DOES CLIMATE CHANGE MAKE INDUSTRIALIZATION AN OBSOLETE DEVELOPMENT STRATEGY FOR CITIES IN THE SOUTH?

Le-Yin Zhang
Senior Lecturer
Development Planning Unit
University College London
34 Tavistock Square
London WC1H 9EZ
United Kingdom
le-yin.zhang@ucl.ac.uk

Summary: This paper attempts to explore the implications of climate change for economic development strategies in cities in the South. In particular, it examines whether industrialization still represents a viable development strategy in such a context. It starts by examining the effects of climate change and the challenges posed for the cities concerned, followed by a discussion of the role of industrialization in economic development and climate change. It then investigates how these issues affect Southern cities by considering the experiences of Shanghai, Bombay and Mexico City. The paper concludes that industrialization still represents an effective, and to some extent indispensable, development strategy in the context of climate change, even for those that are affected by deindustrialization.

Key Words: Climate change; the city economy; industrialization; de-industrialization; economic development strategies; cities; developing countries

DOES CLIMATE CHANGE MAKE INDUSTRIALIZATION AN OBSOLETE DEVELOPMENT STRATEGY FOR CITIES IN THE SOUTH?

I. INTRODUCTION

In a world of rapid urbanization and global integration, climate change represents only one of the many challenges that cities in the South have to grapple with in the coming decades. It is nevertheless a fundamentally important challenge for these cities because failing it will not only diminish their own long-term prospects, but also let the world seriously down.

This is for several reasons. First, developing countries already produce more than half of the total global emissions, and this share is rising fast. Non-OECD emissions of carbon dioxide exceeded OECD emissions by 7 percent in 2005, and are projected to exceed those from the OECD countries by 72 percent in 2030 (International Energy Agency 2008). Therefore, although developing countries are under no formal obligation at the present to mitigate, this is bound to change. Second, any prospective changes in terms of mitigation obligation will foremostly affect cities in the South, as they embody a majority of the economic activities there.[i] Third, concerns about climate change have the potential to bring forward a new energy system and, associated with it, a new international trading environment. If some of the legislative changes (e.g. cap-and-trade scheme in USA) currently proposed are to become reality, this could substantially alter the comparative advantage of developing countries, with great impact on cities in their role as bridgeheads of international trade.

Therefore climate change can affect and be affected by economic development pathways in a fundamental way. This is why climate change has to be mainstreamed through economic development strategies (Zhang 2008). Accordingly, this paper attempts to explore the implications of climate change (and its impact) for economic development strategies in cities of developing countries. In particular, it examines whether industrialization still represents a viable development strategy for these cities, although industrial activities are a major source of emissions in the South (see Figure 2).

The paper starts by examining the effects of climate change and the challenges that it poses for developing cities, especially in terms of industrialization. This is followed by a discussion of the role of industrialization in economic development, and the relationship between industrialization and climate change issues, highlighting tensions as well as synergy between the two. The paper then examines how these issues are affecting developing cities by considering the experiences of Shanghai, Bombay and Mexico City. It concludes that industrialization still represents a viable and, to some extent, indispensable development strategy for these cities in the context of climate change, even for those that are affected by pre-mature deindustrialization.

II. CLIMATE CHANGE AND THE DEVELOPING COUNTRIES

2.1. The challenge of climate change

Climate change poses challenges of mitigation and adaptation for the mankind. Mitigation is defined as "an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC 2001a:379), whereas adaptation is any "adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities." (IPCC 2001a:365).

With regard to mitigation, Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) states that the ultimate objective of the Convention is "to achieve… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". To contain the cost of adaptation and prevent the worst consequences, constraining global mean temperature change to less than 2 ^{o}C has been widely accepted as the prominent climate protection goal (Bruckner et al. 2007; European Commission 2007; United Nations Development Programme (UNDP) 2007). This requires the stabilization of greenhouse gases (GHG) concentrations at or below 400 ppm $CO_{2,}$ or limiting global carbon emissions to about 3 billion tons by 2100 (equivalent to an emission budget of 0.3 tons of carbon per capita or one metric ton of CO_2-equiv. per capita) (Banuri *et al* 2001: 89). This means that emissions have to peak by 2015 and global emissions to decline by 50-80% between 2000 and 2050 (IPCC 2007:21). The last is a tremendous challenge to the present mode of development, since global emissions of GHG have increased by 70% from 28.7 Gt to 49 Gt of carbon dioxide equivalent (Gt CO_2-eq) between 1970 and 2004 (or 1.58% per annum on average).

The Kaya Identity suggests:

CO_2 emissions = Population X (GDP/Population) X (energy/GDP) X (CO_2 emissions /energy) (Equation 1), or:

CO_2 emissions = Population X (GDP/Population) X (CO_2/GDP) (Equation 2)

Equation 2 shows that the growth of CO_2 emissions is the sum of the rates of change in population, per capita income, and the ratio of emissions to GDP (or emissions intensity). This implies that, to achieve below-zero emissions growth, increases in income level and population - inherent to economic development - will have to be off-set by reductions in emissions intensity.

Mitigation poses a potentially serious challenge for developing countries. As Table 1 shows, although tCO_2-eq emissions per capita in these countries were only one-fourths of those in Annex I countries by 2004, they had already exceeded the 'emission budget' by a factor of 4 and were responsible for more than half of the total emissions. On the other hand, GHG emissions per unit of GDP were 50% higher in non-Annex-I countries**.** Thus there is significant scope for mitigation in developing countries. Moreover, even if there is no immediate obligation to mitigate, there is growing economic incentive to do so in the context of an emerging global carbon market and the Clean Development Mechanism under the Kyoto Protocol (Zhang 2008).

However, since their population and economic growths are generally faster than in developed countries, faster reductions in emissions intensity will be needed in order to offset these growths so as to achieve de-carbonization. As Equation 1 shows, this can be achieved by either reducing energy intensity (i.e. energy/GDP), or reducing the carbon intensity of energy (i.e. CO_2 emissions /energy). Key strategies include improving energy use efficiency, industrial restructuring (i.e. reducing the weight of energy-intensive economic activities) and energy switch (i.e. reducing the weight of emission-intensive fuels).

Table 1. Distribution of global GHG emissions (2004)

Grouping	**tCO_2 eq/cap**	**$KgCO_2$ eq/ US\$GDP$_{ppp(2000)}$**	**Share in global totals (%)**		
			Population	**GDP**	**Emissions**
Annex I countries	16.1	0.683	19.7	56.6	46.4
Non-Annex I countries	4.2	1.055	80.3	43.4	53.6

Source: Rogner et al. (2007), p.106, Figure 1.4a and Figure 1.4b. a: all Kyoto gases including those from land-use.

On the other hand, developing countries face an even greater challenge in adaptation. This is principally concerned with reducing vulnerability and developing adaptive capacity (Burton, Diringer, & Smith 2006), although it should also aim to exploit the beneficial opportunities. Defined as “the likelihood of injury, death, loss, disruption of livelihoods or other harm” (Eriksen & O'Brien 2007:338), vulnerability inevitably affect populations whose livelihood or wellbeing is already undermined by high incidence of poverty. However, developing countries are more at risk also because of their geography, greater reliance on agriculture and lower adaptive capacity (Burton, Diringer, & Smith J. 2006; McCarthy et al. 2001; World Bank 2008). This places premium on non-agricultural productive activities and factors that strengthen their adaptive capacity, which include economic resources, technology, information and skills, infrastructure, institutions and equity (Smit et al. 2001: 895).

2.2. The implication for economic development in the South

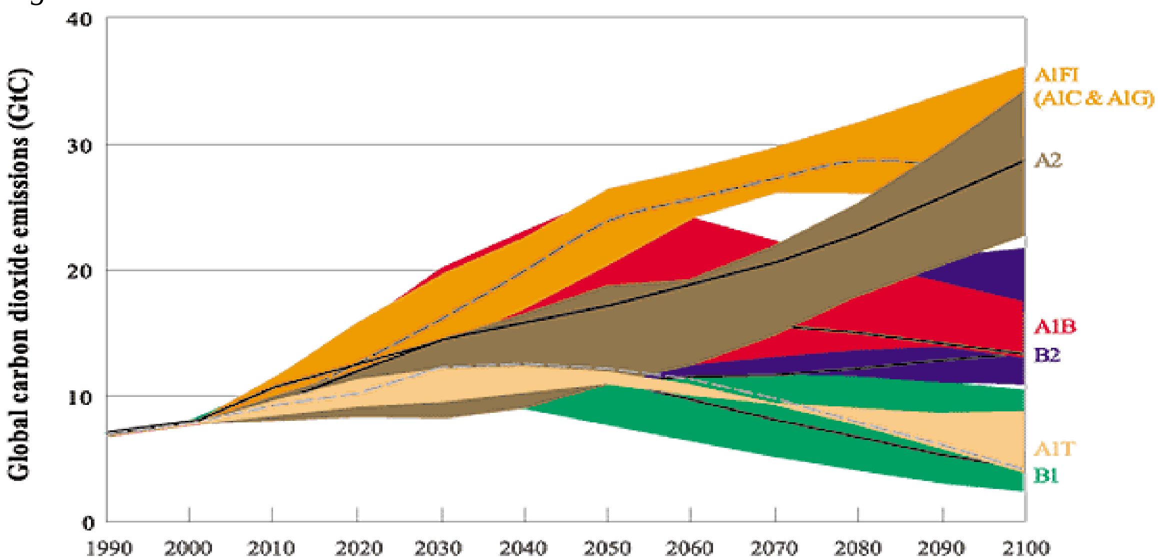
Thus developing countries need to take action in both mitigation and adaptation, aiming at reduction of emissions, reduction of poverty and the strengthening of adaptive capacity. What does this mean for their economic development strategies?

The Special Report on Emissions Scenarios (SRES) (Nakicenovic et al. 2000) is instructive here. Guided by the Kaya Identity and building upon a common set of driving forces, including global population growth, economic development, technological diffusion, energy systems and land use, and assuming that no specific climate policies are implemented, the SRES outlines a set of four alternative scenario ‘families’ comprising 40 SRES scenarios. These scenarios indicate a wide range of CO_2 emission possibilities, ranging from less than 10 GtCO2 to almost 35 GtCO2 by 2100 (Figure 1). The corresponding CO_2 concentration and global mean temperature increase (from 1990 to 2100) varies respectively from 500 to 1000 ppm and from 1.3^{o}C to 5.8 ^{o}C, with the

B1 scenario offering the lowest emissions. The drivers of the six illustrative scenarios are summarized in Table 2.

Figure 1 and Table 2 demonstrate a striking range of future possibilities. First, with everything else being equal, the A1 scenario, characterized by fast economic growth and population growth, could either lead to extremely high emissions or intermediate to low emissions, depending on the nature of the energy systems. Second, combining a service-based economy with cleaner energy produces B1, a scenario of very low emissions (lower than the level of 1990). Third, a combination of intermediate growth rates for the economy and population, and lower degree of global convergence would result in B2, characterized by relatively low emissions level, which is nevertheless higher than the level of 1990. Finally, the worst scenario would be A2, characterized by slow economic growth, fast population increase, less global convergence and very high emissions level. These contrasting scenarios point to one conclusion: the rate of economic growth is not the decisive factor for mitigation. Much will depend on the kind of energy systems adopted and the economic structure.

Figure 1. Emission Scenarios



Source: Nakicenovic et al (2000), Figure TS-8. Each colored band shows the projected emissions of the six illustrative scenarios.

Table 2. Emissions Scenarios and Drivers

<table>
<tr><td rowspan="2">Illustrative emissions scenarios</td><td colspan="6">Key Drivers of Emissions</td><td rowspan="2">Underlying theme</td></tr>
<tr><td>Economic growth</td><td>Economic structure</td><td>Population growth</td><td>Global Convergence</td><td colspan="2">Energy systems</td></tr>
<tr><td rowspan="3">A1</td><td rowspan="3">Fast</td><td rowspan="3"></td><td rowspan="3">Peaks in mid-21st century, then declines</td><td rowspan="3">Fast</td><td>A1FI</td><td>Fossil energy intensive</td><td rowspan="3">Convergence and reduced regional gaps</td></tr>
<tr><td>A1T</td><td>Non-fossil energy sources</td></tr>
<tr><td>A1B</td><td>Balanced energy sources</td></tr>
<tr><td>A2</td><td>slow</td><td></td><td>Continuously increasing</td><td>slow</td><td colspan="2"></td><td>Self-reliance and preservation of local identities</td></tr>
<tr><td>B1</td><td>fast</td><td>Towards a service and information economy</td><td>Same as A1</td><td></td><td colspan="2">Cleaner technology</td><td>Global solutions to sustainability</td></tr>
<tr><td>B2</td><td>Inter-mediate</td><td></td><td>Similar to A2, but at lower rate</td><td>Slower, more diverse than B1 and A1</td><td colspan="2"></td><td>Emphasis on local solutions, including equity</td></tr>
</table>

Source:Own elaboration on the basis of Nakicenovic et al.(2000:22)

Admittedly, industry is a major source of emissions. Table 3 shows GHG emissions by sector in 2004, with industry accounting for 19.4% of total emissions. However, including energy supply would increase industry's share to more than 40% of total emissions.

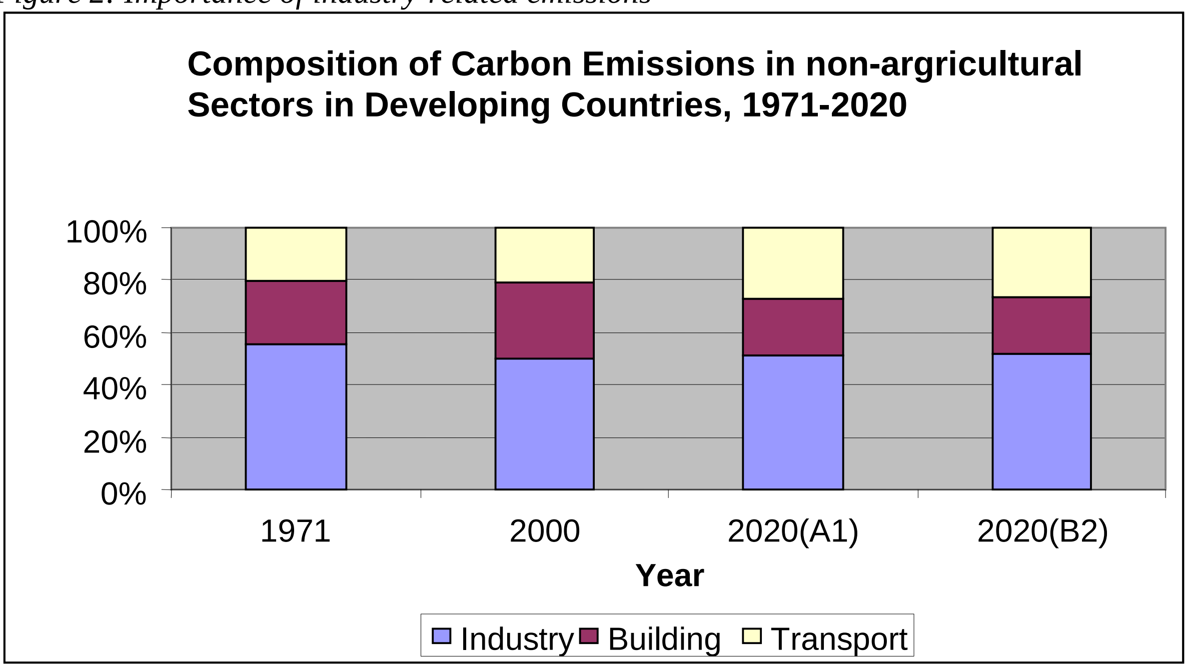
Table 3. Global GHG emissions by sector in 2004

Source of emissions	%	Source of emissions	%
Energy supply	25.9	Agriculture	13.5
Transport	13.1	Forestry	17.4
Residential and commercial buildings	7.9	Waste and Wastewater	2.8
Industry	19.4		

Source: IPCC (2007c): 105.

Moreover, the share of industry related emissions is even higher in developing countries. According to Price et al (2006), the SRES divided all emissions under four headings, namely industry, building, transport, and agriculture. Analysis of the detailed data shows that the share of industry in non-agricultural emissions declined from 55.4% in 1971 to 49.8% in 2000. However it is projected to rise to 51% in 2020 under scenario A1 and 51.9% under scenario B2 (see Figure 2).

Figure 2: Importance of industry-related emissions



Source of data: Price et al (2006). Own calculation and drawing. 2020 (A1) and 2020 (B2) represent respectively projections for SRES A1 and B2 scenarios.

Does this mean that industrialization is no longer a viable development strategy? We explore this question below.

III. INDUSTRIALIZATION AS AN ECONOMIC DEVELOPMENT STRATEGY FOR SOUTERN CITIES

3.1. Why industrialization?

Economic development refers to the process whereby the real per capita income of a country increases over a long period of time while simultaneously poverty is reduced and the inequality in society is generally diminished, or at least not increased (Martinussen 1997:37). It is characterised by the structural transformation of the economy, or systematic changes in the allocation of factors of production and in improved techniques of production (Meier 1995:7). Industrialization, changes in demand and trade patterns, and urbanization are key aspects of such changes (Kuznets 1966; Syrquin 1988). A principal objective of any economic development strategy is to enhance the prospects for sustained economic growth, poverty reduction and structural transformation.

Industrialization, a process in which the share of industry (especially manufacturing) in both national income and employment increases in a country (Dasgupta & Singh 2006: 18), has traditionally played an important role in the economic development of almost every country (Chenery, Robinson, & Syrquin 1986). Indeed, it distinguishes three stages in the process of their economic development: 1) primary production, when the production of primary goods-typically agricultural products- dominates the economy; 2) industrialization; and 3) developed economy, characterized by de-industrialization, the process when manufacturing's shares in employment and then in GDP declines while the weights of services increase. During the course of industrialization, per capita income was found to rise from $400 to $2100 in 1970 dollars (equivalent to a change from $1,734 to $9,127 in 2007 dollars).[ii]

The process of industrialization is the most dynamic phase in the course of development, characterized by fast economic growth and technological progress, shift of resources from less to more productive activities and the building-up of the so-called 'social overhead' (i.e. basic infrastructure) (Kaldor 1966; Kaldor 1978; Young 1928). Many of the benefits of industrialization derive from the economies of scale associated with manufacturing industry. The Kaldor's growth laws state:

- There exists a strong positive correlation between the growth of manufacturing output and the growth of GDP;
- There exists a strong positive correlation between the growth of manufacturing output and the growth of productivity in manufacturing
- There exists a strong positive relationship between the growth of manufacturing output and the growth of productivity outside of manufacturing (Thirlwall 2003): 79)

Moreover, industrialization is also an effective means for poverty reduction (Fukunishi et al. 2006). Cross-country experiences have shown that, to lift a large number of people out of poverty, one of the essential ingredients is to provide the poor with the opportunities to use their most abundant asset, namely labour (World Bank 1990: 51). In this regard, export-oriented industrialization is particularly effective, as it enables the exploitation of a market much larger than the domestic market, and creates jobs for a significant number of semi-skilled labours. It also has positive impact on distribution.

Industrialization could also fundamentally strengthen adaptive capacity by diversifying the economy and promote socio-economic features that strengthens adaptive capacity. One of the most interesting works in this area is the study by (Roberts & Parks 2007). From analyzing a universe of more than 4,000 climate-related disasters across the world over the past two decades, they found that, when other factors are held constant, national poverty explained virtually none of the trends in deaths and homelessness. Five other variables were found far more consistent predictors of such death and homelessness than was per capita GDP: income inequality; urban and coastal populations; press freedom; and property rights. For instance, people living in more urbanized nations were less likely to be killed, made homeless, or affected by climate related disasters than people living in more rural nations. Further more, a narrow export base explained about 1/3 of homelessness, from 1/7 to 1/3 of deaths, and about 40% of national patterns in who were affected by climate-related disasters. The authors thus concluded that "(I)t is not poverty per se, but a highly correlated suite of variables that can be traced back to a common causal origin: dependence on a narrow range of low-value exports." (p. 105).

The above discussion demonstrates that industrialization is still an important development strategy in the context of climate change. However, some metropolitan cities in developing countries are already experiencing de-industrialization.

3.2. Deindustrialization

De-industrialization, evidenced by the fall in the share of manufacturing employment or an absolute fall in such employment (Dasgupta & Singh 2006), has both demand-side and supply-side causes (Rowthorn & Ramaswamy 1999). The experiences of London and Glasgow (Graham & Spence 1995; Lever 1991) demonstrate that two other factors are influential in metropolitan economies. First, competition for increasingly expensive real estates could drive manufacturing activities out of urban centre. Second, mis-guided policy attempts to de-congest established urban areas have similar effects. However, de-industrialization has predictable consequences. It generally slows down overall productivity rise (i.e. economic growth) and causes unemployment and dereliction. It affects the semi-skilled labours most strongly, but also has wider repercussions around the economy. Such negative effects can be compensated by the growth of knowledge-based and high-value added services, as in developed economies.

Unfortunately, however, many developing countries are apparently undergoing de-industrialization at a low level of development (per capita GDP of around US$3000). Dasgupta & Singh (2006) describes this as pre-mature de-industrialization. They identified two ideal types of de-industrialization since 1980s: 1) the Indian type, where manufacturing employment is not expanding in the formal sector, but is growing with large informal sector, and there is nevertheless expansion of manufacturing products. 2) the Latin American and African type, where contraction in manufacturing stops the economy from achieving its full potential of growth, employment and resource utilization. Since manufacturing produces the material inputs for infrastructure (and for construction), pre-mature de-industrialization would reduce these countries' ability to develop infrastructure and more generally adaptive capacity.

3.3 The way out: Industrialization coupled with de-carbonisation

The above analysis suggests that there is synergy as well as tension between industrialization and climate change policy goals. While industrialization accelerates productivity and technological changes, reduce poverty, and facilitates the development of adaptive capacity, industry presently also produces a large amount of emissions. So what is the way out?

The Kaya Identity indicates that in order to retain the benefits of industrialization, the only way out is de-carbonization (i.e. the reduction of emissions intensity). These mean that industrialization has to be combined with de-carbonisation to remain a viable economic development strategy. The above discussion is summarised in Table 4.

Difficulty may this sounds, de-carbonizing industrialization is quite feasible. An important insight in the industrial ecology literature is that “new paths are always pioneered outside the dominant regions.” (Robins & Kumar 1999:78). Such precedents include the American invention of mass production of autos and the Japanese pioneering of lean manufacturing. Evidently, this is already happening. For example, a study by Chandler et al. (2002) of mitigation experiences in six large developing countries (Brazil, China, India, Mexico, South Africa and Turkey) shows that efforts undertaken by these countries have reduced their emissions growth over the past three decades (1970s-1990s) by approximately 300 million tons a year. In particular, energy intensity started to fall from 1995 in India and declined by an average of 4% per annum during 1977-1997 in China. More importantly, these countries have significant scope for further mitigation: experts estimated that India could reduce projected emissions over the next 30 years by nearly one-quarters for less than $25 per ton of carbon equivalent. Another encouraging sign is that, according to a recent HSBC report ((Robins, Clover, & Singh 2009), it is China and South Korea, as well as USA, that lead the green investment league table in their fiscal stimulus packages in response to the current global financial turmoil. The Chinese investment is more than twice as big as the USA’s.

Table 4. A summary of strategies and their potentials

Strategies and outcomes	Potential to reduce the following characteristics		
	Emissions intensity	Vulnerability	Poverty
De-industrialization	M	L	L
Decarbonising industrialization	H	H	H
Note: H = High; M = Medium; L= Low. Own elaboration.			

IV. EVIDENCE FROM THREE CITIES

In this section, an attempt is made to examine how the issues raised above are affecting Southern cities with case studies of Shanghai, Mumbai and Mexico City.

To start with, these three cities are the most important economic powerhouse of their home economies, at different levels of development. As Table 5 shows, both GNI per capita and emissions per capita is highest in Mexico and lowest in India. However, emissions per capita in China is very close to Mexico's, although its GNI per capita is only less than one-fourths of the last. This is explained by the diffidence in their energy systems and the economy structures: As Table 6 shows, industry is much more important in China's economy than Mexico's. The last also means though that economic growth is much faster in China.

Table 5 Country profiles: China, India and Mexico

Indicator	Emissions (metric tons per capita) (2004)	GNI per capita (Atlas method, US$) (2004)	GDP annual growth (%)	
			1990-2000	2000-05
India	1.24	630	4.2	4.7
China	3.86	1500	10.6	9.6
Mexico	4.29	6930	3.1	1.9

Source: World Bank (2007).

Table 6. De-industrialization in China, India and Mexico

Manu. Employment (1,000)	Manufacturing employment (1,000)			Industry value-added as % of GDP		
	China	India	Mexico	China	India	Mexico
1990	53040	6118		42	28	28
1991			3628			
1992	55417					
1993			3838			
1995		6767				
1997		7068				
2000	32400	6119	5749			
2003			5178			
2005				48	27	26
2007			5449			

Source: International Labour Organisation (1998 -2009); World Development Indicators online database.

Interestingly, measured by manufacturing employment, China started to de-industrialize the earliest in 1992 (partly as a correction of its over-industrialization before the onset of its economic reform), followed by India in 1997 and Mexico in 2000 (Table 6). Since industry's share in GDP increased in China during 1990-2005, but declined in both India and Mexico, it means that industrial productivity has risen faster in China than in India and Mexico. This is consistent with efficiency-driven reform measures in China and informalization in India and Mexico (Dasgupta & Singh 2006).

At the city level, all three cities have de-industrialized, although to different extents and with varying levels of manufacturing significance (Table 7). Of the three cities, Mexico City was the earliest de-industrializer, beginning probably even before 1970, followed by Mumbai (from early 1980s) and finally Shanghai (in 1990). Interestingly, these cities have done so for quite different reasons, in addition to normal demand and supply factors. In Mumbai, this was largely due to the effects of the 1981 textile workers strike and land ceiling policy ((Pacione 2006). In the case of Mexico City, the rise of manufacturing along the USA-Mexico border and de-concentration policy played a role(Grajales forthcoming). Finally for Shanghai, the government's prioritization policies as well as surging domestic demand for services are responsible (Zhang 2003).

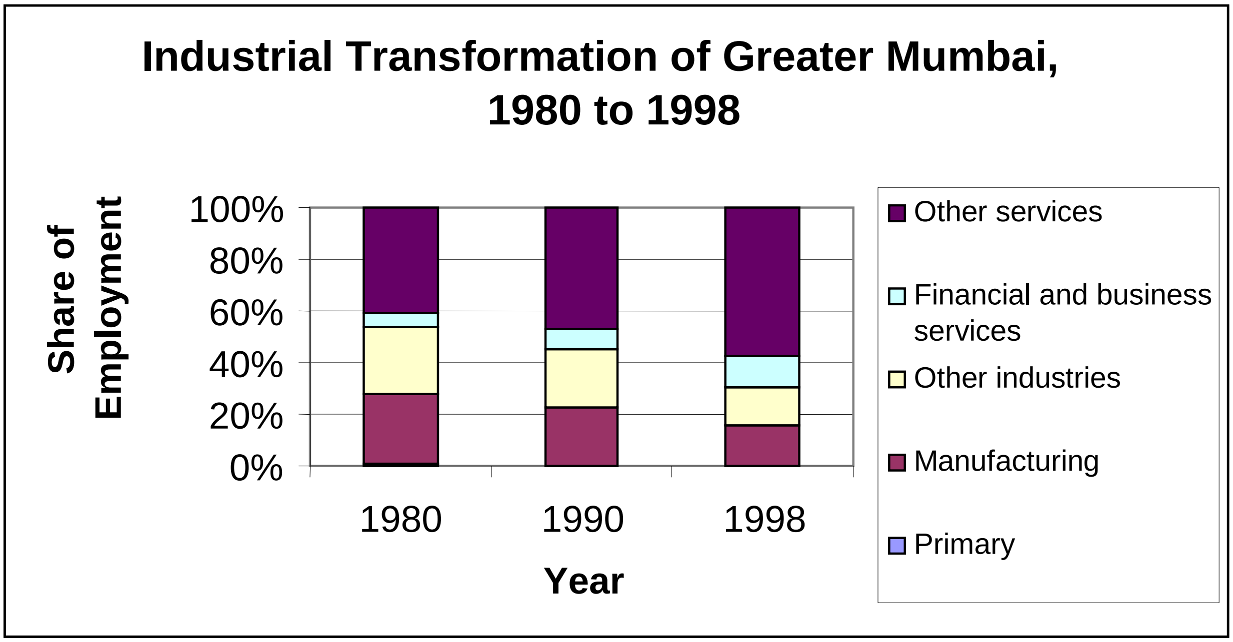
Table 7. De-industrialization trends in Mumbai, Shanghai and Mexico City

	Greater Mumbai (Manufacturing employment as % of total employment)	Shanghai (Industrial employment as % of total employment)	Mexico City Metropolitan Area (Manufacturing share in GDP)
1960			21.26
1970			23.80
1980		42.90	23.78
1985	35.97	44.30	
1988			23.78
1990		53.88	
1993	28.47		18.61
1995		49.96	
1998			19.21
2000	17.84	39.72	
2006		32.13	

Sources: Mumbai Metropolitan Regional Development Authority (2001); Grajales (forthcoming) and Shanghai Statistical Bureau (various years). Industrial employment for Shanghai covers manufacturing and utilities.

Although the lack of comparable data precludes any attempt to quantify the effect of de-industrialization, it is evident that the three cities perform differently in economic terms. Grajales (forthcoming) notes that from 1980 to 1998, MCMA progressively slid down the national labour productivity league table for cities from the 8th place to 19th place. Mumbai's annualized GDP growth rate registered 8.5% from 2001/2 to 2006/7, which is only slightly above the national growth rate of 8% for the same period (The Economic Times, 20 Jan. 2008). Its economic structure, characterized by a small manufacturing sector and a large group of low value-added 'other services', is a likely contributor to this outcome (Figure 4). In comparison, Shanghai's GDP grew by 12.5% per year between 1992 and 2007, compared with 9.4% per annum for the national average (1992-2006). It would seem that economic structure matters here too.

Figure 4. De-industrialization in Mumbai



Source of data: Mumbai Metropolitan Regional Development Authority (2001).

There is also evidence that industry is not where the greatest mitigation challenge lies. This is clearly illustrated by the experience of Shanghai. While energy consumption has declined significantly in industry, it has risen rapidly in the rest of the economy and in the household sector (by 14.64% between 2005 and 2006 in the last) (Table 8 and Table 9). On the other hand, while energy intensity is higher than in the secondary sector (especially in industry) than elsewhere, it is falling fast, by 6.18% from 2005 to 2006. By contrast, energy intensity is increasing (although only slowly) in the tertiary sector. These mean that the greatest mitigation challenge will be to contain energy consumption growth outside industry even in Shanghai, the most industrialized city of the three.

Table 8. Allocation of electricity consumption in Shanghai 1990, 2000 and 2007

Year	Industry	Agriculture	Households	The rest
1990	83.5	2.7	5.5	8.4
2000	70.3	1.6	9.5	18.6
2007	65.8	0.5	12.2	21.5

Source: Shanghai Statistical Bureau (2008).

Table 9. Unit Energy Consumption of Different Economic Activities, Shanghai, 2006

Indicators	Unit	2006	Change over 2005 (%)
Energy /GDP	TSC/Yuan	8370	-3.71
Energy/value added			
- Primary sector	TSC/Yuan	9840	-7.79
- Secondary	TSC/Yuan	11120	-6.08
Of which: industry	TSC/Yuan	11600	-6.18
- Tertiary	TSC/Yuan	4950	0.13
Household energy consumption	1,000 TSC	7535.1	14.64

Source:Shanghai Statistical Bureau (2006). TSC stands for tons of standard coal.

IV. CONCLUSION

This paper has attempted to examine the implication of climate change for economic development strategies for Southern cities, focusing on the question whether climate change makes industrialization an obsolete strategy. Through the lens of Kaya Identity, industrial ecology, and theories of industrialization and de-industrialization, and considering the development experiences in Shanghai, Mumbai and Mexico City, it demonstrates that this is not so. The implication is several folds. First, addressing climate change concerns does not call for the abandonment of industrialization, or pre-mature de-industrialization. Second, industrialization can not carry on with its present mode of development nevertheless. For the sake of their local and national long-term prosperity as well as the global sustainability, it's imperative that developing cities meet the challenge of de-carbonizing their industries. Finally, if the experience of Shanghai is any guide, this can be done. Further research is however needed to formulate the practical ways forward.

V. BIBILIOGRAPHY

Bruckner, t., Edenhofer, O., Held, H., Haller, M., Lüken, M., and Bauer, N. (2007). "Robust Options for Decarbonisation, Background Paper for Session II: Energy Security", Postsdam Institute for Climate Impact Research, Potsdam, pp. 1-13. http://www.nobel-cause.de/scientific-background/Nobel_Symposium_energy_security_session_II.pdf (Jan. 7, 2008)

Burton, I., Diringer, E., and Smith J. (2006) *Adapation to Climate Change: International Policy Options*, Pew Center on Global Climate Change, Arlington, USA.

Burton, I., Diringer, E., and Smith, J. (2006) *Adaptation to Climate Change: International Policy Options.*, Pew Center on Global Climate Change, Arlington, USA.

Chandler, W., Schaeffer, D., Zhou, D., Shukla, P., Tudela, F., Davidson, O., and Alpan-Atamer, S. (2002) Climate Change mitigation in developing countries: Brazil, China, India, Mexico, South Africa, and Turkey. Washington D. C., Pew Center on Global Climate Change.

Chenery, H., Robinson, S., and Syrquin, M. (1986) *Industrialization and Growth: A Comparative Study* Oxford University Press, New York.

Dasgupta, S. and Singh, A. (2006) *Manufacturing, Services and Premature De-industrialization in Developing Countries: A Kaldorian Empirical Analysis*. Working Paper No. 327, Centre for Business Research, University of Cambridge.

Eriksen, S. and O'Brien, K. (2007). "Vulerability, poverty and the need for sustainable adaptation measures", *Climate Policy*, 7, 337-352.

European Commission (2007) *Limiting Global Climate Change to 2 Degree Celsius: The Way ahead for 2020 amd Beyond*, European Commission, Brussels, SEC (2007) 7/8.

Fukunishi, T., Murayama, M., Yamagata, T., and Nishiura, A. (2006) *Industrialization and poverty alleviation:pro-poor industrialization strategies revisited*, United Nations Industrial Development Organization (UNIDO), Vienna.

Graham, D. and Spence, N. (1995). "Contemporary Deindustrialization and Tertiarisation in the London Economy", *Urban Studies*, 32 (6), 885-911.

Grajales, G. (forthcoming) *The Manufacturing-Service Nexus in a de-industrialising city economy: The case of Mexico City*, Unpublished doctoral dissertation, University College London, London.

International Energy Agency (2008) "Chapter 7 - Energy-Related Carbon Dioxide Emissions," in *International Energy Outlook 2008*, International Energy Agency. http://www.eia.doe.gov/oiaf/ieo/emissions.html (Feb 27, 2009)

International Labour Organisation (1998-2009) *LABORSTA Labour Statistics Database*, International Labour Organisation, Geneva. http://laborsta.ilo.org/

IPCC (2007), *Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report*. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf (March 1, 2009).

Kaldor, N. (1966) *Causes of the Slow Rate of Economic Growth of the United Kingdom* Cambridge University Press, Cambridge.

Kaldor, N. (1978) *Further Essays on Economic Theory* Holmes and Meier, New York.

Kuznets, S. (1966) *Modern economic growth: Rate, Structure and Spread* Yale University Press, New Haven, CT.

Lever, W. F. (1991). "Deindustrialization and the Reality of the Post-Industrial City", *Urban Studies*, 28 (6), 983-999.

Martinussen, J. (1997) *Society, State and Market: A guide to competing theories of development* Zed Books, London and New York.

McCarthy, J. J., Canziani, O. F., Leary, N. A., Jijjeb, D. J., and White, K. S. (2001) *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Cambridge University Press, Cambridge.

Meier, G. M. (1995) *Leading Issues in Economic Development. 6th edition* Oxford University Press, New York and Oxford.

Mumbai Metropolitan Regional Development Authority (2001) *POPULATION AND EIMPLOYMENT PROFILE OF MUMBAI METROPOLITAN REGION*, Mumbai Metropolitan Regional Development Authority. http://www.mmrdamumbai.org/ (March 9, 2009)

Nakicenovic, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., Gregory, K., Grübler, A., Jung, T. Y., Kram, T., La Rovere, E. L., Michaelis, L., Mori, S., Morita, T., Pepper, W., Pitcher, H., Price, L., Riahi, K., Roehrl, A., Rogner, H.-H., Sankovski, A., Schlesinger, M., Shukla, P., Smith, S., Swart, R., van Rooijen, S., Victor, D., and Zhou, D. (2000) *Special Report on Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK..

Pacione, M. (2006). "City Profile: Mumbai", *Cities*, 23 (3), 229-238.

Roberts, J. T. and Parks, B. C. (2007) *A Climate of Injustice: Global Inequality, North-South Politics, and Climate Policy* The MIT Press, Cambridge, Massachusetts and London, England.

Robins, N., Clover, R., and Singh, C. (2009) *A Climate for Recovery: The colour of stimulus goes green*, HSBC Bank plc, London.

Robins, N. and Kumar, R. (1999). "Producing, providing, trading: manufacturing industry and sustainable cities", *Environment and Urbanization*, 11 (2), 75-94.

Rowthorn, B. and Ramaswamy, R. (1999). "Growth, Trade and Deindustrialization", *IMF Staff Papers*, 46 (1), 18-41.

Shanghai Statistical Bureau (2006) *2006 Communique of Energy GDP Unit Consumption Indicators of Shanghai Municipality*. Shanghai Statistical Bureau, Shanghai. http://tjj.sh.gov.cn/2005shtj/xw/node49/userobject1ai2936.html (March 1, 2009)

Shanghai Statistical Bureau, *Shanghai Statistical Yearbook*, Shanghai Statistical Bureau, Shanghai. Variou issues.

Smit, B., Pilifosova, O., Burton, I., Challenger, B., Hug, S., Klein, R. J. T., and Yohe, G. (2001) "Adaptation to Climate Change in the Context of Sustainable Development and Equity," in *Climate Change 2001, A Contribution of the Second Working Group to the Third Assessment Report*, p. 797-912.

Syrquin, M. (1988) "Patterns of Structural Change," in *Handbook of Development Economics*, vol. One H. Chenery and T. N. Srinivasan, eds., Elsevuer Science Publishers, Netherlands, p.203-273.

Thirlwall, A. P.(2003) *Growth and Development: With Special Reference to Developing Economies. 7th edition* Palgrave Macmillan, Basingstoke and New York.

UN-HABITAT (2006) *State of the World's Cities 2006/7*, UN-HABITAT.

United Nations Development Programme (UNDP) (2007) *Human Development Report 2007/2008. Fighting climate change: Human solidarity in a divided world*, Palgrave Macmillan, Basingston and New York.

World Bank (1990) *World Development Report 1990/1991*, World Bank, Washington, D.C.

World Bank (2007) *2007 World Development Indicators*, 2007, Washington, DC.

World Bank (2008) *World Development Indicators 2008*, World Bank, Washington, DC.

Young, A. A. (1928). "Increasing Returns and Economic Progress", *Economic Journal*, 38 (,December), 527-542.

Zhang, L.-Y. (2008) *Climate Change and Sustainable Development: Linakges and Approaches for integration.* A commissioned report for DESA, UN.

Zhang, L.-Y. (2003). "Economic Development in Shanghai and the Role of the State", *Urban Studies*, 40 (8),1549-1572.

[i] Urban-based economic activities account for up to 55 per cent of gross national product (GNP) in low-income countries, 73 per cent in middle-income countries and 85 per cent in high income countries (UN-HABITAT 2006).
[ii] The 2007 amounts are calculated by using the GDP deflator provided on http://www.measuringworth.com/uscompare/ .