THE IMPACT OF URBANISATION

Infrastructure variables

Summary

This paper deals with the impact that future urbanisation could have on medium-sized cities, drawing on work by the OECD and others. It has been prepared to help members of the SCAD (Social Change and Development Group) to think about their long-term future, and uses Thirunelveli, a medium sized city in Tamil Nadu, as a case study.(see Appendix) The paper identifies the various forms of infrastructure that will affect growth, different forms of growth, and potential sources of technical and other help. It concludes by identifying the main variables that will affect the growth of cities, and considers the possible environmental impact or sustainability of different sizes and shapes of cities

Challenges for urban infrastructure

The growth of towns and cities is almost inevitable so long as resources allow, given demographic trends and demands for higher living standards.[1] Less certain is the impact of urbanisation, which depends not just on where development takes place, but also the quality and level of infrastructure. Infrastructure includes not just 'hard' physical provision, such as energy, water, waste and transport, but also 'soft' facilities such as education and health facilities. The impacts can include not only physical factors, such as pollution or congestion, but also economic factors, such as business development, employment and incomes, and just as importantly social factors, such as equality and health.[2] Demands on over-stretched water resources, for example, can lead to famine and wars, yet at the same time large amounts of water go to waste through leaky pipes or inadequate reservoirs.[3]

Though infrastructure is essential for development it often lags behind, as it largely paid for out of public expenditure or taxes. This can produce adverse consequences, such as rising inequalities as poorer people are squeezed into living in the worst places or forced to move far away from work or services. At the worst conflicts can break out in riots or civil war that destroy towns and cities. Inequalities can also worsen if food becomes harder to obtain, for example if development takes over productive fields and people can no longer grow their own food, or poorer people have to spend more time and money getting to work. The Rockefeller Foundation, in its work on Resilient Cities, categorise the root causes as urbanisation, globalisation and climate change, which may seem too big a challenge for any city to tackle. Significantly one of the Foundation's main themes is Transportation and Infrastructure www.rockefellerfoundation.org

Yet properly planned and managed, development not only raises living standards, but also can help pay for improvements to infrastructure. For example, higher density neighbourhoods

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[1] Edward Glaeser, Triumph of the City: how urban spaces make us human, Pan Books 2012
[2] Judith Rodin, The Resilience Dividend; being strong in a world where things go wrong, 2014
[3] Fred Pearce, When the Rivers Run Dry; what happens when our water runs out? Transworld Publishers 2007

can make it easier to walk to jobs or services, and support better quality public transport than is possible in dispersed rural villages. Similarly better housing can cut time wasted in fetching water and also can improve health through improved sanitation. Tree planting can cool streets, and save energy, and piped water can save lives as well as wastage. Community development can build social capital, and help create jobs in small enterprises, which can be easier when more people live closely together. With adequate natural resources and careful management, 'smarter growth' should pay for itself, and create a legacy that future generations can enjoy.[4]

The impact of urbanisation

The importance of infrastructure to the growth of cities has been recognised for thousands of years, and we still marvel at Roman aqueducts and cisterns that enabled urban populations to thrive. Today many cities are growing faster than their infrastructure can support, leading to appalling air quality in capital cities such as Delhi and Beijing, and to the loss of underground water reserves in rural areas, while cities such as Chennai suffer from flooding. While there is no simple formula, research into building sustainable communities suggest we are using up resources far faster than we are replenishing them: for example in India water is being extracted from underground at two and half times the rate it is being replenished by rains, leading to ever deeper wells and acute hardship.[5] Yet higher agricultural productivity is essential to supporting the long-term shift of population into urban areas.

The technical solutions are largely known, and being applied in some places, for example Israel. However there are major institutional barriers to be overcome before they are applied more widely and on the scale required. For example a study of Indian cities concluded that *'urban planning is probably one of the most straight-forward means through which the green agenda (ie protecting the natural environment) and the brown agenda (ie protecting human growth0 can be effectively linked. Unfortunately this linkage has been hitherto missing in the Indian urban planning systems'*[6]. Just as in the UK, pressures to produce short-term results and the dominance of business and property interests leads urban sprawl, as those who can move further out, while the poor get concentrated in the worst locations.

To find out what leads to successful urbanisation, recent research by the OECD examined 1200 cities across 29 OECD countries. The report found that 275 metropolitan areas with more than 500,000 residents accounted for half the total population and also produced half the OECD countries' economic growth between 2000 and 2010.[7] The OECD argues that larger cities do better than smaller ones because they appeal to the most talented young people, have higher levels of economic productivity and innovation, and lower environmental costs thanks to better public transport and higher densities of development. In short they enjoy what economists call 'agglomeration economies'. However diseconomies can set in once a certain size is reached, as people have to spend too much time travelling, air quality

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[4] Jeffrey Sachs, Common Wealth: economics for a crowded planet, Penguin Press 2009
[5] Fred Pearce op.cit.
[6] Chetan Vaidya, Sustainable Urban Form, National Institute of Urban Affairs, March 2011
[7] Metropolitan Century: urbanisation and its consequences, OECD Publishing Paris 2015

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suffers, and poorer areas suffer from an image for crime and disorderly behaviour as disparities widen.

Currently cities contribute 60% of India's Gross National Product compared with 18% for agriculture but only house 31% of the population[8]. Half the population still work in agriculture, so further movement to cities is almost inevitable, especially as younger people seek to make the most of their education and as the economy grows. Furthermore Indian cities are very imbalanced with four 'mega' cities, of which Chennai is one, counting for most of the economic and population growth. The contribution of cities to national GNP is forecast to rise to 75% in the next 15 years, but the rate of urbanisation has so far been much lower than in comparable countries such as Brazil, Russia, and China. Hence there are major questions about the direction growth will take, with the likely shift of people from marginal villages to over-crowded towns and cities.

Levels of investment, especially in infrastructure, are low in India compared with China, leading to complaints from businesses about poor roads, and erratic energy supplies. According to an expert report for the Indian government quoted by in an Arup study for the Rockefeller Foundation, approximately £640 billion needs to be invested in urban infrastructure and services by 2031 if India is to maintain and accelerate economic growth. This calls for new forms of local investment, as municipal corporations are often under-funded., and are widely perceived as corrupt.[9] It may also call for medium sized cities to grow much faster than they have been doing by developing sustainable urban extensions or new satellites or by developing waste land near their centres that can be linked to existing infrastructure. This will put extra strains on their management capacity and finances, but will also create new sources of jobs. A case in point is water, where according to one study of world supply and demand, *'Water availability in India is projected to decline from 1,820 cubic metres per year in 2001 to 1,140 cubic metres per person per year in 2050 as a result of population growth alone'.*[10]

Infrastructure variables

Further urbanisation calls for prioritisation as well as concentrating development where there is most infrastructure capacity. A useful analysis of urban form for the UK Government's Foresight Programme on the Future of Cities sets out the main elements or variables of infrastructure which affect growth.:[11]

a. The energy sector: includes electricity, gas, solar, wind, other renewables and all their ancillary 'hardware' e.g. power stations (nuclear, coal, oil, gas turbines, combined heat and power systems), grids, wind turbines, photovoltaics, and gas pipelines. 8

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[8] Report on Opportunities and Barriers to Urbanisation, Arup for the Rockefeller Foundation, 2015
[9] HPEC report 2011 quoted in Arup's briefing
[10] Alok Joha, The Water Book, Headline Books 2015
[11] Katie Williams, Urban Form and Infrastructure: a morphological review, Future of Cities Foresight Working Paper, Government Office for Science, 2014

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b. Transport sector: includes road, rail, air, cycling and walking and all the supporting facilities e.g. the trunk road network, rail network, stations, airports and seaports, cycle ways, and pedestrian facilities.

c. Water supply sector: includes all infrastructure needed to supply domestic and nondomestic users with water at appropriate quality and quantity, with facilities that source water from rivers, estuaries, coasts and groundwater sources through a system of water treatment plants and pipes to end users.

d. Waste-water sector: infrastructure required to process and dispose of waste water e.g. the system of sewers, pumps and sewage treatment works.

e. Solid waste sector: infrastructure required to process and/or dispose of domestic and non-domestic waste, including the system of transfer stations, recycling and other processing facilities, land fill sites, and incinerators.

f. Information and communication technologies (ICT): comprises all communication and computation systems, including: fixed and mobile telephony, broadband, television, navigation systems, data and processing hubs, with the associated 'hardware' of: wired and wireless networks (cables, masts, satellites), broadband, voice, data, positioning and broadcast services.

g. Cultural and social infrastructure sector: comprises facilities needed to keep the population healthy, educated, and with access to culture. This includes education facilities (e.g. schools, colleges and universities), health facilities (e.g. doctors' surgeries and hospitals) and cultural facilities (e.g. museums, galleries, community venues)

. h. 'Green' and 'blue' infrastructure: the interconnected networks of land and water that support species, maintain ecological processes, sustain air and water resources, and contribute to the health and quality of life of communities and individuals (Olofsdotter et al., 2013)

As the infrastructure variables are so complex and inter-related, it will become ever more important for medium-sized cities to plan how they grow. As cities grow in population or economic activity, they consume more services, such as energy, and require more capital to supply them. Building new houses is not enough. URBED's studies of British growth suggest that the infrastructure cost of a new home is as much as the construction cost.[12] As an example the expected growth of Cambridgeshire, with its very successful high tech. sector, would result in an infrastructure cost of £55, 000 per home, of which 57% is transport, 14% health, 12% utilities and 10% education, with a number of other smaller cost items.[13]

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[12] Nicholas Falk, The Steps to Quality Growth: towards a new business model for house-building, URBED for Cambridgeshire Horizons, 2010
[13] Study by Deloittes for Cambridgeshire Horizons

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An analysis based on British capital investment, which was used in URBED's Wolfson 2014 Economics Prize winning submission, shows that urban extensions offer a better return than totally new settlements because they can take advantage of existing infrastructure. If development is located where it can take advantage of existing or planned transport infrastructure, and share health and education with existing communities, the costs will be far less than creating somewhere from scratch. However the results of densification in the wrong place may also be to increase congestion, for example leading to slum housing if no actions are taken to improve older areas. Alternatively if development can be located on land that would otherwise go to waste, some of the increase in property values can be ploughed back into infrastructure provided the location is not too isolated from public transport and other utilities. A good place to start would be land alongside the railways and close to existing urban areas, as land within a mile of Indian railways is owned by the government.

Sustainable urban extensions offer better returns
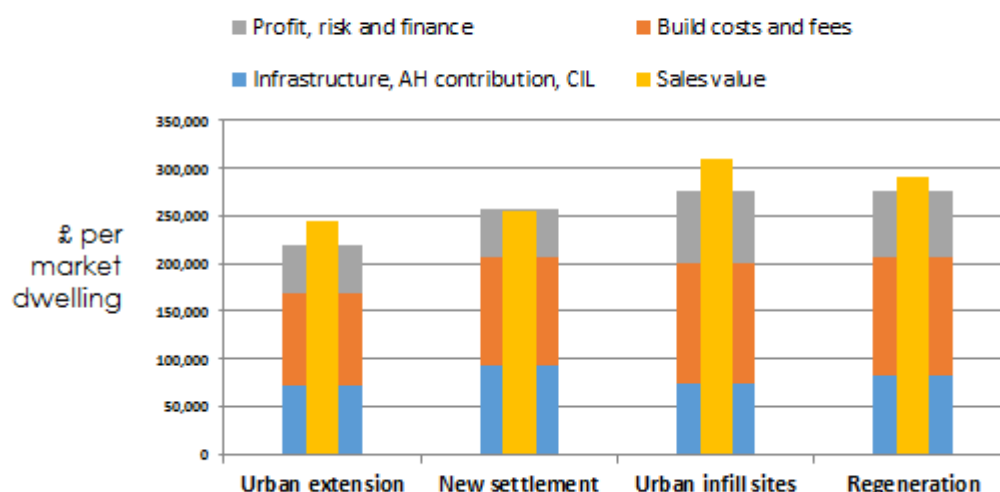
Development options

The development of more sustainable communities involves at least four dimensions, and planner Hugh Barton has clearly set out. These are dispersal or concentration: segregation or mixture; density (which includes plot ratios and the space between buildings), and shape, whether nucleated or linear. [14] So let us consider how the basic variables might be affected by different patterns of development, and the policies that can help local people to benefit from growth. As cities grow, actions can be taken to promote sustainable or 'smarter growth'. This involves the traditional principles of sound planning, particularly 1. Survey, 2. Analysis, 3. Consultation, 4. Plan 5.. Financing and 6. Implementation. There are many possible measures or programmes to improve local infrastructure which could create local jobs, such as:

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[14] Ed. Hugh Barton, Sustainable Communities: the potential for eco-neighbourhoods, Earthscan , 2000

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a. minimisation of waste through recycling;
b. water and energy efficiency;
c. local materials for construction;
d. sustainable agriculture and horticulture which do not rely on imported fertilisers or seeds;
e. micro-credit to finance self-employment and new small businesses;
f. local building designs and materials;
g. and maximising accessibility rather than mobility.

The costs associated with urbanisation and related infrastructure, will also vary according to the urban form or shape that is adopted, and there are at least four possible scenarios:

- Concentrated or compact cities, with an overall plan, and where people can walk to meet almost all their needs
- Dispersed or scattered growth, where there is no plan and some form of private transport is essential to getting from the suburbs to places of work
- Transit oriented development, where development is focussed along public transport corridors and around stops or stations enabling trips to be made without private transport
- A polycentric network, where different needs are met in different towns that complement each other and where towns are well-connected with each other.

Clearly the more dispersed or spread out the pattern of development, the greater the capital and social costs. Transit oriented development (TOD) is only possible when enough density is achieved. Compact cities on the European model sound attractive but can decay into slums if they are not properly maintained and managed. Compact cities on the Chinese model are very expensive, as high rise towers are much costlier than low rise apartment blocks or terraces. Polycentric settlements, such as in London, can work well but take a long while to develop. Inspiration can also be taken from other cities in dry climates, such as Beersheeva in Israel or Curitiba in Brazil, where universities are playing a major role in developing new settlements around the growth of the 'knowledge economy'.

Agglomeration Economies

Though larger cities often suffer from extremes of congestion, pollution and crime, they also can offer benefits, such as cultural freedom and economic opportunity. Up to some point the savings could well exceed the costs, due to what economists call 'economies of scale' or 'agglomeration economies'. The idea of agglomeration economies, or spatial economies of scale, was developed by economists such as Jevons in the 19th century, and is related to the more recent idea of 'clusters', where interdependencies cut costs. While little seems to be known about the precise relationships, a number of hypotheses can safely be put forward: The most compelling argument is the 'law' put forward by Dr Geoffrey West, an American physicist who argues that each doubling of population leads to a 15% increase in GNP per capita. It also is associated with crime rates and other less positive effects, as successful cities draw people into them.

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But cities do not exist in isolation. In 1999 an economist, Xavier Gabaix showed how Zipf 's law about the relative size of things applies to cities. He demonstrated how in most countries the largest city is twice the size of the second city, three times the size of the third etc.. England however does not fit this rule because London is more than three times larger than any other city. This is largely due the shift of population away from the crowded inner city areas when Britain built urban extensions and new towns in the post war period. It was aggravated by subsequent 'urban flight' when traditional industries collapsed in the 1980s and after. So cities rise and fall, and in the process accumulate infrastructure, such as transport systems, hospitals and other public buildings. These may later be abandoned and decay, or form the raw material of later efforts to regenerate inner city areas. [15]

Urban trends, though strong, are not inevitable. The buildings that once housed rich merchants may later become slums, as immigrants crowd into them. They may then be 'gentrified' when they are rediscovered a few generations later by wealthier newcomers. In London the examples of both Notting Hill and Spitalfields come to mind. Similarly rural railway lines that are abandoned for lack of demand may get brought back to use a few generations later to reduce the impact of congestion on over-loaded roads. At one time the 'smart' thing for educated people to do will be to move to the largest city, only for those who can to leave when pollution becomes intolerable.

Some environmentalists, such as Susan Owens in Cambridge, have suggested there is an ideal size of city, which in the UK could be around 250,000.[16] This would be large enough to enjoy all the benefits of a rich cultural life, including being able to use good public transport, without the problems of overcrowding such as congested roads. In an Asian context this would equate to a medium sized city of between 500,000 to one million inhabitants, or what the OECD usefully calls a *Metro City.* As cities evolve over time, often by absorbing surrounding villages and townships, the usual pattern is some kind of agglomeration or conurbation, connected primarily by road, but also by other services. What then matter is how well the component parts are connected both to each other and to other cities, judged in terms of both efficiency and fairness. So the absolute size is less important than the relationship between both different cities, and the districts or neighbourhoods within them.

What Peter Hall called the Polycentric Metropolis could become the dominant model for emerging cities in growing economies as well as in Europe.[17] Rather than a Grid of streets, which characterises planned cities like New York and Barcelona, the model is likely to be more like Copenhagen, with its 'Green Fingers' between corridors of development. So instead of trying to replicate the European Compact City, it may be more practical to promote the Connected City, in which different independent settlements are linked by rail lines and rapid transit routes that have priority over private cars, as well as possibly by water and power networks[18]. Such a pattern of development can encompass both planned medium density urban extensions and even spacious new garden cities, as well as dense business or university quarters around the major railway stations or city centres, as URBED's work in the UK has demonstrated.[19]

[15] David Rudlin and Nicholas Falk, Sustainable Urban Neighbourhood: building the 21st century home, Routledge 2009

[16] S Owens and Cope, D, Land Use Planning Policy and Climate Change, HMSO, 1992

[17] Peter Hall and Kathy Pain, The Polycentric Metropolis: learning from mega city regions in Europe, Routledge 2009

[18] Brian Love, The Connected City, Love Architecture, www.lovearchitecture.org 2015

[19] David Rudlin, Sheffield Garden City? Options for long-term urban growth, www.urbed.coop 2015

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Funding Smarter Cities

So how might such ideas be taken forward in Southern India or other places with growing cities in emerging economies? Inevitably public sources of funding will be required, and it will be important to tap into programmes that share knowledge, like UN Habitat, as well as into action research funds, such as the Innovate Scheme in the UK. The Indian Government is promoting a number of programmes, such as improving services and infrastructure in 67 cities, supporting conservation in 12 heritage cities, and the Smart Cities programme aimed at bringing growth and a better quality of life to 100 cities. There is also AMRUT which aims to support projects to improve basic infrastructure in 500 cities. The funds are accessed through bids for area-based schemes as well as pan-city initiatives and can involve retrofitting, redevelopment or greenfield development.

Bids for the Smart Cities Mission must cover the four 'pillars' of :

- Physical: the built environment and infrastructure systems
- Social: aspects that enrich human experience such as education and healthcare
- Economic: employment and business infrastructure
- Institutional: structure of government and citizen participation.

Bids are required to be linked to spatial development plans and to deal with implementation, through, for example, Public Private Partnerships and Special Purpose Vehicles. Technical consultancy help is available for those cities making bids. [20] Whether a bid is successful or not, the very process of thinking about a city's future, and bringing together different stakeholders or interest groups, should be invaluable. Thirunelveli could be an excellent candidate for applying 'smarter growth' principles.

Conclusions

Anticipating the future, or the impact of any one form of investment is hugely difficult, and is bound up with how people behave. Will landowners, businesses, government agencies, and NGOs work together or in opposition? Will they welcome a better future or act like ostriches, ignoring both the urban trends and the opportunities they open up? Can projects be promoted that will act as models or inspiration for others? Alternatively will all the mistakes of past developments be repeated, such as suburban sprawl?

While it is dangerous to make generalisations, it is likely that the main priorities for growing cities in tropical conditions, such as in Southern India, will be first tackling water and energy shortages through local networks that make use of renewable resources, such as solar power, and second improving transport for both people and foodstuffs so that waste and conflict is avoided, and living standards improved. These can be importance sources of local employment and do much to improve living conditions provided that urban development is closely linked to infrastructure. For this is what 'Smarter Growth' should be all about.

Dr Nicholas Falk September 2015 rev December 2015

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[20] Summarised from Arup's report op.cit.

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APPENDIX

Why Tirunelveli?

Tamil Nadu is India's second largest state, with 72 million inhabitants and 532 railway stations, so there are plenty of potential places where sustainable forms of development might take place. The state stands out, along with neighbouring Kerala and the Northern state of Hamachal Pradesh for its high levels of literacy and early child care, and is rightly praised by Nobel winning economist Amartyeh Sen.[21] Tamil Nadu has a relatively high GNP per capita, linked to its successful manufacturing industry, and is relatively urbanised. It is the home of India's motor industry, which is concentrated around the state capital of Chennai (the former Madras). With a large educated and English speaking population, good communications, an abundance of sun and wind all year round, and some major companies, Tamil Nadu offers an excellent base for diversification into related industries, and for applying innovations in sustainable development.

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[21] Amartyeh Sen and Jean Dreze, An Uncertain Glory: India and its contradictions, Allen Lane 2013

TAMIL NADU'S MAJOR CITIES ⊘ urbed –

CITY	POPULATION (2011)	GROWTH (2011/2001)
Chennai	6,560,000	40%
Coimbatore	1,061,000	14%
Madurai	1,017,000	11%
Tiruchirappalli	847,000	13%
Salem	831,000	19%
Ambattur	478,000	54%
Tirunelveli	475,000	15%

Tirunelveli is currently the seventh largest city in Tamil Nadu, with a population growth rate of around the national average (15% over ten years), and is starting to sprawl. It is an important railway junction on the newly electrified line going North to Madurai, along with three other lines, and is connected by a fast new highway to the port city of Tuticorin to the East. But there is no longer any significant local industry. Most of the jobs in town are in the service sector, and there are major hospitals and educational establishments but little else to employ the many graduates. The city is therefore losing out to others as educated young people have to move away to get good jobs. Though the City does not feature as a place for tourists to visit in the Rough Guide or Lonely Planet Guides it has huge potential appeal as one of India's oldest cities with a historic centre that is largely unspoilt. However the centre is threatened by an excess of traffic in the historic centre, glass fronted buildings that are starting to replace fine older ones, and isolated new houses that are starting to be built near main roads.

Tirunelveli acts as the administrative centre for the southern part of the State, which remains predominantly rural, and rooted in poverty, with very limited opportunities for earning more. Supporting the health and community development of villages of salt workers or sari weavers, while highly desirable, cannot by itself overcome marginalisation. The natural result of improved education is that as children from village backgrounds finish school, they will leave their family behind and move to the larger cities for employment, stimulation and the prospects of better housing. As a consequence mega cities, such as Chennai, see their populations exploding, and poverty and informal settlements mushroom as businesses expand, while medium sized cities such as Tirunelveli sprawl or stagnate.

The idea of sustainable or 'smarter growth' involves not just minimising environmental impacts and addressing climate change (as SCAD is doing so well in fields such as bio digestion), but also improving local incomes and standards of life so that the gaps between rich and poor are narrowed. The fortunes of town and country cannot be dealt with in isolation, but are interlinked. The more major cities such as Tirunelveli (and its suburbs) grow as 'engines of the economy', the easier it will be to hang on to the most talented students, and to attract investment in new forms of better paid economic activity, such as services and the 'green economy'. In turn the higher incomes will enable rural families to

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improve their homes and villages without depending on unpredictable 'political' donations, such as televisions! The key question is not whether cities like Tirunelveli should grow but where, how and for whom?

On an initial assessment the prospects for sustainable growth in Tirunelveli are good compared with many other parts of India. Nobel Prize winner Amatyeh Sen's recent book highlights the state of Tamil Nadu, and provides some useful statistics in an appendix. Within India, Tamil Nadu with 72 million inhabitants, has recorded the highest growth rate in GNP per capita (7.5% in the 2001-11) and has done relatively well compared with other states on indicators such as youth literacy and infant mortality.[22] Tamil Nadu scores well on villages with electricity (89%) and improved water (94%), but lags significantly behind neighbouring Kerala on toilets (39% vs 97%). It also is relatively well provided with durable goods, but with no doubt major disparities between urban and poorer more rural areas. Tamil Nadu, with its relatively advanced manufacturing sector around Chennai and Coimbiatore, is therefore in a key position to influence future growth and wellbeing. Tirunelveli, with just under 500,000 inhabitants, is well-placed to qualify.

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[22] Jean Dreze and Amartyeh Sen and An Uncertain Glory: India and its contractions, Allen Lane 2013

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