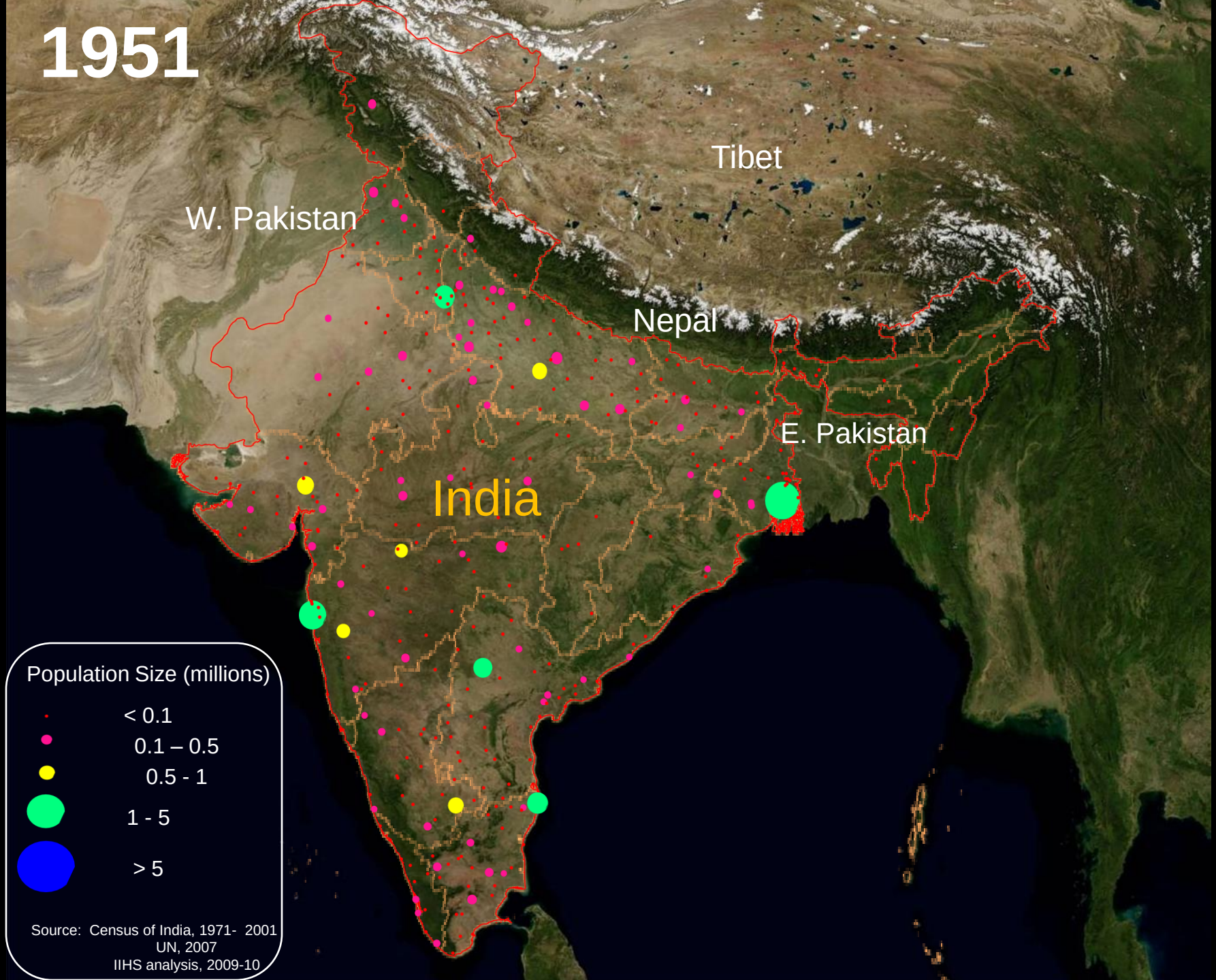


The urban informal sector with a quarter of the workers produces roughly a quarter of the GDP. The urban formal sector with 5 percent of the workers produces a similar share of the GDP.

The Dynamics of Indian Urbanisation (1951-2031)

India's Coming transition (2011-2031)

- India will add at least 300 million new people to its cities in the next 30 years
- This is on top of the current urban population of ~300 million, of whom over 70 million are poor
- In 2031, three of the ten largest megacities in the world will be in India: Delhi, Mumbai, Kolkata
- Over 75 other cities will have a population of over 1 million
- This will be the second largest urbanisation in human history creating huge market opportunities and development challenges
- The only option to avoid complete systemic urban breakdown is the simultaneous transformation of India's cities and its villages
- A wide range of technical, institutional and social innovations will be required to enable this


1951
Tibet
W. Pakistan
Nepal
E. Pakistan
India
Population Size (millions)
< 0.1
0.1 – 0.5
0.5 - 1
1 - 5
> 5
Source: Census of India, 1971- 2001
UN, 2007
IIHS analysis, 2009-10

1961

Urban Population Growth

Kolkata
(5.7)

Population Size
(millions)

< 0.1

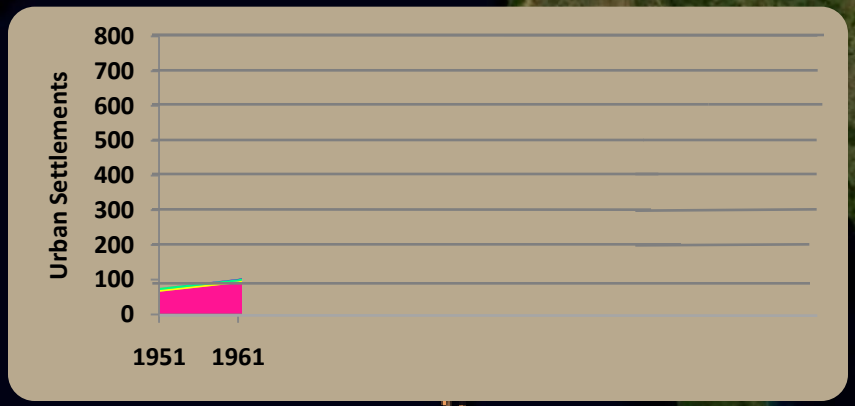
0.1 – 0.5

0.5 - 1

1 - 5

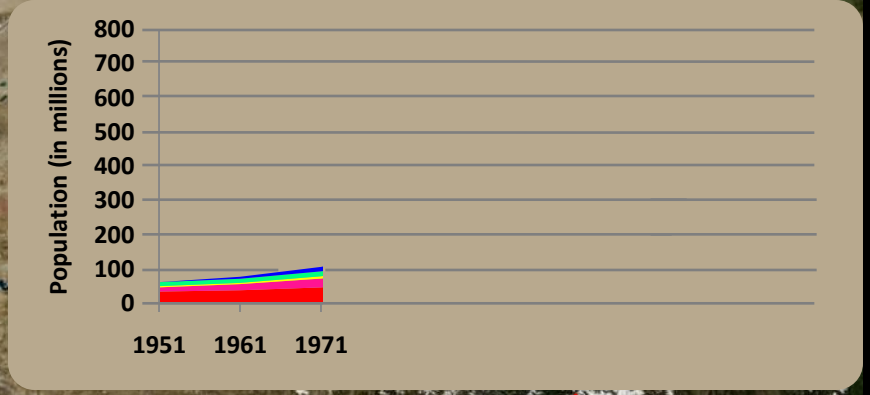
> 5

Source: Census of India, 1971-2001
UN, 2007



Large Urban Settlement Growth

1971



Urban Population Growth

Kolkata
(6.9)

Mumbai
(5.8)

Population Size
(millions)

< 0.1

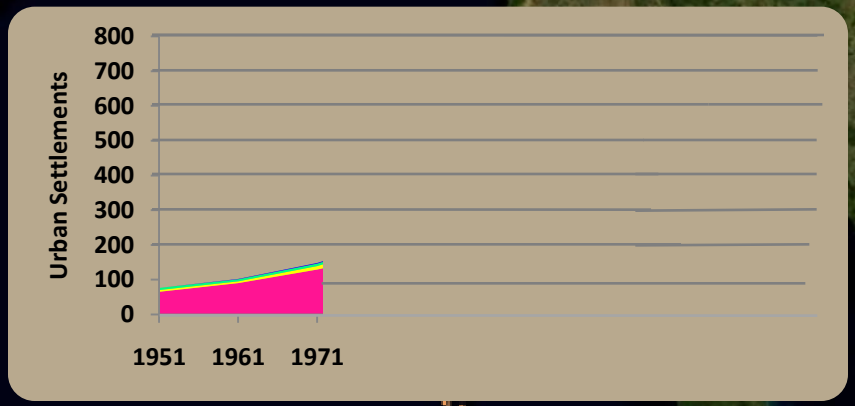
0.1 – 0.5

0.5 - 1

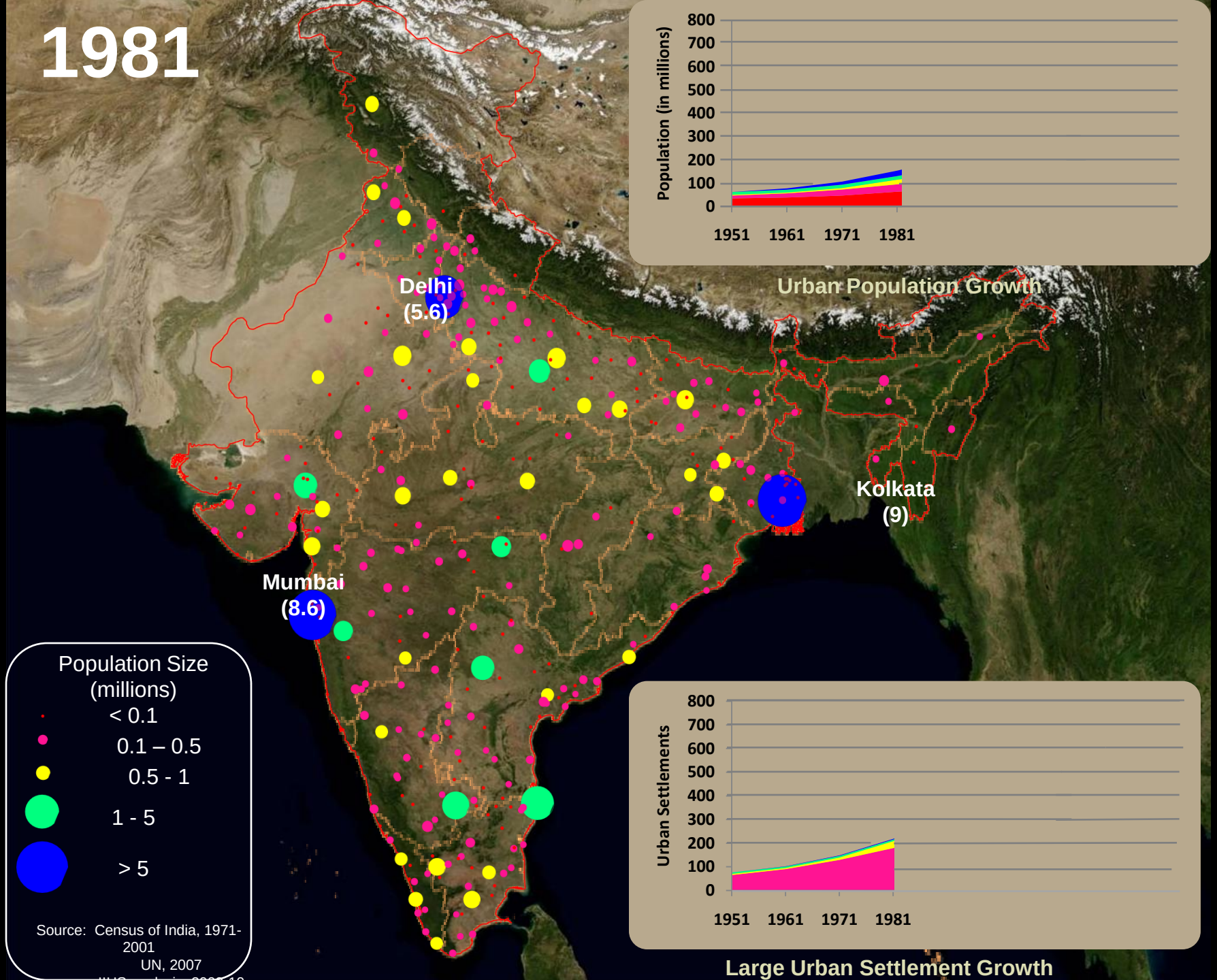
1 - 5

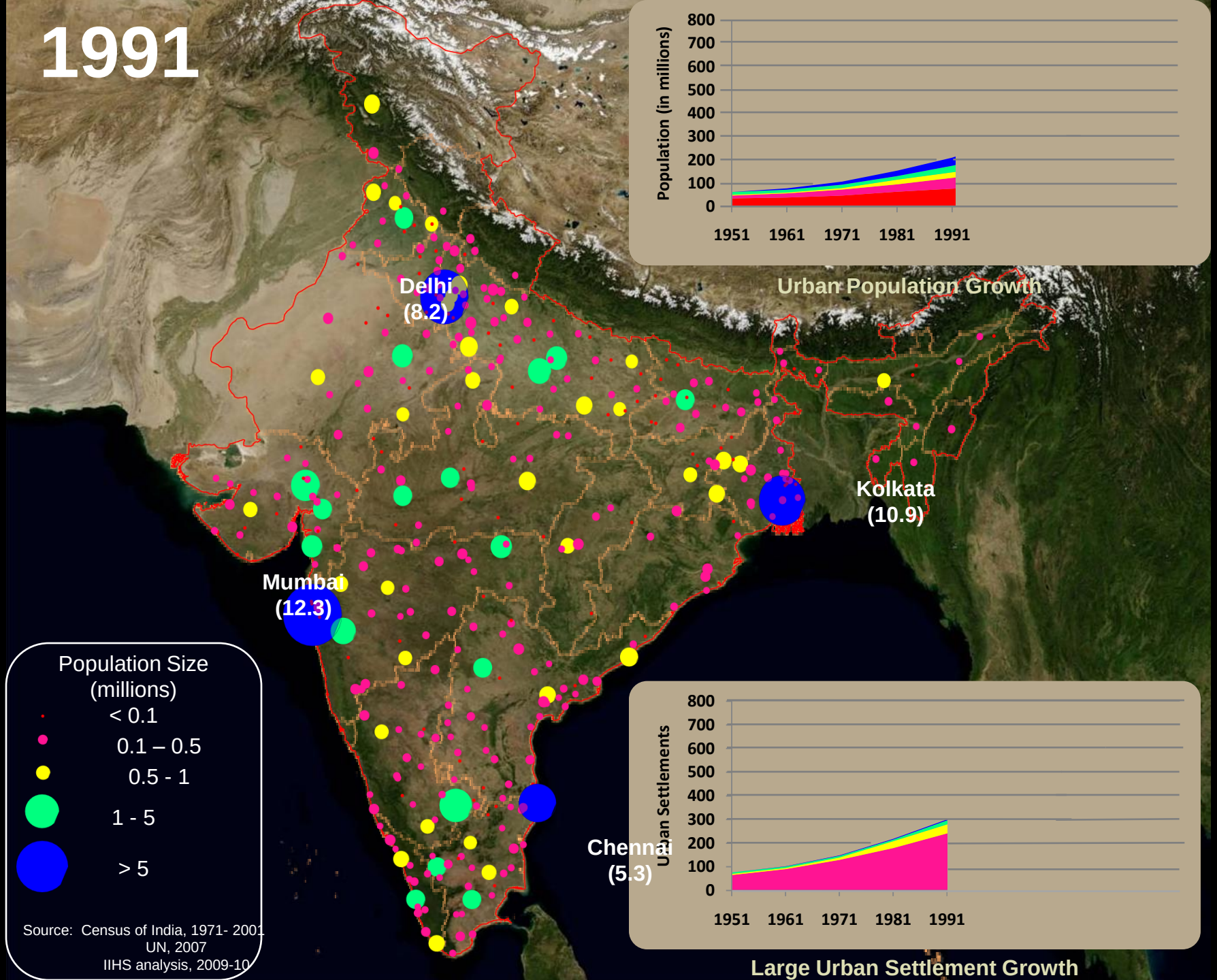
> 5

Source: Census of India, 1971- 2001
UN, 2007
IIHS analysis, 2009-10

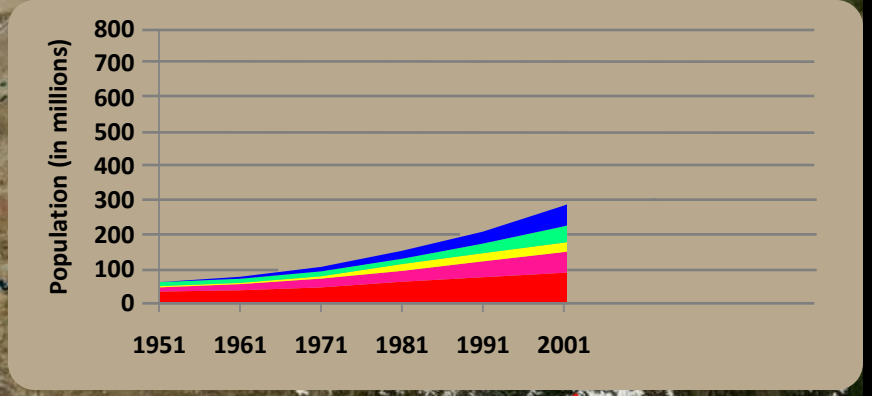


Large Urban Settlement Growth


1981
Delhi
(5.6)
Mumbai
(8.6)
Kolkata
(9)
Urban Population Growth
Population (in millions)
800
700
600
500
400
300
200
100
0
1951
1961
1971
1981
Urban Settlements
Large Urban Settlement Growth
Population Size
(millions)
< 0.1
0.1 – 0.5
0.5 - 1
1 - 5
> 5
Source: Census of India, 1971-2001
UN, 2007


1991
Population (in millions)
800
700
600
500
400
300
200
100
0
1951
1961
1971
1981
1991
Urban Population Growth
Delhi
(8.2)
Kolkata
(10.9)
Mumbai
(12.3)
Chennai
(5.3)
Urban Settlements
Large Urban Settlement Growth
Population Size
(millions)
< 0.1
0.1 – 0.5
0.5 - 1
1 - 5
> 5
Source: Census of India, 1971- 2001
UN, 2007
IIHS analysis, 2009-10

2001



Urban Population Growth

Delhi
(12.4)

Kolkata
(13.1)

Mumbai
(16.1)

Hyderabad
(5.4)

Bangalore
(5.6)

Chennai
(6.6)

Population Size
(millions)

< 0.1

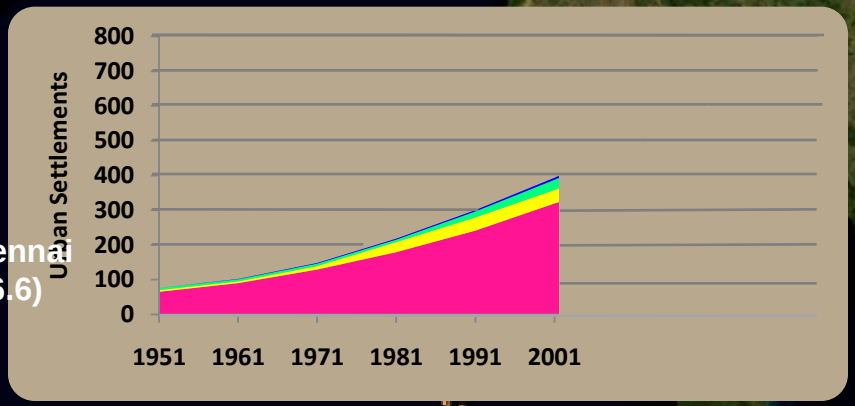
0.1 – 0.5

0.5 - 1

1 - 5

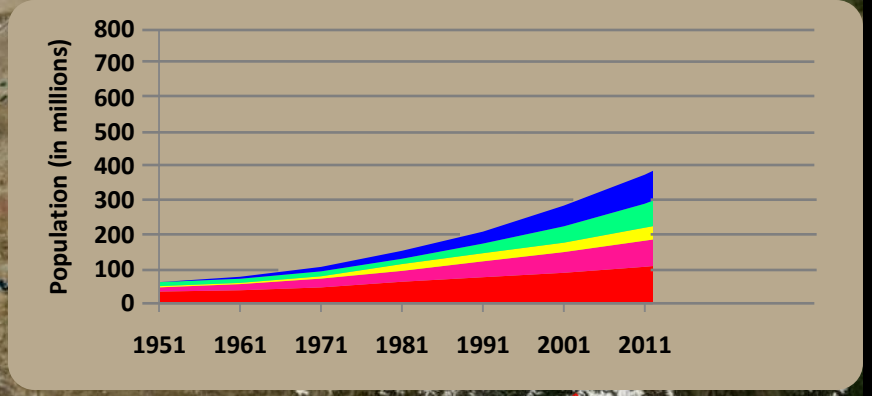
> 5

Source: Census of India, 1971- 2001
UN, 2007
IIHS analysis, 2009-10



Large Urban Settlement Growth

2011



Urban Population Growth

Delhi
(16.9)

Ahmedabad
(5.7)

Kolkata
(15.5)

Mumbai
(20)

Hyderabad
(6.7)

Pune
(5.0)

Bangalore
(7.2)

Chennai
(7.5)

Population Size
(millions)

< 0.1

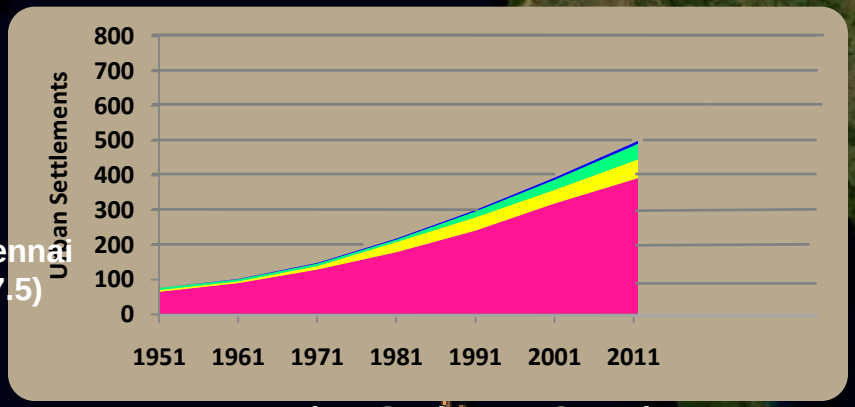
0.1 – 0.5

0.5 - 1

1 - 5

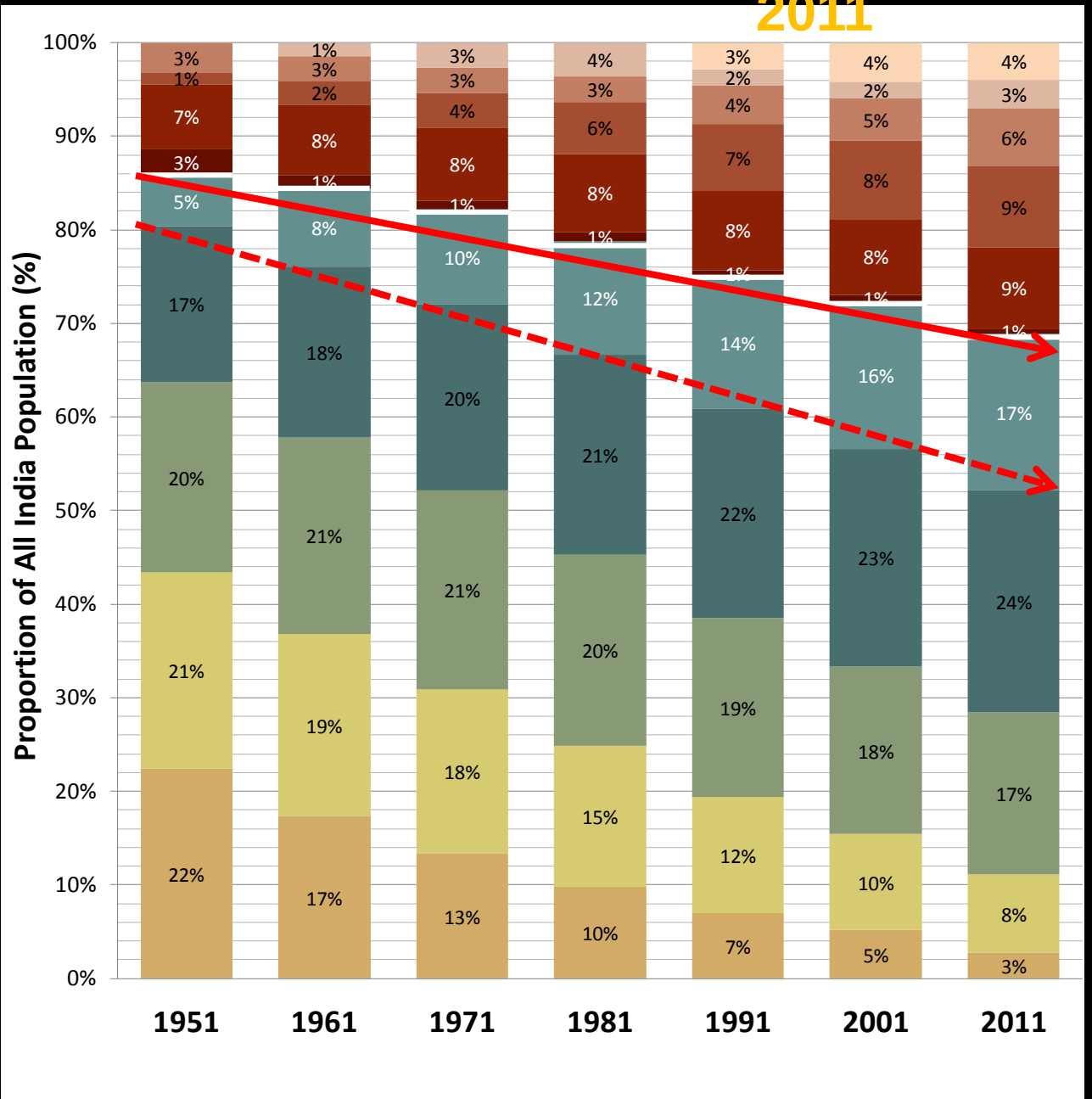
> 5

Source: Census of India, 1971- 2001
UN, 2007
IIHS analysis, 2009-10



Large Urban Settlement Growth

Distribution of India's Population by Settlement Size : 1951-2011



265m

Class I Cities

112m

Other Urban Centres

200m

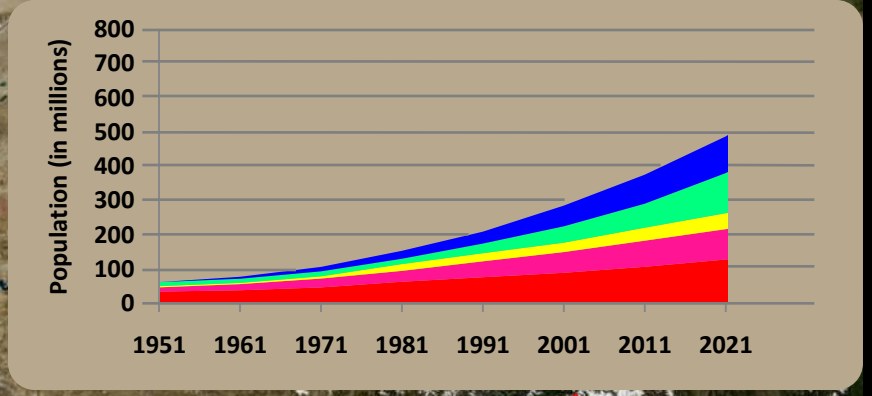
Large Villages

537m

Medium and Small Villages

Source: : IIHS, 2011

2021



Urban Population Growth

Delhi (20.4)

Ahmedabad (5.7)

Surat (5.1)

Kolkata (18.6)

Mumbai (23.9)

Hyderabad (8.2)

Pune (6.1)

Bangalore (8.8)

Chennai (9.1)

Population Size (millions)

< 0.1

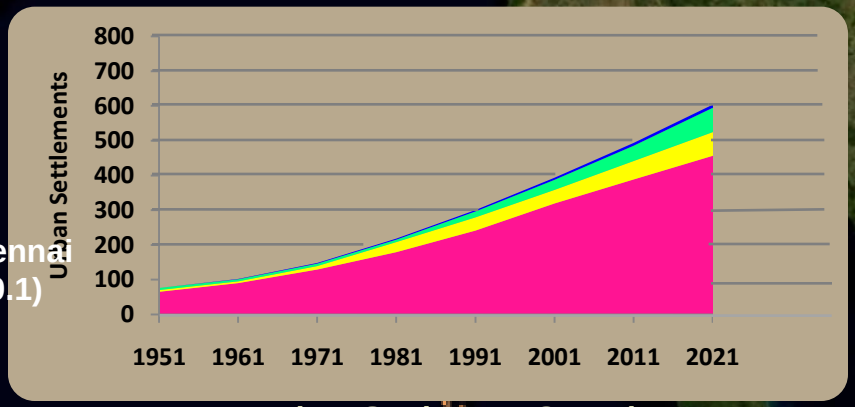
0.1 – 0.5

0.5 - 1

1 - 5

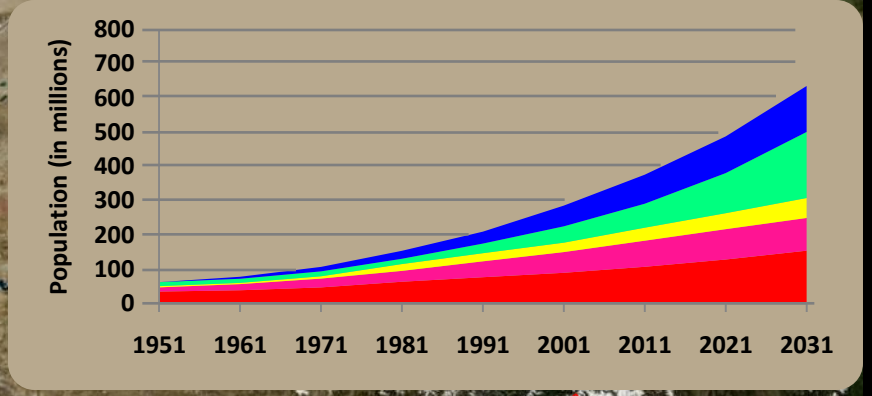
> 5

Source: Census of India, 1971-2001
UN, 2007
IIHS analysis, 2009-10



Large Urban Settlement Growth

2031



Urban Population Growth

Delhi (24.4)

Kanpur (5.1)

Ahmedabad (8.5)

Surat (6.3)

Kolkata (22.3)

Mumbai (28.6)

Hyderabad (9.9)

Pune (7.4)

Bangalore (10.6)

Chennai (11.1)

Population Size (millions)

< 0.1

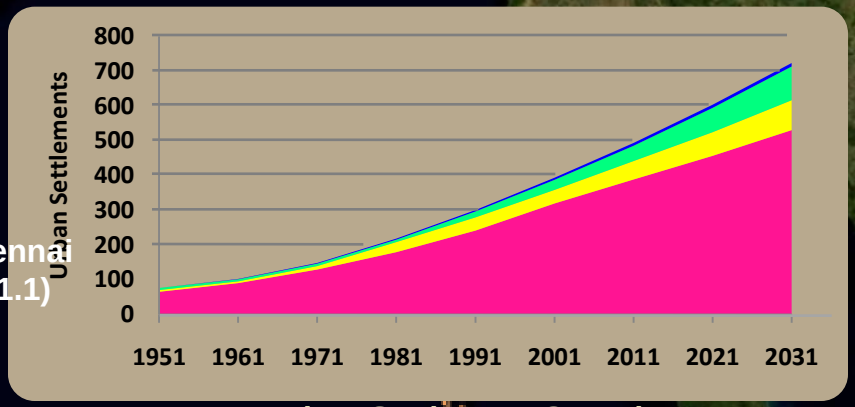
0.1 – 0.5

0.5 - 1

1 - 5

> 5

Source: Census of India, 1971-2001
UN, 2007
IIHS analysis, 2009-10



Large Urban Settlement Growth

Goa 2030:
the Challenge of Scale-up ..

Sustainable Forest, Food and Fisheries Production

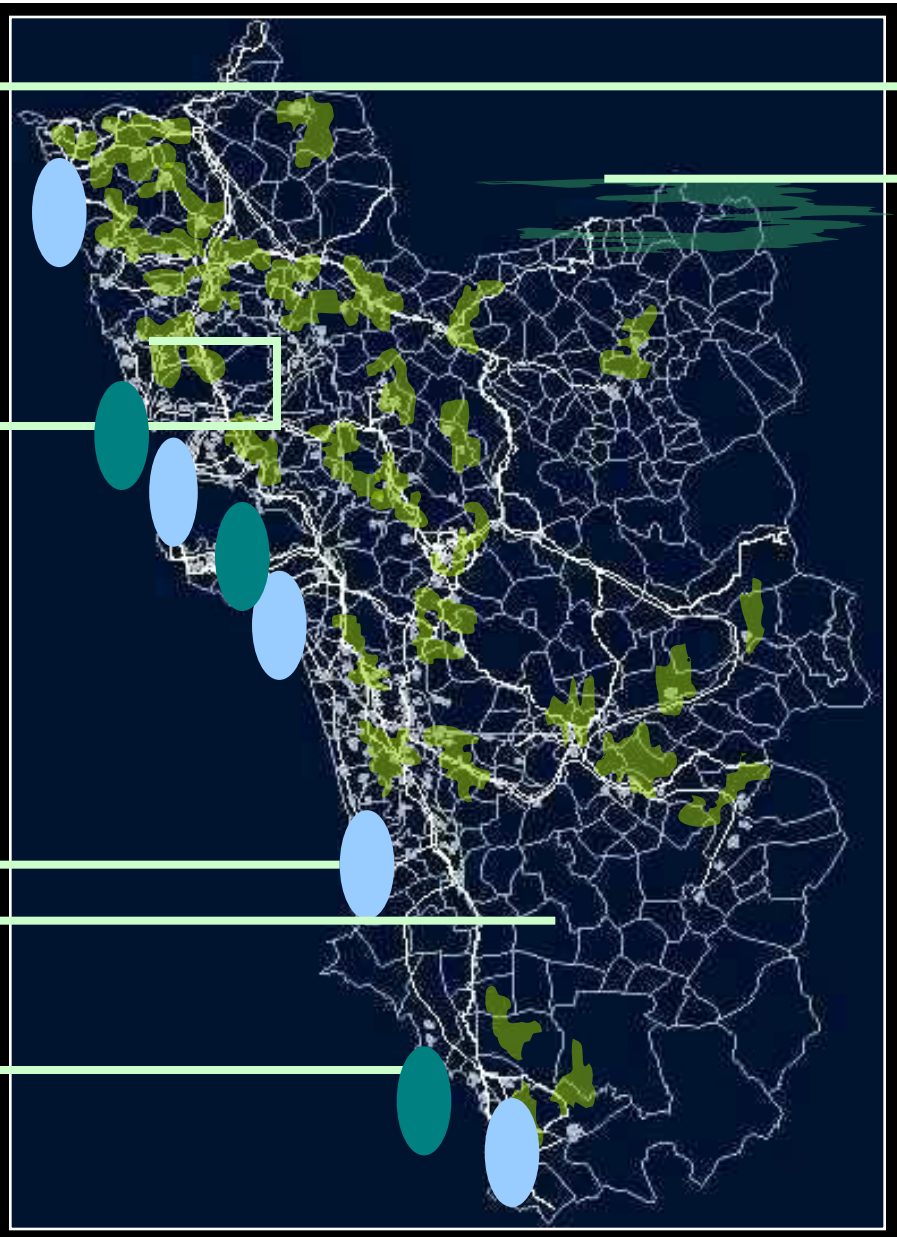
FOREST CONSERVATION ZONE

***RURBAN* AGRICULTURE ZONES**

DEEP SEA FISHERIES NODES

URBAN FORESTRY ZONES

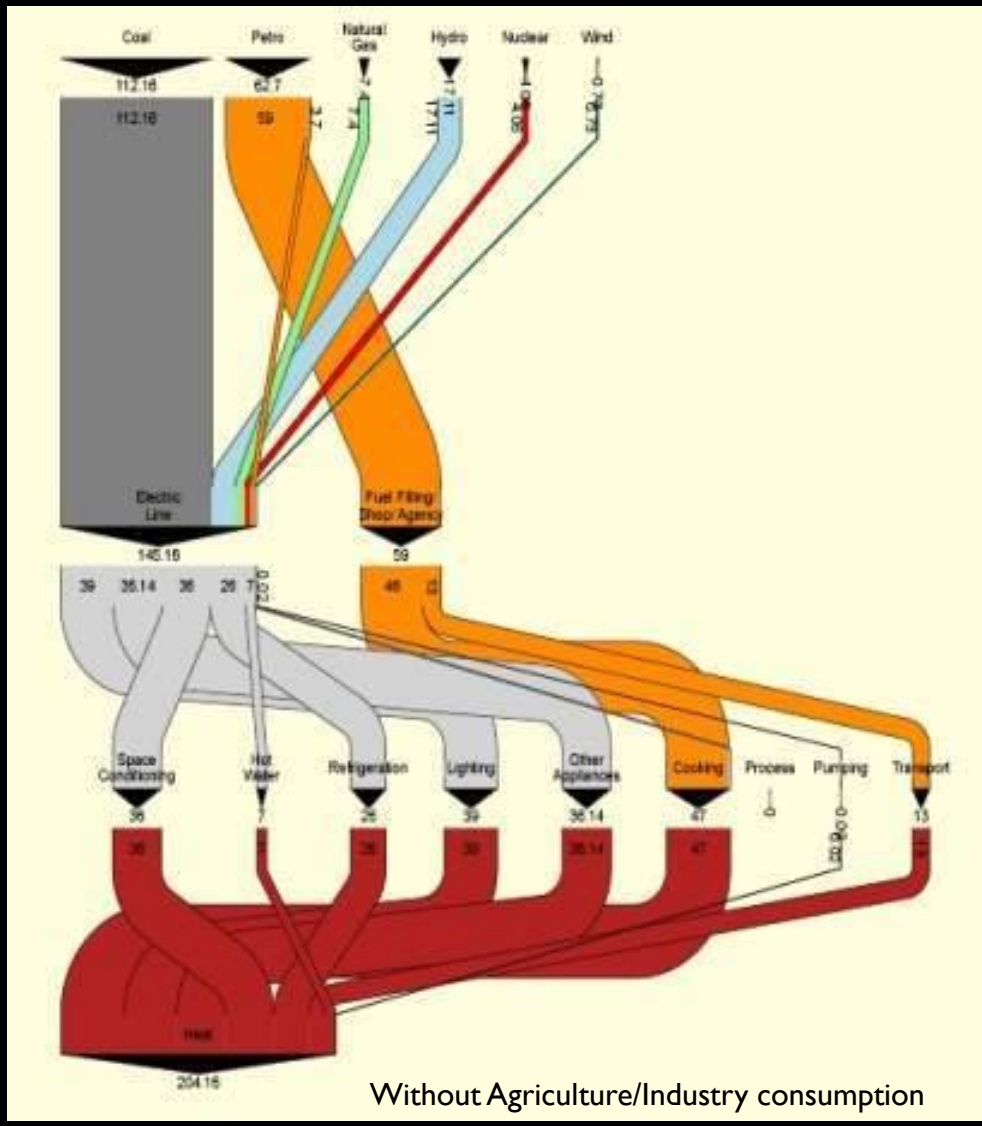
ESTUARINE FISHING NODES



Goa 2030: Energy Futures

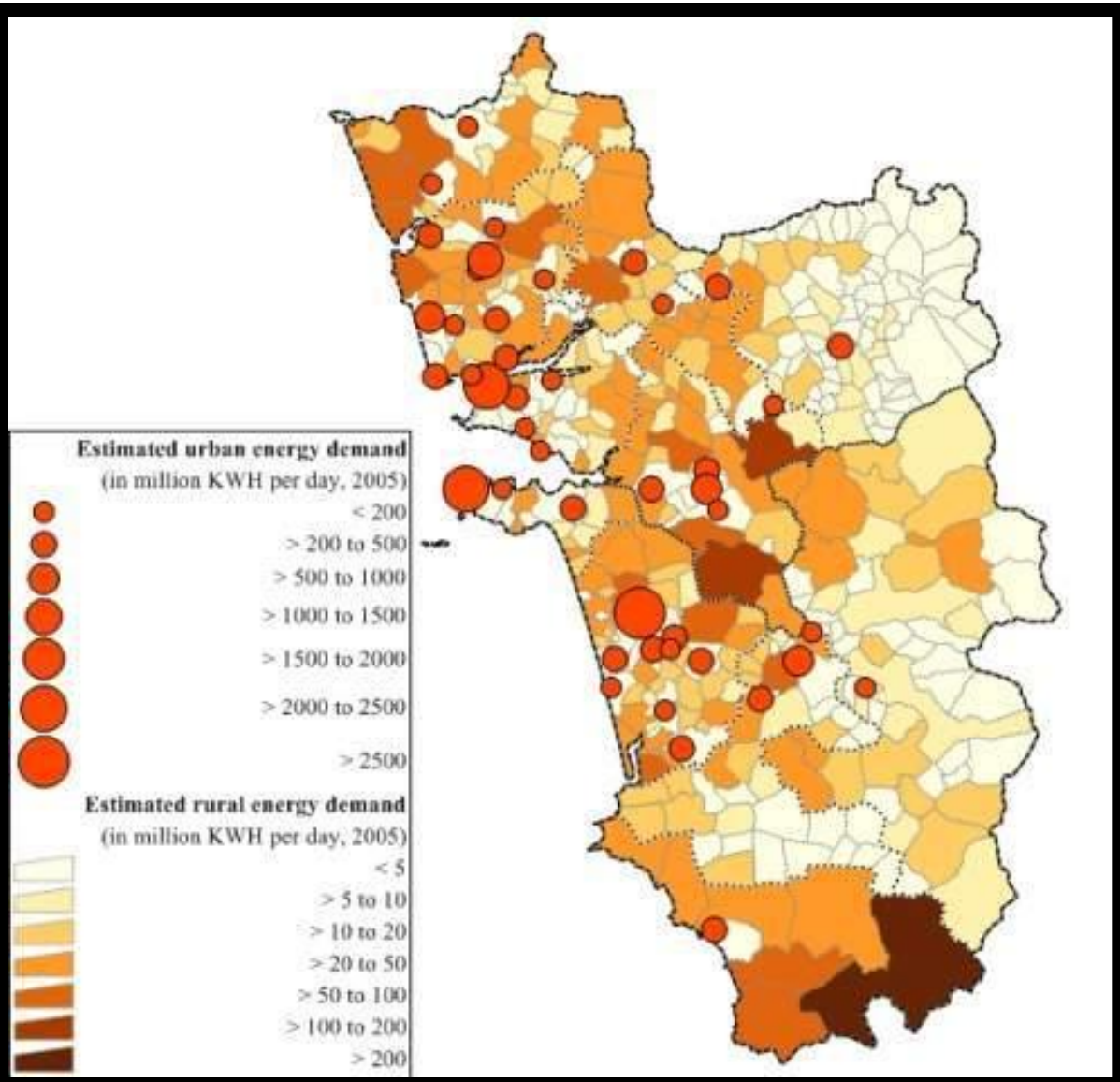
Goa Urban Energy Consumption (2005)

- Main sources: Electricity and LPG
- Relatively high demands
- No heat recovery or efficiency



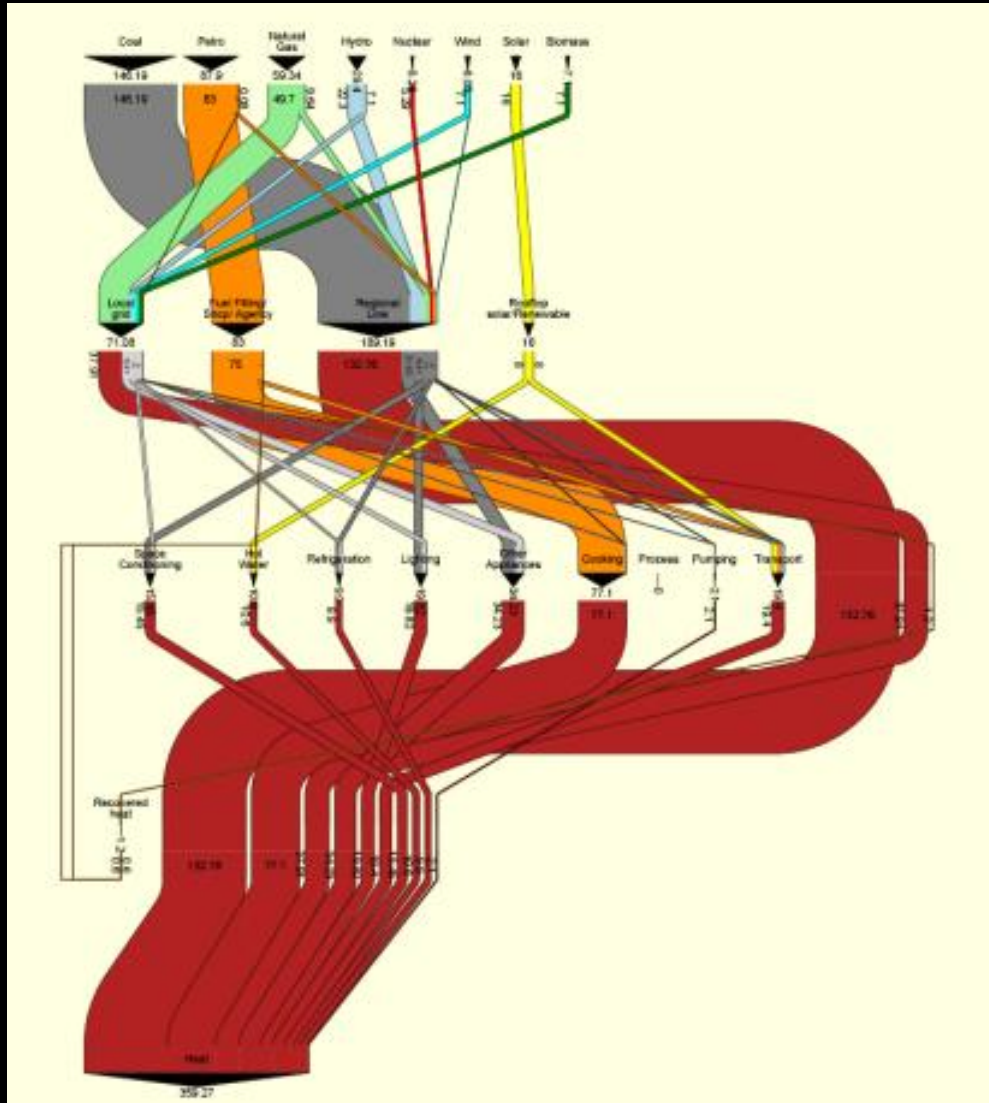
Goa Consumption Energyscape (2005)

- Great difference between rural and urban demands
- Specific energy consumption is low



Sustainable Goa Energy Fluxes (2030)

- Two grids: Local and Regional
- Local Grid is Fed by Gas, Wind, and Biomass
- Increasing Demand with Conservation
- Moderate heat recovery
- Moderate rooftop harvesting



Without Agriculture/Industry consumption

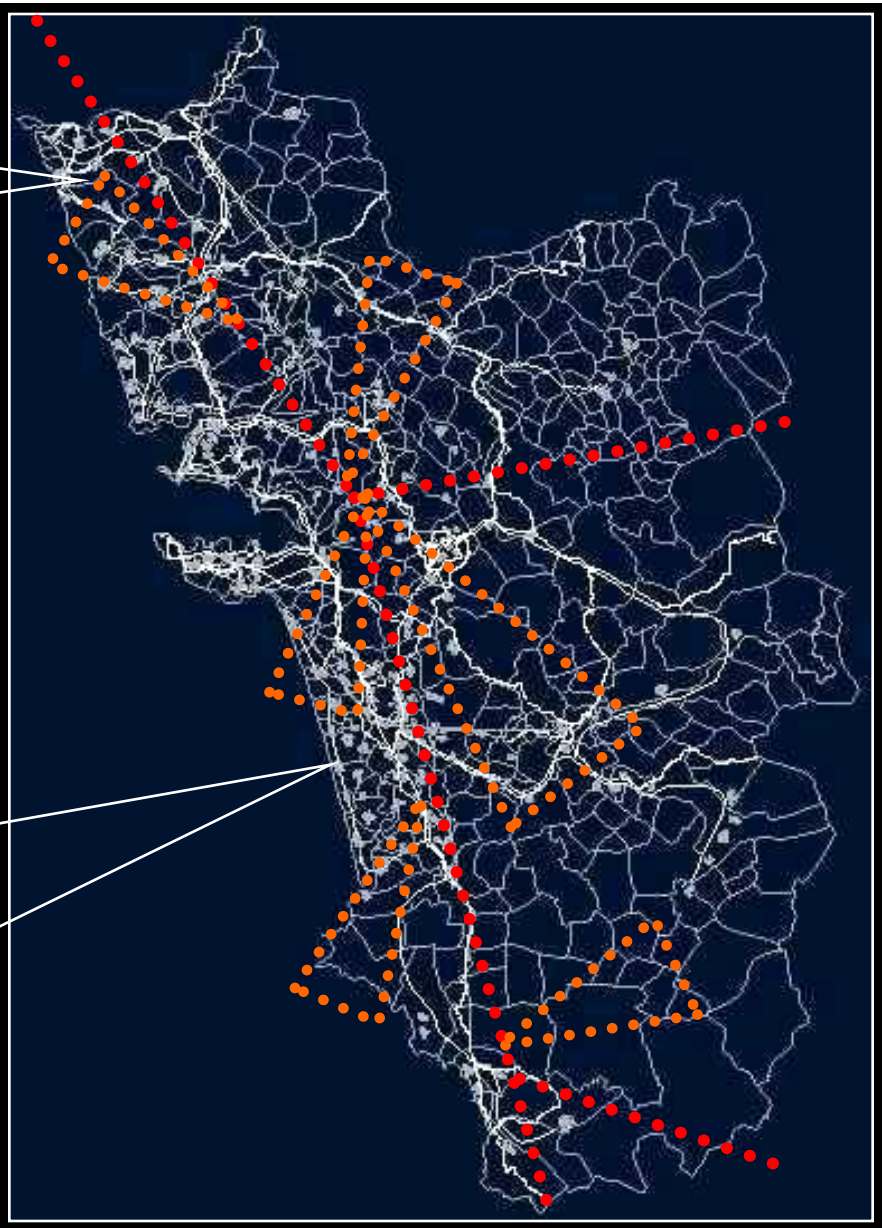
500 MW of terrestrial & 1000 MW off-shore wind power

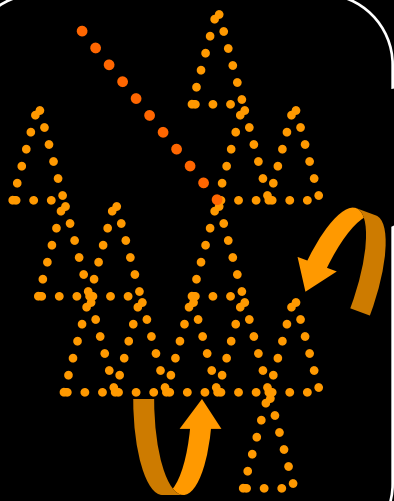
TERRESTIAL
WIND FARMS

OFF-SHORE
WIND FARMS

Two way Power networks & a possible Gas network

BIO-GASIFIERS





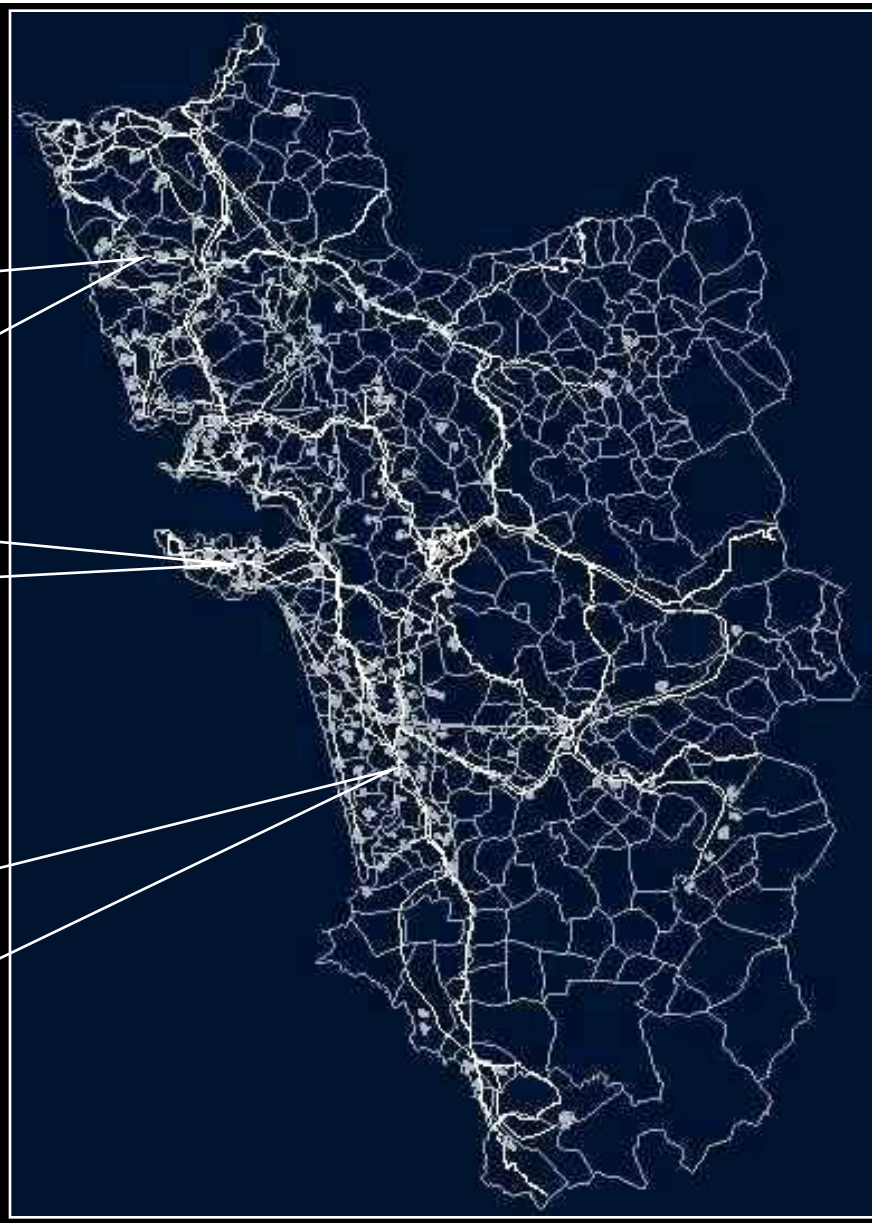
LOCAL NETWORKS

Other Renewable & Soft Power sources

SOLAR WATER HEATING

TRI-GENERATION

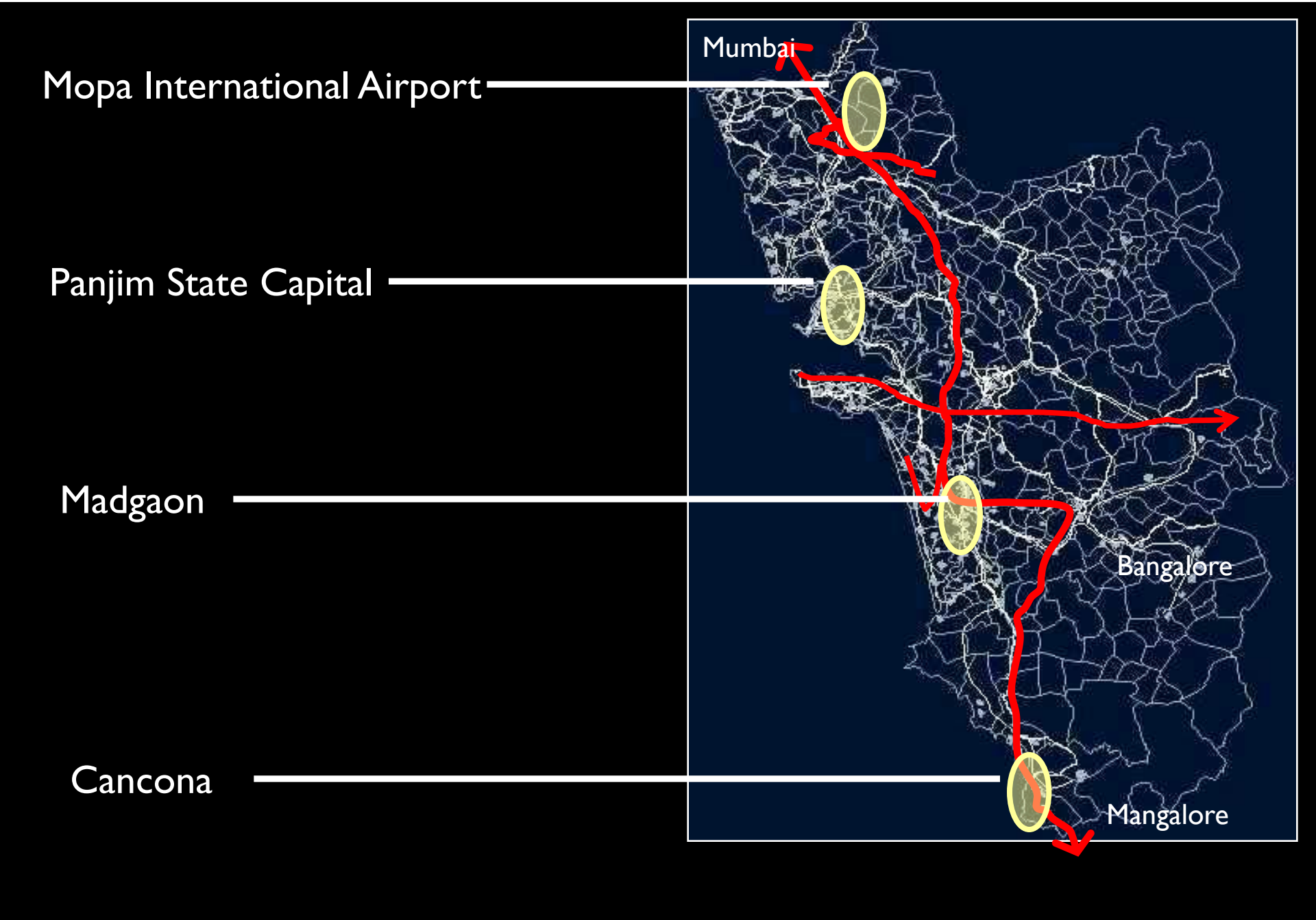
BIO-METHANATION



Offshore and onshore wind turbines punctuate the Panjim skyline by 2030

A Key Change Driver:
Sustainable Transportation Networks

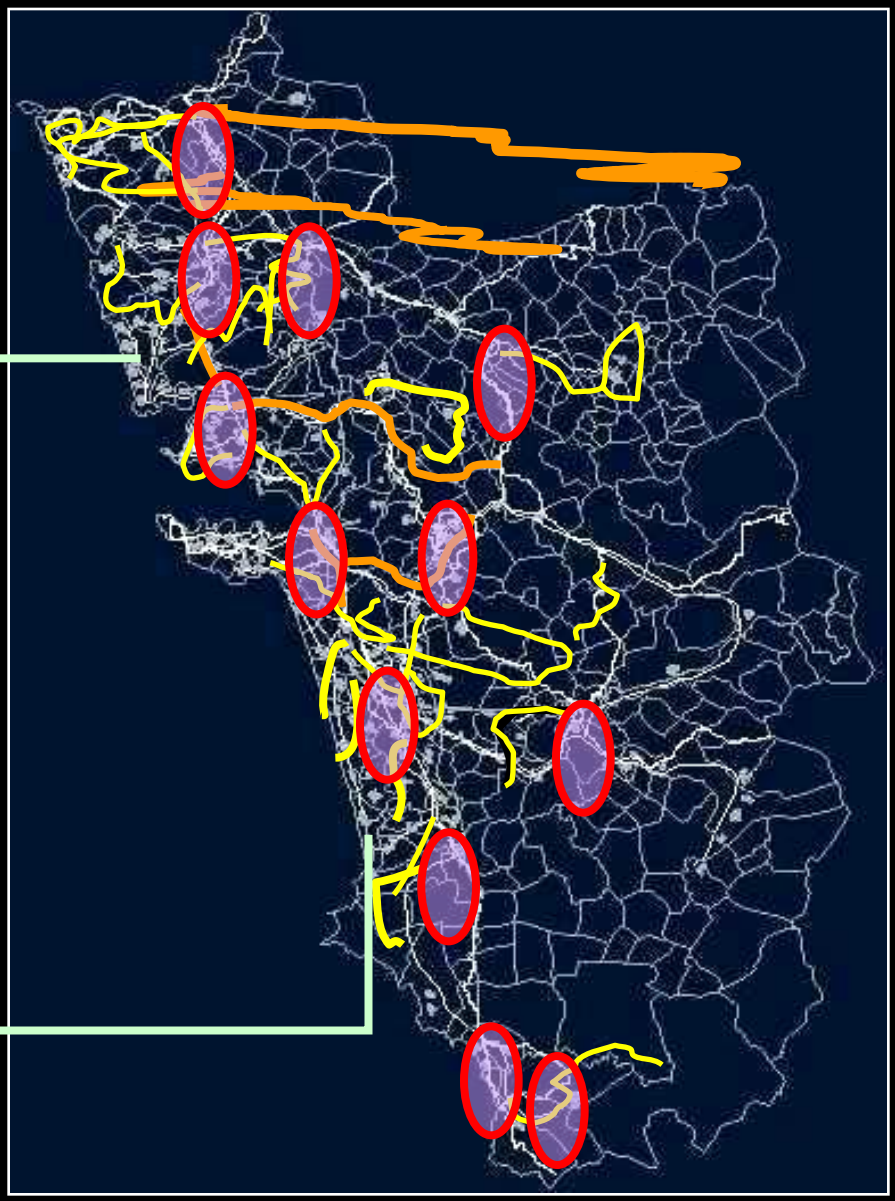
High Speed Inter-regional Rail corridor



Intercity Light Rail & High Capacity Bus systems

INTERCITY LIGHT RAIL NETWORK

INTER-NUCLEI HIGH CAPACITY BUS SYSTEM NETWORK



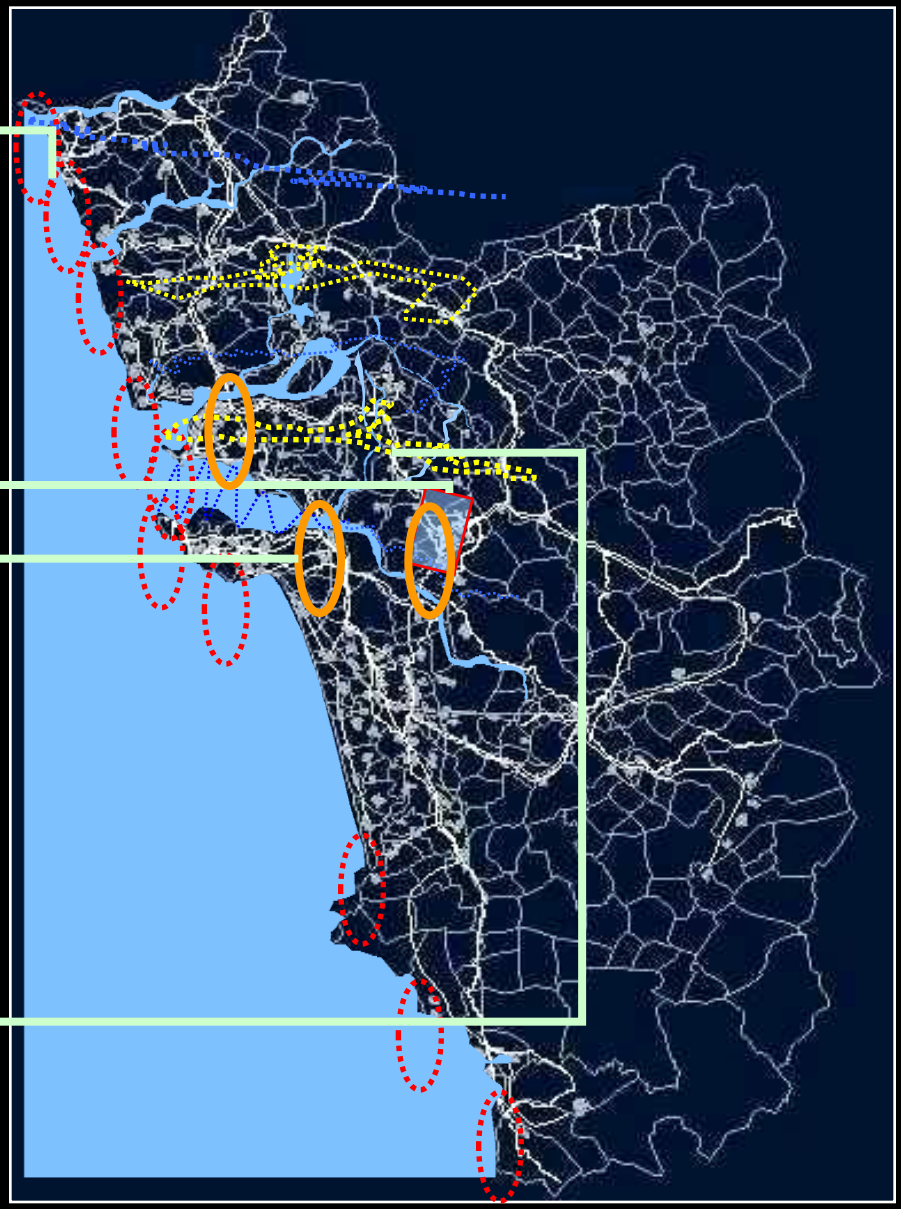
Hydrofoil and All season River Transport Systems

HYDROFOIL NODES

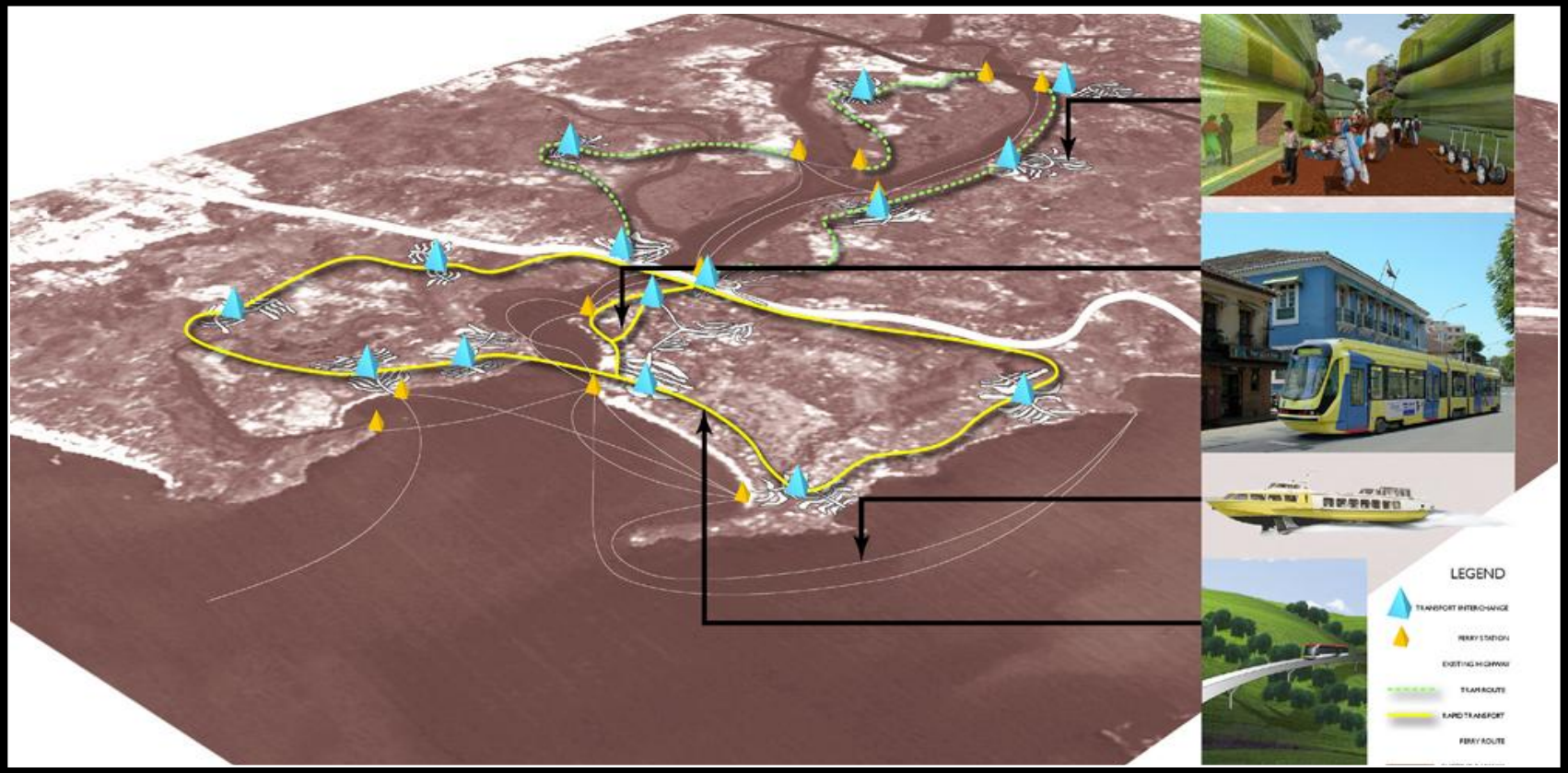
NEW CANAL NETWORK FOR MAJOR URBAN CENTRES

THREE INTRA-MODAL TERMINII

SOLAR FERRY NETWORKS



RUrban scale Mobility systems



Key Change Driver:
Clean ‘Factor 4’ Manufacturing

‘Green’ manufacturing zones

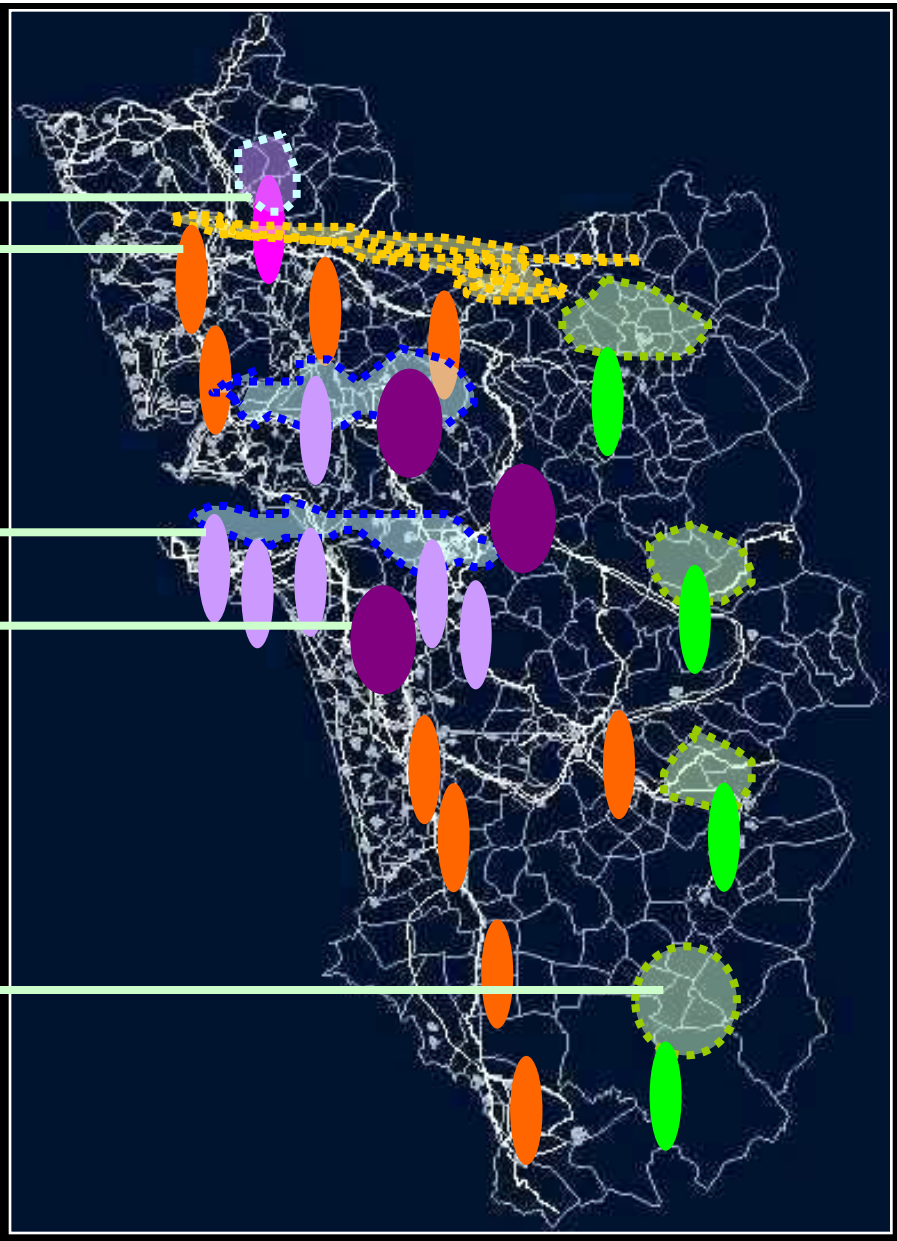
AEROSPACE HUB

ADVANCE MATERIAL MANUFACTURING UNITS

GAS BASED UNITS

LARGE ‘GREEN’ MANUFACTURING NODES

BIOTECH AND PHARMA UNITS



Key Change Driver:
Service-sector led development

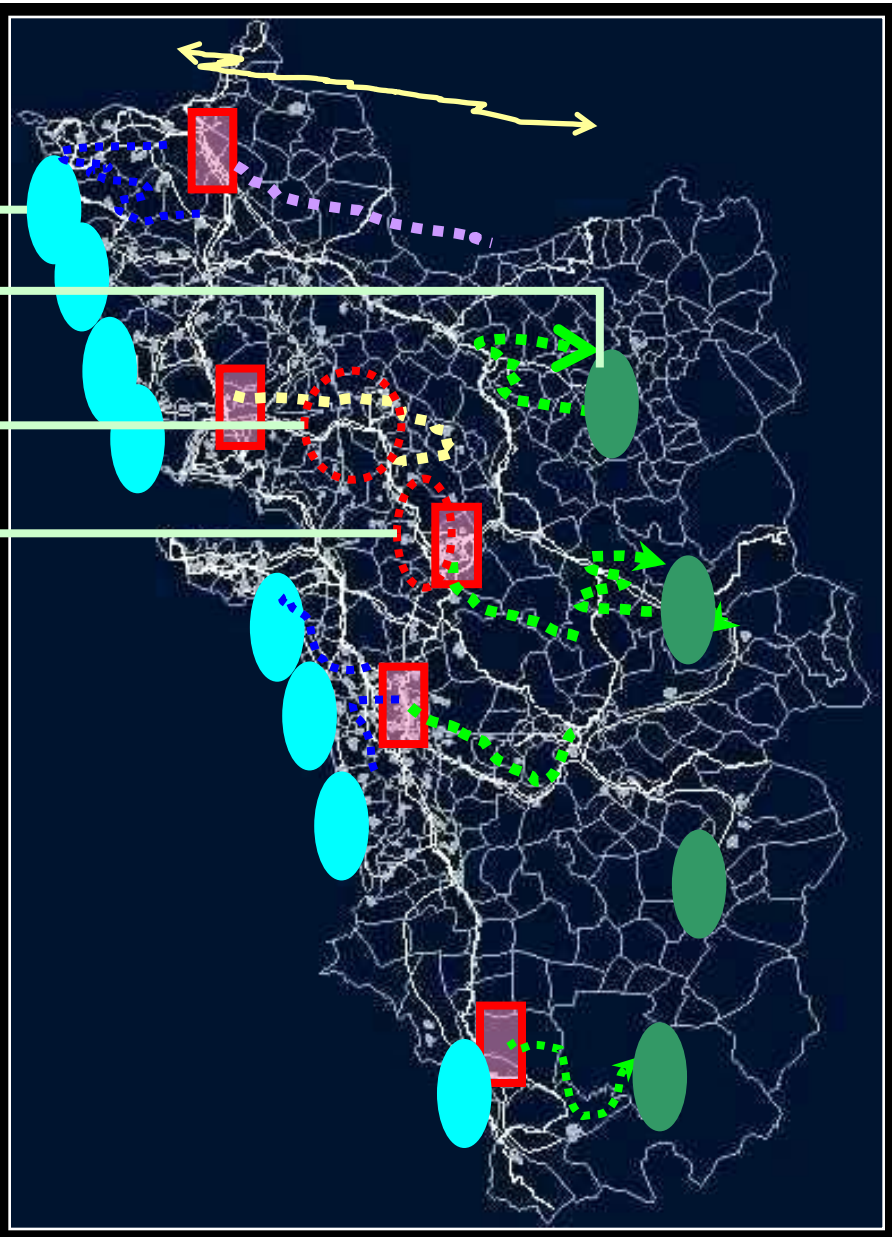
Tourism Networks

BEACH TOURISM NETWORK

ECO- TOURISM NETWORK

HERITAGE TOURISM NETWORK

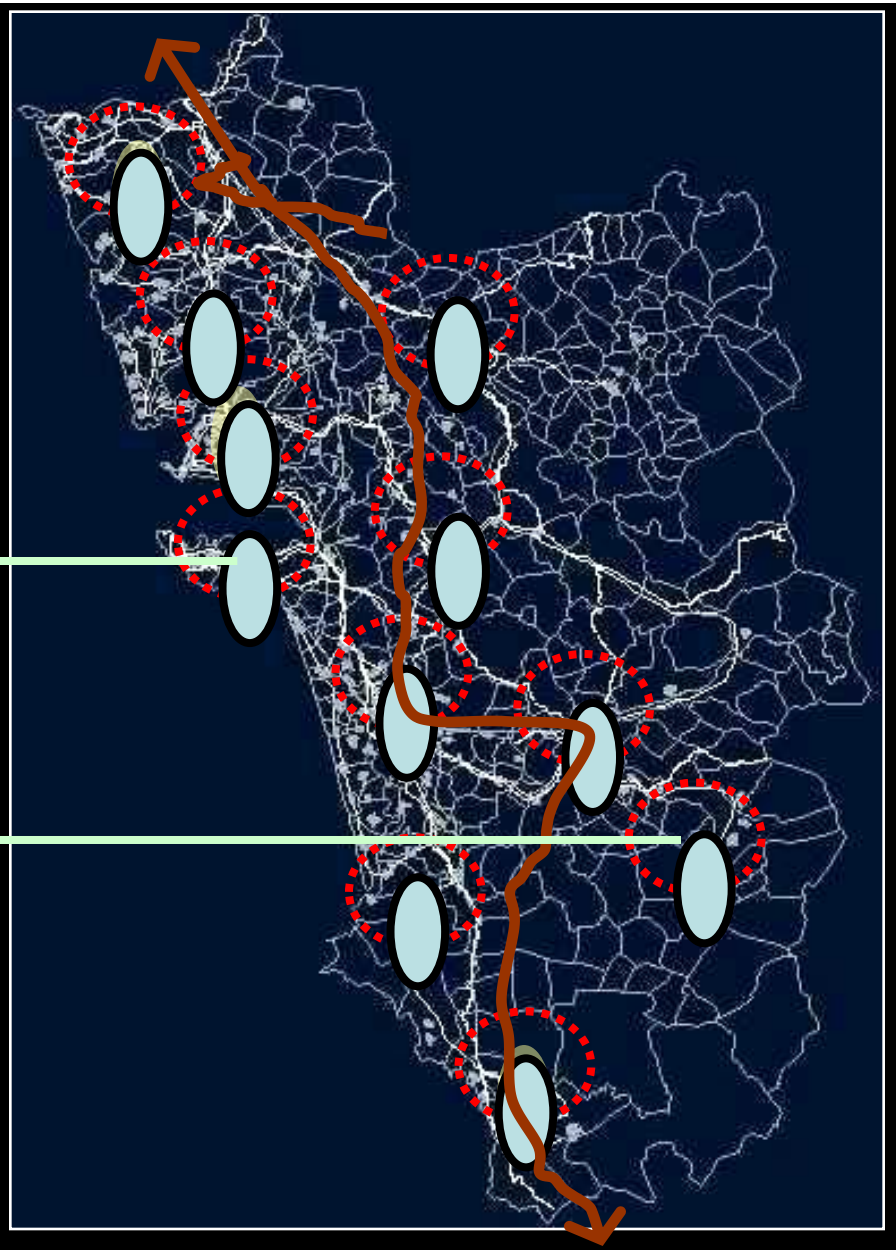
RELIGIOUS TOURISM NETWORK



Wellness nodes & networks

HEALTH TOURISM NODE

LOCAL HEALTH NODE



Educational & Technology networks

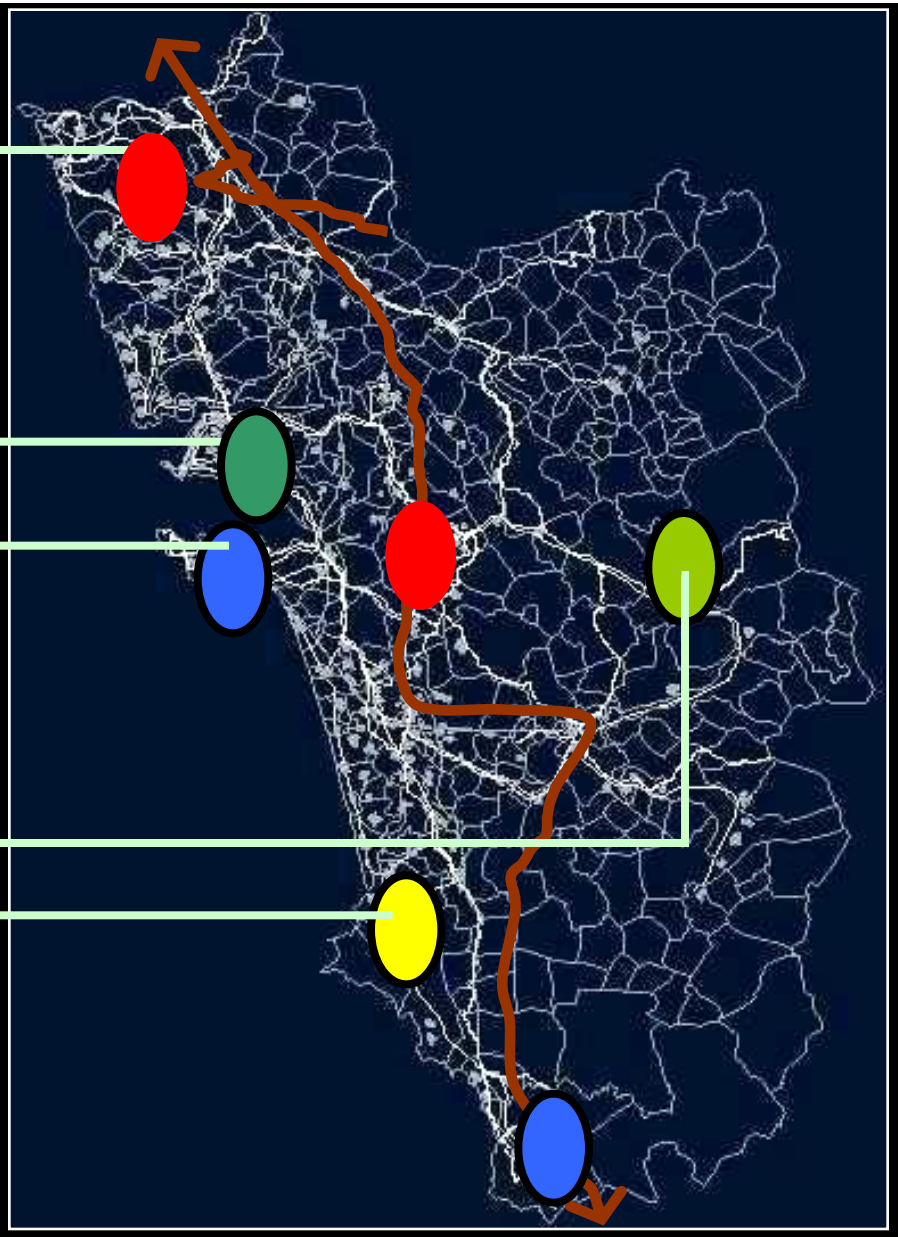
ICE TECHNOLOGY PARK

INDIAN HABITAT SCHOOL

TECHNICAL SCHOOLS

BIOTECHNOLOGY PARK

BUSINES SCHOOL



Goa 2030: Sustainability Investment Plan (2005-2030)

A Sustainability transition is economically and financially viable within the following envelope:

- A 30-year transition to a service-sector dominated economy with low material-energy throughput
- Steady improvement in the quality of life, but voluntary restraints on unsustainable consumption combined with efficiency, dematerialisation and high savings rates
- An investment of between $ 15 to $ 18 billion over 30 to 50 years, financed by internal using soft credit and innovative financing mechanisms e.g. CDM

Conclusion

Four Transformative Challenges for Sustainable Habitat

- Transformation of exploitative and an increasingly unsustainable agrarian and Biomass-based economy to become more equitable, productive, eco-efficient and resilient (Mollison 1990)

- Transformation of industrial ecologies from linear source to sink processes to resource-conserving cyclic processes with dramatically lower environmental impacts (Hawken et. al. 1999).

- Reversal of the livelihood shift from industrial employment back to sustainable ecological services (e.g. sustainable agriculture, ecosystem services management and recycling) (Revi. et. al. 2006)

- Within the Knowledge Economy spreading the access to and benefits further along with a greater emphasis on dematerialization, lifestyle choices and embracing more community-oriented initiatives (Revi et. al. 2006)