Urbanization

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How has the concentration of the world's population in urban settlements changed in the past 300 years? Where and when has urban growth occurred, and why? What has happened to the distribution of cities by size? The first purpose of this chapter is to answer these questions by laying out the evidence on urban growth since 1700.

Has this urbanization resulted in environmental change? Is further urbanization likely to do so in the years ahead? Neither the social nor the physical sciences have answered these questions, yet the broad outlines of an answer certainly can be sketched. Until the middle of the twentieth century, urbanization levels were too low and the number of large cities was too small for there to be anything other than local climatic and hydrologic impacts. To the extent that urbanization produced environmental modification, it was in urban-centered gradients of agricultural land use and mineral and forest exploitation as urban demands diffused into the surrounding countryside. As late as 1900, there were barely 43 cities in the world exceeding 500,000 population, of which only 16 exceeded 1,000,000.[1] But since 1950, the number of large cities has increased very rapidly – close to 400 now exceed 1,000,000. Sprawling metropolitan areas have formed even larger agglomerations, and some very large urban regions with populations in the tens of millions have emerged. The question that arises in these cases is whether or not changes in the biosphere are unfolding at a regional scale that, in turn, might have global impacts. There is little to suggest that historic urban developments were active agents in climatic change. There is significant evidence that the modern metropolis has climatic and hydrologic consequences that increase with city size and urban densities. There is at least the suggestion that these consequences may be compounded at a regional scale in the largest agglomerations. But if our analysis is correct, regional-scale impacts may be more likely in the years ahead in Third World nations, where very large urban agglomerations are emerging, rather than in the most economically advanced countries, where a transformation is unfolding that is resulting in dispersed and relatively low-density urban networks. The very regions in which environmental alterations are most likely are those regions in which increasing shares of the world's population are concentrating.

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Urbanization in 1700: City-Centering of World Economies

The world of 1700 was largely agrarian. Urban populations were less than 10% of the whole. Yet in Fernand Braudel's view, this world was divided into a number of *city-centered world economies*: "economically autonomous sections of the planet able to provide for most of their own needs, sections to which their internal links and exchanges gave a certain organic unity" (Braudel 1984: 22). World economies, he said, centered on *world cities* that were in perpetual political and economic rivalry with each other, some rising and some falling. Each world city was surrounded by an immediate *core region* within which modification of the earth was greatest, a fairly developed *middle zone*, and a vast and relatively untouched *periphery* (Braudel 1984: 39). The core contained the concentration of everything that was most advanced and diversified, lying at the heart of the middle zone, the settled area of the state.

Thus, in the seventeenth century. Amsterdam was the "warehouse of the world" and the United Provinces were the middle zone. In this zone, urbanization levels rose to more than 30% (Wrigley 1987: 183): a high degree of agricultural specialization in cash crops for both the urban consumer and the industrial market developed; agriculture became close to gardening; ingenious methods of crop rotation were developed that were also to transform the English agricultural landscape; new drainage technologies were developed that enabled Holland's cultivable area to be increased and the British fenland to be settled; and the new middle-class spirit of Protestantism linked to capitalism was fostered, carrying with it associated ideas of man's dominion over nature. The closer to Amsterdam, the greater the degree of cash-crop specialization and the greater the extent of environmental modification to support agricultural development. The pattern was universal; the further from the world city, the less the clearance of the woodlands for ships' timbers, fuelwood, and farming. The more the city grew, the more intense the modification of the core and the wider the ring of diffusion into the middle zone. Furthest from the world city was the periphery, "with its scattered population, representing on the contrary backwardness, archaism, and exploitation by others" (Braudel 1984: 39; also Wallerstein 1974).

Tertius Chandler's statistics provide graphic evidence of the city-centeredness of Europe's world economies of 1700 (Chandler 1987; see also Table 1). What is impressive is both the sharpness of the primacy of most of Europe's world cities, many times the sizes of the other towns within their world economies, and the smallness of the capitals themselves, even though they accounted for a large share of the total urban population. Europe's six significant world economies centered on physically compact world cities that ranged in population from 200,000 to 700,000. Their surrounding core regions were equally small, as were the zones of active environmental modification.

This pattern was repeated elsewhere in the world. In China, new Manchu rulers had by 1700 restored the state apparatus of the Ming Dynasty. The Ching state (1644–1911), managed by competitively selected literati, engaged in economic planning to assure adequate supplies and effective distribution of foodgrains, presiding over a flexible market structure linking urban areas to the rural economy. Water management for both irrigated agriculture and transportation was one of the central administration's main duties, and was the measure of the efficiency of the state (Wittfogel 1957). The key component of the Chinese urban system was the establishment of a capital city – the emperor's seat and supreme political and spiritual authority of the empire – dominating and controlling the entire kingdom and concentrating the power of the bureaucracy. Beneath the capital city was an echelon of military-administrative centers, and beneath them the *Hsien* (county) capitals, which fulfilled the administrative roles of tax collection, military garrison, and dispensing public functions (Eisenstadt and Shachar 1987: 130).[2]

Similarly, in India, the Mogul Empire had been firmly established under the rule of Akhbar (1556–1605), who instituted a well organized central administration that was the cornerstone of governance over the next centuries and the basis of primate-city dominance. A similar dominance was evidenced in Japan even before reunified national political authority was asserted during the

Table 1 Urban Centers of the World Economies in 1700

France		**Britain-Holland**	
Paris	550,000	London	550,000
Lyon	97,000	Dublin	80,000
Marseille	75,000	Edinburgh	35,000
Rouen	63,000	Norwich	29,000
		Bristol	25,000
		Amsterdam	210,000
		Leiden	56,000
		Rotterdam	55,000
		Haarlem	48,000
		The Hague	36,000
Ottoman Empire		**Spanish Empire**	
Constantinople	700,000	Naples	207,000
Cairo	175,000	Palermo	124,000
Smyrna	135,000	Milan	113,000
Adrianople	85,000	Madrid	105,000
Damascus	70,000	Seville	80,000
Aleppo	67,000	Brussels	70,000
Bursa	60,000	Antwerp	67,000
Mecca	50,000	Mexico City	85,000
Baghdad	50,000	Potosi	82,000
Bucharest	50,000	Puebla	63,000
Belgrade	40,000		
Salonika	40,000		
German States		**Portugal**	
Hamburg	63,000	Lisbon	188,000
		Oporto	23,000
Austria		**Russia**	
Vienna	105,000	Moscow	114,000
Prague	48,000		
China		**Japan**	
Peking	650,000	Yedo	688,000
Hangchow	303,000	Osaka	380,000
Canton	200,000	Kyoto	350,000
Sian	167,000	Kanazawa	67,000
Soochow	140,000	Five more over	50,000
Nanking	140,000		
Wuchang	110,000	**Korea**	
Kingtehchen	100,000	Seoul	158,000
Niaghsia	90,000	Pyongyang	55,000
12 more over	50,000		
Moghul Empire		**Persia**	
Ahmedabad	380,000	Isfahan	350,000
Aurangabad	200,000	Tabriz	75,000
Dacca	150,000	Qazvin	60,000
Srinagar	125,000		
Patna	100,000	**Siam**	
Benares	75,000	Ayutia	150,000
Agra	70,000		
Delhi	60,000		

Source of data: Chandler 1987.

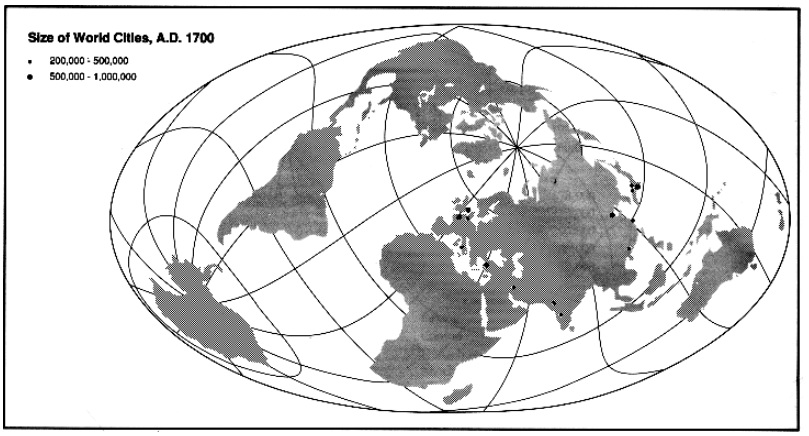

Fig. 1 The world cities in A.D. 1700

Tokugawa Shogunate (17th to 19th centuries). Japan's major cities were not simply political-administrative centers, but also centers of trade, tightly controlled by wholesale and retail monopolies and by the guilds. As in Europe, Asian world cities and the *ecumene* were small. The world urban map of 1700 was nearly empty. Only 5 cities exceeded 500,000 population, and only 34 exceeded 100,000.

Beyond Europe and Asia, in Central and South America, the largest urban places were those of the Spanish and Portuguese empires. Outside the Ottoman Empire, the largest of Africa's cities were Muslim – Algiers, Fez, Meknes, Tunis, and Sale-Rabat exceeded 50,000 in the Mahgreb, whereas the principal south Moslem centers were Katsina, Kazarganu, and Zaria. Only Oyo reached 50,000 in Black Africa. A few small dots on the map contained the majority of the world's urban population (Fig. 1).

Eighteenth-Century Quickening: Britain Emerges

The first example of urban-led economic growth that brought urbanization levels above 10% was that of the Netherlands from the early sixteenth century through their great age of economic supremacy in the seventeenth century (Braudel 1984; DeVries 1981; also see Fig. 2). The next example was that of Britain, whose navies and trading companies established their ascendancy during the eighteenth century as European nation-states reached outward to expand their world economies, establishing

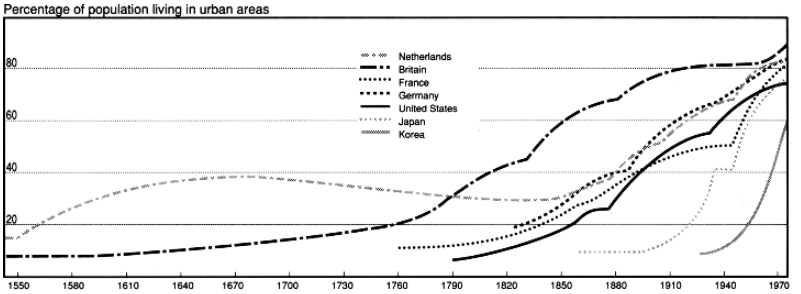

Fig. 2 Changing levels of urbanization, 1550–1980: The Netherlands, Britain, the United States, France, Germany, Japan, and Korea

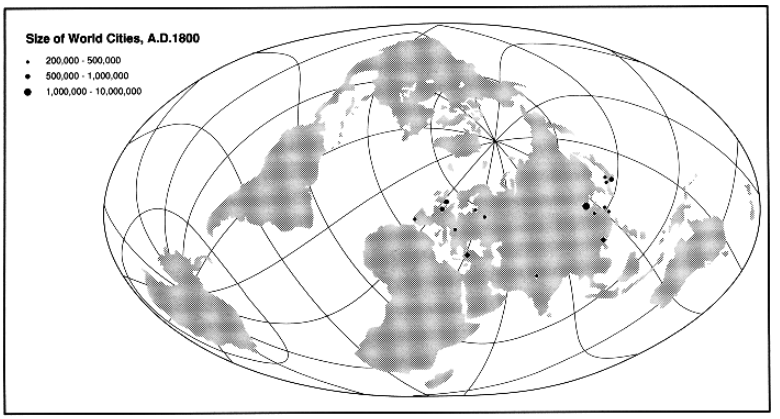

Fig. 3 The world cities in A.D. 1800

colonial outposts to exploit the resources of the peripheries and setting in motion the expansion of pioneer settlement frontiers. Radiating outward, there were waves of clearance, drainage, conversion, and extraction; with the extent of environmental modification – of human dominion over nature – patterned by gradients of accessibility to the world cities. London grew to be the largest city in Europe. Its food market radically changed the agricultures of the Kentish and East Anglian core. Its wealthy merchants bought country estates and hired the landscape gardeners who created England's rural landscape. The wealthy merchant classes of the core became the principal dissenters who set in motion Europeans' drive to master the North American wilderness. Yet by 1800, the world's urban map had scarcely changed (Fig. 3). Chandler's statistics show that the number of cities in the world with greater than 500,000 population had increased only from 5 to 6 and that the number of additional places exceeding 100,000 had increased only from 29 to 44 (Tables 2 and 3).

In contrast to the stationary state of Holland in the eighteenth century, it was Britain's growth that had been quickening. As a result, the urbanization of the population had been increasing since the mid-seventeenth century. But the pattern still was one of world-city concentration as mercantile expansion took place. Britain's urban percentage rose from 8.25% in 1600 to 17.0% in 1700, and London's share of the national population increased from 5% to 11.5% (Wrigley 1987: 163), justifying James I's fear that "soon London will be all England." The concentration of Britain's urban population in London increased from 60% in 1600 to 67% in 1700. The city's net population increase of 275,000 from 1650 to 1750, at a time when its death rates exceeded its birth rates, was achieved by absorbing the natural increase of a population of 5 million people, in which the surplus

Table 2 Changes in City-Size Distributions, 1700–1975

	Numbers of Cities Exceeding Specified Sizes (population in thousands)					
	>100	>200	>500	>1,000	>10,000	>20,000
1700[a]	34	14	5			
1800[a]	50	17	6	1		
1900[a]	287	142	43	16	1	
1950[b]	950	N.E.	179	76	N.E.	
1975[a]	N.E.	N.E.	422	191	7	1
2000[b]	1,699	N.E.	859	440	N.E.	N.E.

[a] Adapted from Chandler 1987: 521.
[b] United Nations 1980.
N.E.: not estimated.

Table 3 Major Cities in the World Economies of 1800

Britain[a]		**British Empire**		**Portugal**		**Austria-Hungary**	
London	861,000	Lucknow	240,000	Lisbon	237,000	Vienna	231,000
	(959,000)	Murshidabad	190,000	Oporto	67,000	Venice	146,000
Dublin	165,000	Benares	179,000			Prague	77,000
Glasgow	84,000	Hyderabad	175,000	**Holland**			
Edinburgh	82,000	Patna	170,000	Amsterdam	195,000	**Russia**	
Manchester	81,000	Calcutta	162,000	Rotterdam	60,000	Moscow	248,000
	(89,000)	Bombay	140,000			St. Petersburg	220,000
Liverpool	76,000	Surat	120,000	**Ottoman Empire**			
	(83,000)	Madras	110,000	Constantinople	570,000	**Japan**	
Birmingham	71,000	Dacca	106,000	Smyrna	125,000	Yedo	685,000
	(74,000)			Damascus	90,000	Osaka	383,000
				Adrianople	80,000	Kyoto	377,000
France				Aleppo	72,000	Nagoya	92,000
Paris	547,000	**French Empire**				Kanazawa	71,000
Lyon	111,000	Cairo	186,000	**Chinese Empire**			
Bordeaux	92,000			Peking	1,100,000	**Marathas and Rajputs**	
Marseille	83,000			Canton	800,000	Delhi	140,000
Rouen	80,000			Hangchow	387,000	Ujjain	100,000
Nantes	70,000			Soochow	243,000	Ahmedabad	89,000
				Sian	224,000	Baroda	83,000
Spain				Kingtehchen	164,000	Jodhpur	75,000
Madrid	182,000	**Spanish Empire**		Wuchang	160,000	Bharatpur	75,000
Barcelona	113,000	Mexico City	128,000	Tientsin	130,000	Nagpur	74,000
Seville	96,000	Manila	77,000	Foshan	124,000		
Cadiz	87,000			Chengdu	97,000	**Burma**	
Italian States				Langchow	90,000	Amarapura	175,000
Naples	430,000	**German States**		Changsha	85,000		
Rome	142,000	Berlin	172,000	Ningpo	80,000	**Korea**	
Palermo	135,000	Hamburg	117,000	Kaifeng	80,000	Seoul	194,000
Milan	122,000	Warsaw	75,000	Hsuchow	75,000	Pyongyang	68,000

Source: Chandler 1987.

[a] The alternative populations placed in parentheses are those appearing in Wrigley 1987: 160.

of births over deaths was 5 per 1,000 per annum (Wrigley 1987: 135–36). Capital-city concentration was a feature not only of English urban growth: during the eighteenth century fully 80% of European urban growth took place in its capital cities (DeVries 1981: 88).

It was Britain that first broke with the pattern of world-city urban concentration. From 1700 to 1800, the degree of urbanization in England increased from 17.0% to 27.5%, but London's share of the national population remained constant at around 11.0%, while its share of the urban population dropped from 67% to 40%. Urban growth accelerated outside London, with the main burst of expansion occurring in the last quarter of the century in such cities as Manchester, Liverpool, Birmingham, and Glasgow, and a second echelon in the 20,000-to-50,000 range that included Leeds, Sheffield, Newcastle, Stoke, and Wolverhampton. The English share of European urban growth had been 33% in the seventeenth century, but was over 70% in the second half of the eighteenth century (Wrigley 1987: 177), and this increased share was concentrated outside London in the newly industrializing north.

This was, of course, the initial wave of the Industrial Revolution, brought about by major advances in the cotton and iron industries, the first flush of factory building, significant

improvements in waterborne transportation, and also colonial policies that systematically destroyed Indian cotton-textile production and guaranteed imperial markets to Lancashire's producers. As a result of the quickening of growth, there were already heavy pressures on land use for bread grains and pasturage early in the century, to which one response was the Enclosure Movement. There was need for timber for shipbuilding, oaks for the Royal Navy, and wood ash for the alkalies used in the bleaching process by the textile industry. But above all, an energy shortage afflicted the economy at midcentury, calling forth the key inventions of Cort and Watt: the development of a substitute (coal) for progressively scarcer wood (the production of 10,000 tons of charcoal-iron required the felling of 40,000 hectares of forest; Wrigley 1987: 79); the need to drain the coal mines (steam engine); and the need to transport the coal (canals). Coal output increased in Britain from 3 to 10 million tons in the eighteenth century, particularly in the northeast, with easy access by sea to the London market.

The origins of the factory system were in another crisis: the shortage of spinners to supply the hand-loom weavers. The water frame and spinning jenny came into use in the 1770s. Water-powered scribbling mills were introduced in the 1780s, taking over the tasks of teazing and carding, but they were as dispersed as the weaver-crofters. It was only after 1800 that factory production concentrated on the coal fields, rivers, and canals; when steam began to replace the power of the overshot water wheel; and when the scribbling mill, the power mule, the dyehouse, the fulling mill, the warehouse, and the cropping shop were incorporated under a single roof. Only then did industrial urbanization begin in earnest, coal-field-oriented, with housing developments confined to walking distance of the mills, and it was reinforced after the turn of the century by the railroad and the steamship.

Long Waves of Industrial Urbanization

The late-eighteenth-century burst of industrial growth was concentrated in Britain, and ended in the sharp depression that followed the Napoleonic Wars and the War of 1812. From initial acceleration to a peak in 1792, followed by a turnaround into deceleration to depression, the wave of growth lasted about 55 years. This 55-year pattern has been repeated three more times in modern history. Each growth upswing quickened urbanward migration; each slowdown was followed by a lower rate of urban growth. From the 1820s on, the rhythms were sharpest in the United States, where the urbanward migrants came not only from America's farms, but from Europe too. The waves of emigration to the New World that increased in good times and decreased in bad times flattened the 55-year rhythms of European urban growth.

Urban growth, of course, has two components: natural increase and net migration. It is in urbanward migration that the 55-year long-wave rhythmicity of urban growth is revealed. If this rhythmicity is compared with the long swings of economic growth (as measured by the average annual growth rates of real GNP and of real GNP per capita), it is clear that the urbanward migrants were simply responding to economic opportunity; the waves of urban growth in the United States were sympathetic and somewhat lagged responses to waves of economic growth (Fig. 4). Each burst of economic growth called forth a rush of urbanward migrants and raised the level of urbanization.

It was the Soviet economist Nikolai Kondratiev who first drew attention to the 55-year-long-wave phenomenon (Kondratiev 1935; like all such ideas, this one had antecedents, for example van Gelderen 1913). As enriched by growth theorists such as Schumpeter (1934), the theory of long waves centers on the role of key innovations that become the leading sectors in growth. In the eyes of these theorists, clusters of innovations produce accelerated expansion until markets are saturated; there is then a recessionary turning point, acceleration turns to deceleration, and deceleration turns to stagnation and collapse in a depression. Venture capitalists then look for new sources of profit,

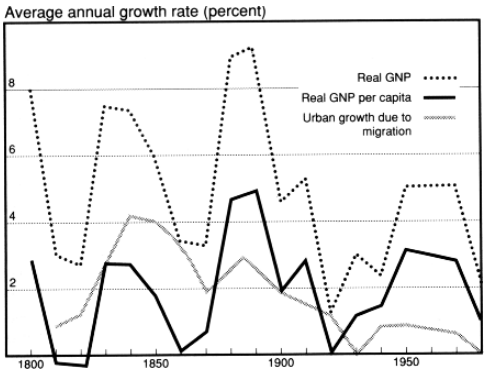

Fig. 4 Long waves of economic growth and urbanward migration in the United States, 1790–1980

investing in new technologies that become the leaders for the next wave of growth. The span from depression to depression averages some 55 years.

Following this argument, the late-eighteenth-century growth that was Britain's alone (the "first Kondratiev") was sparked by innovations in the water-powered textile industries. Britain's second wave of growth (the "second Kondratiev") was coal-based and steam-powered, marked by mechanization of the textile factories, initial railroadization, and the growth of the iron industry. It was in this wave that Britain became the "workshop of the world" and the center of the Atlantic economy. Around 1830, jerry-builders hit upon an ingenious house design that could save both land and building materials and that produced increasing urban concentration – the back-to-back house. Built in double rows under a single roof, with a standpipe for water supply at the end of the streets and a couple of earth closets devoid of privacy for each 150 people, this design could cram large numbers of houses into small spaces, without either sunlight or ventilation. The result was ". . .the despair of medical officers . . .(with) a mortality rate greater by 15 or 20 percent . . .the absence of a general system of sewerage, the imperfect conditions of the streets and roads, the confined courts, the open middens and cesspools, stagnant ditches and insufficient water supply" (F. Tillyard, quoted in Aldridge 1915).

It was apparent that the new urbanization was creating unhealthy environments – environments that persisted long into the twentieth century and were responsible for the growth of the modern public health and urban planning professions. Even in 1913 in Birmingham

> 200,000 people were housed in 43,366 buildings of the back-to-back type already long condemned or injurious to health because of lack of ventilation. In the worst six wards, from 51 percent to 76 percent were back-to-backs. Even more serious was the fact that 42,020 houses had no separate water supply, no sinks, no drains, and 58,028 no separate w.c., the closets being communal and exposed in the courts. This meant that over a quarter of a million people lived in cavernous conditions. The real objection to back-to-back houses lies not so much in their method of construction as in the degrading and disgusting condition of their out-buildings, which frequently made decency impossible and inevitably tended to undermine the health and morals of the tenants (Bourneville Village Trust 1941: 16).

There was lagged emulation of both the best and the worst of Britain's second-Kondratiev growth, in which factory chimneys and smoky atmospheres were the mark of progress. Victorian England became the hub of a worldwide economy. Liverpool and Manchester became the first noncapital cities in the world ever to rival in size the capital cities of the world empires. Railroadization and both industrial and urban growth diffused outward, finally reaching the world's furthest peripheries late in the twentieth century (Berry et al. 1987: 415–16).

As the Victorian boom began in Britain, the first wave of United States industrial and urban growth also took place, but it was predominantly water-powered (Fig. 5; Borchert 1967); this was the epoch in which the northeastern mill towns grew. Only toward the end did the railroads and the iron industries expand. It was not until after the Civil War that the locus of initiative shifted to

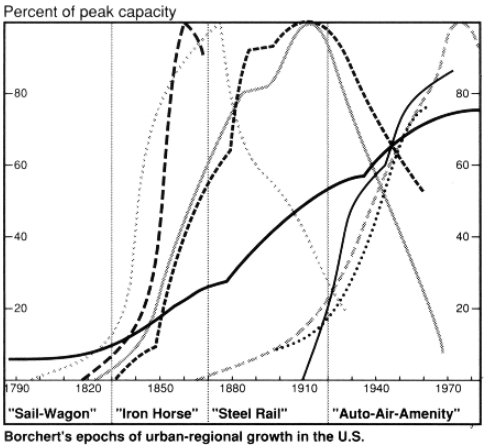

Fig. 5 Changing levels of urbanization in the United States compared with the dominant mode of transportation, 1790–1980

the United States and to continental Europe as the leading growth regions (Fig. 6). Urban growth rates in Britain slowed down, and were further depressed by the magnitude of emigration. It was the third Kondratiev that was the principal epoch of coal-based steam power in the United States (later supplemented by gas and electricity), of steel rails and ships, and of the growth of the chemical industry. New steel-frame technologies enabled urban densities to be increased by going upward at the same time that the balloon frame enabled rapid construction of workers' housing further outward. New communications technologies enabled the head office to be separated from the factory floor, and the office skyscraper core of the modern central business district was born. Large-scale mass production gave rise to the essence of urbanization, "a process of population concentration" (Tisdale 1942), characterized by increasing size of cities, increasing population densities, and the increasing heterogeneity of their immigrant populations (Wirth 1938). Radiating rail lines and omnibuses, originally horse-drawn but soon steam- (and later electric-) powered, first enabled owners and managers (and later the workers) to commute to residences beyond the confusion and smoky atmospheres of the concentrated core. By the end of the nineteenth century, the modern metropolis as we know it had been born.

When, in 1899, he wrote his monumental study *The Growth of Cities in the Nineteenth Century*. Adna Ferrin Weber concluded that "the most remarkable social phenomenon of the present century is the concentration of population in cities" (Weber 1899: 1). Chandler's statistics reveal a fivefold increase in the cities exceeding 125,000 population and an eightfold increase of those exceeding 500,000 between 1800 and 1900 (Table 2). The ancient Asian urban hierarchies of 1800 were replaced by a map dominated by major cities within Northern-hemisphere industrial regions, linked by overseas gateways to colonial empires (Fig. 7).

Britain's urban map was dominated in 1900 by nine major cities and a constellation of smaller industrial towns:

London	6,480,000
Manchester	1,435,000
Birmingham	1,248,000
Glasgow	1,015,000
Liverpool	940,000
Newcastle	615,000
Leeds	430,000
Sheffield	402,000
Edinburgh	400,000

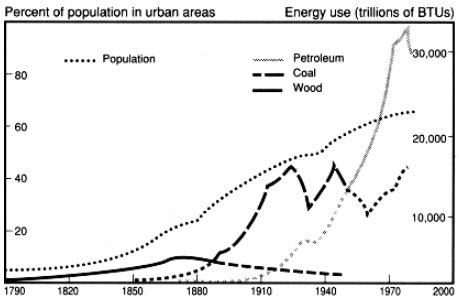

Fig. 6 Dominant sources of energy compared with the level of urbanization, 1790–1980

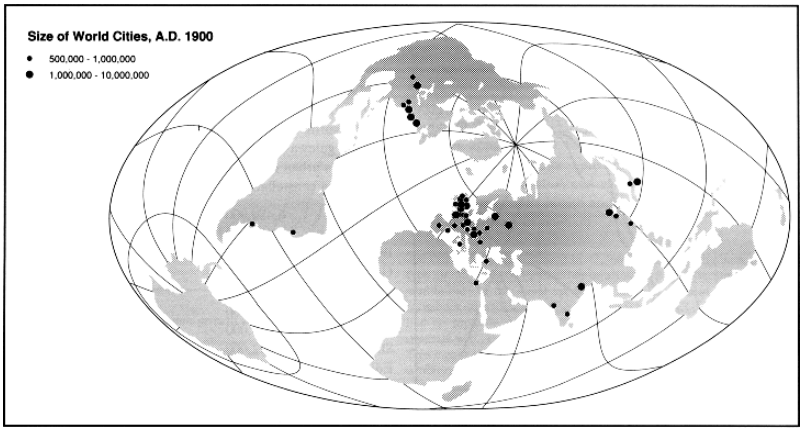

Fig. 7 The world cities in A. D. 1900

Eight urban complexes marked out Germany's industrial heartland:

Berlin	2,707,000
Hamburg	895,000
Ruhrgebiet	766,000
Dresden	540,000
Leipzig	532,000
Munich	499,000
Cologne	437,000
Breslau	427,000

Paris (3,330,000) still dominated France, but Lyon (508,000) and Marseille (410,000) had grown. Barcelona (552,000) now rivaled Madrid (539,000) in Spain, and Italy's first wave of industrialization had seen the rise of Milan (491,000), alongside Naples (563,000) and Rome (438,000). And instead of small mercantile centers on the eastern seaboard of North America in 1800, there now was the northeastern manufacturing belt marked out by major urban centers:

New York	4,242,000
Chicago	1,717,000
Philadelphia	1,418,000
Boston	1,075,000
St. Louis	614,000
Pittsburgh	562,000
Baltimore	508,000
Cincinnati	417,000

Standing in a dependent relationship to this heartland, radiating out across the national landscape, were resource-dominant regional hinterlands. But whereas within the United States the resources of the hinterlands had been brought within the nation's boundaries during the course of the nineteenth century by purchase and conquest, many of Europe's resource hinterlands were parts of overseas empires, and major cities had grown at the points of colonial penetration. To be sure, San Francisco (439,000) was a gateway to the West, but in the zones of active European settlement in the Southern Hemisphere, comparable gateway cities included Buenos Aires (806,000), Rio de Janeiro (744,000), Melbourne (485,000), and Sydney (478,000). Cairo's growth (595,000) reflected the flow of world commerce through the Suez Canal, Calcutta (1,085,000), Bombay (780,000), and Madras (505,000) were the gateways through which British Imperial domination of India was exercised, and even though Peking (1,100,000) remained China's largest city, external influence through Tientsin (700,000), Shanghai (619,000), Canton (585,000), and Hankow (480,000) dictated the dissolution of that imperial system. The balance of the world's urban map in 1900 was the more familiar one of the centers of the world empires: Europe's other capitals had grown [St. Petersburg (1,439,000), Moscow (1,112,000), Constantinople (900,000), Warsaw (724,000), Brussels (561,000), Amsterdam (510,000), and Copenhagen (462,000)]; and Tokyo (1,497,000) and Osaka (970,000) were still dominant in Japan; but there was a great gulf between them and lesser cities within their regions.

As impressive as these numbers may be, the change had not yet produced any truly urbanized societies, save perhaps Great Britain. Only 43 cities in the world exceeded 500,000 population in 1900, although 16 of them were now more than a million. Barely ten nations had more than 25% of their populations living in urban centers of more than 10,000 people in 1900 (Great Britain, Belgium, the Netherlands, Germany, France, the United States; Turkey-in-Europe, plus Australia, Argentina, and Uruguay) – a level of urbanization that was surpassed in 1985 by all but a few of the very poorest of the world's nations (Figs. 8 and 9).

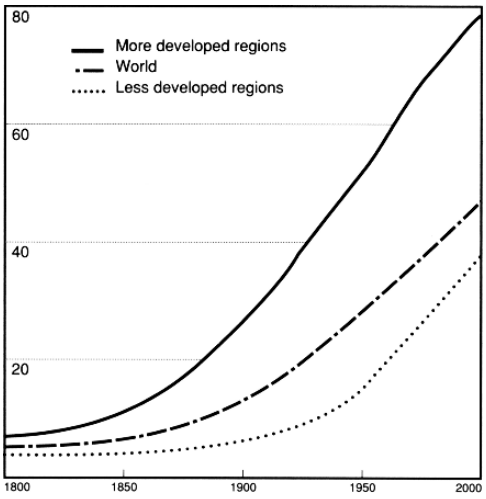

Fig. 8 Increases in the level of urbanization in the world's more- and less-developed regions. 1800–2000

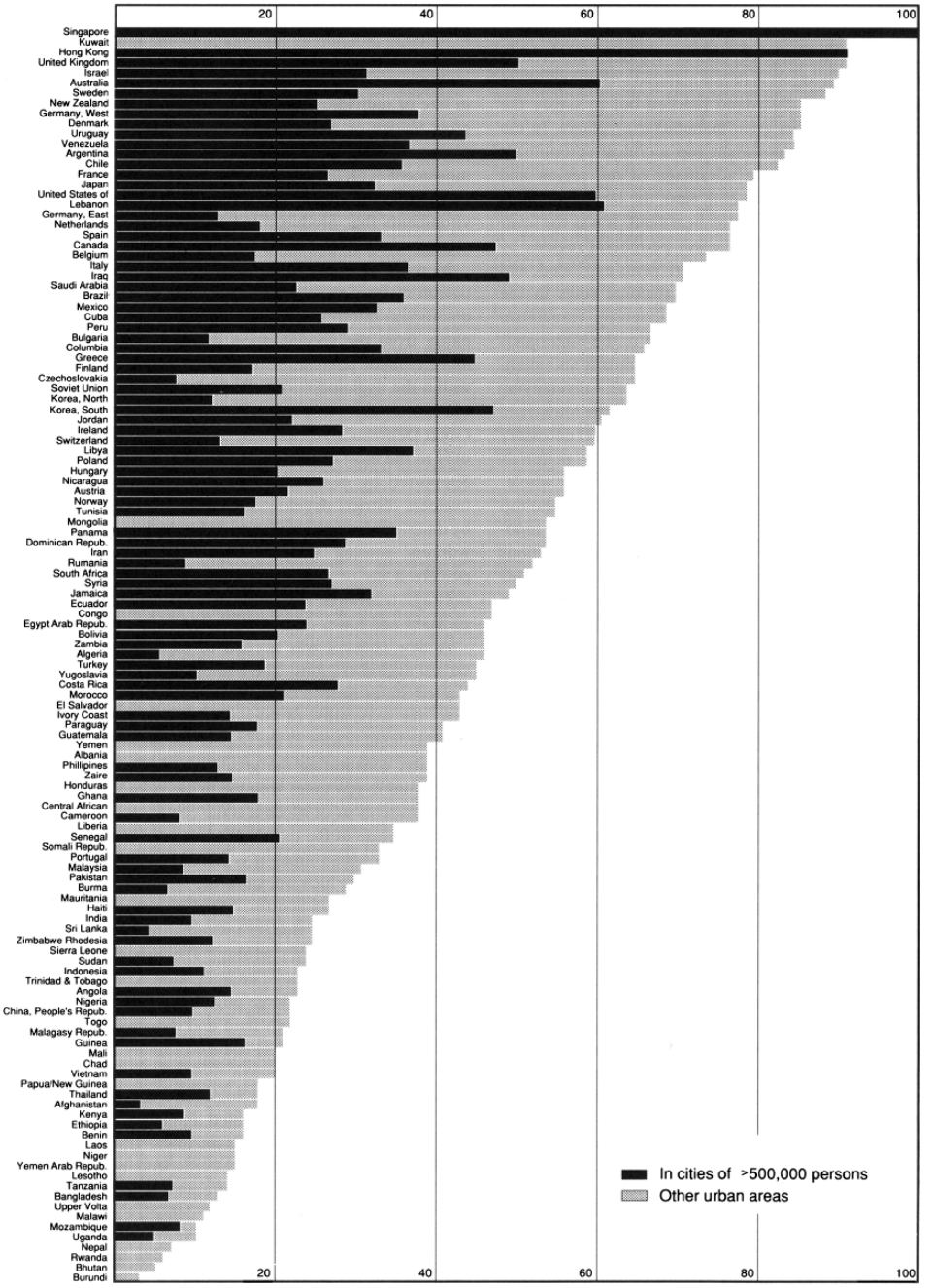

Fig. 9 World urbanization levels in 1985

What was significant about late-nineteenth-century growth was not that it urbanized the world, but that it produced a new scale and texture of world empires; the heartland (core) and hinterland (periphery) pattern of regional specialization in which multiechelon hierarchies of urban places played the critical structuring role. In the United States this involved the concentration of big cities in the northeastern manufacturing belt, the great heartland nucleation of industry and the national market, the focus of large-scale national-serving industry, the seedbed of new industry responding to

the dynamic structure of national final demand, and the center of high levels of per capita income. Standing in a dependent relationship to the heartland, radiating out across the national landscape there developed resource-dependent regional hinterlands specializing in the production of raw material and intermediate outputs for which the heartland reached out to satisfy the input requirements of its great manufacturing plants. In the hinterlands, resource endowment was a critical determinant of the particular cumulative advantage of the region and hence its growth potential. In each case, the basic conditions of regional growth were set by the heartland. It was the lever for successive development of newer peripheral regions by reaching out to them as its input requirements expanded, and it thereby fostered specialization of regional roles in the national economy. The heartland experienced cumulative urban-industrial specialization, while each of the hinterlands found its comparative advantage based on narrow and intensive specialization in a few resource subsectors – diversifying only when the extent of specialization enabled the hinterland region to pass through that threshold scale of market necessary to support profitable local enterprise. Flows of raw materials inward and finished products outward articulated the whole. Large cities grew at the center of each region and at the top of each regional hierarchy – centers of activity and of innovation, focal points of the transport and communications networks, locations of superior accessibility, at which firms could most easily reap economies of scale and at which industrial complexes could obtain economies of localization and urbanization, encouraging labor specialization and efficiency in the provision of services.[4]

The urban-industrial system that evolved within the expanding national boundaries of the United States was duplicated globally by each of Europe's imperial powers. Each developed an economic heartland and each reached out globally for resource-dependent hinterlands, in the core-periphery pattern described by V. I. Lenin's "colonial model." Only imperial Russia mirrored the United States by bringing its peripheries within the frontiers of the nation-state. For Britain, France, Germany, Italy, Spain, and Portugal, the mother-country, urban-industrial cores reached out both for colonial raw materials and for safe colonial markets. Systems of imperial preference cemented the relationship, along with active European settlement of more temperate areas, from which the indigenous populations were relatively easily displaced. Urban-centered interconnections held the colonial networks together – networks that were to be disconnected in the twentieth century by two global wars separated by a profound depression. World War I disassembled the ancient Habsburg and Ottoman empires. World War II stemmed Germany's ultimately unsuccessful search for *lebensraum* and Japan's attempt to create its "greater East Asia co-prosperity sphere" by military means, but the price to the victors also was a loss of empire.

The Great Depression marked another technological watershed – from coal, steam, and rail to petroleum and the internal combustion engine. The base for new rounds of urban growth was the kind of city that had emerged in the nineteenth century, built on productive power, massed population, and industrial technology, and credited with the creation of a system of social life founded on entirely new principles. "Urbanization," wrote Tisdale (1942) "is a process of population concentration. It proceeds in two ways; the multiplication of the points of concentration and the increasing in size of individual concentrations. . . . Just as long as cities grow in size or multiply in number, urbanization is taking place. . . . Urbanization is a process of becoming. It implies a movement . . . from a state of less concentration to a state of more concentration." It was these concentrated urban environments that produced the local climatic and hydrologic alterations discussed in the section that follows.

In part, the reason for agglomeration was the concentration of large-scale production facilities at strategic points on efficient interregional transportation networks. It resulted partly from the specialization of functions that large-scale industry made possible, with external economies to be reaped within the agglomerations. But relatively poor intraregional transportation (still predominantly foot and horse until the Great Depression) meant that externalities could be captured only in the most central locations within the agglomerations. Supported by new building technologies, high-rise central business districts developed at the urban cores, surrounded by inner-city manufacturing, and then

by high-density rings of workers' housing. Only the upper classes could escape the perceived ills of the core-oriented concentrations as street railways, tramways, and the omnibus provided access to more pleasant and lower-density environs.

A new concept was needed to capture the scale of the largest agglomerations. The authors of a report issued by the United States Bureau of the Census (1932) in the 1930s wrote that "the population of the corporate city frequently gives a very inadequate idea of the population massed in and around that city, constituting the greater city. [The boundaries of] large cities in few cases limit the urban population which that city represents or of which it is the center. If we are to have a correct picture of the massing or concentration of population in extensive urban areas it is necessary to establish *metropolitan districts* which will show the magnitude of each of the principal population centres." Spelling out the idea further, the Bureau of the Budget's Committee on Metropolitan Area Definition (1967) wrote: "The general concept of a *metropolitan area* is one of an integrated economic and social unit with a recognized large population nucleus."

The situation was both fluid and dynamic, however, and the form of the metropolis changed rapidly in the period of accelerating economic growth that followed World War II, facilitated by the new technologies that assumed ascendancy at this time. The concentrated industrial metropolis developed because proximity meant lower transportation and communication costs for those interdependent specialists who had to interact with each other frequently or intensively. But shortened distances meant higher densities and the costs of congestion, polluted environments, high rent, loss of privacy, and the like. The technological developments implemented in the fourth Kondratiev had the effect of reducing the constraints of geographic space and the costs of concentration. Modern transportation and communications made it possible for each succeeding generation to live farther apart, producing first, accelerated suburbanization and urban sprawl, and later, real deconcentration. In 1902 H. G. Wells had speculated about the possibility:

> Many of [the] railway-begotten "giant cities" will reach their maximum in the coming century [and] in all probability they . . .are destined to . . .dissection and diffusion . . .[*T*]*hese coming cities will not be, in the old sense, cities at all; they will present a new and entirely different phase of human distribution* [italics added] [T]he social history of the middle and latter third of the nineteenth century . . .[has been] the history of a gigantic rush of population into the magic radius of – for most people – four miles. . . .But . . .[n]ew forces, at present so potently centripetal in their influence, bring with them the distinct promise of a centrifugal application. . . .Great towns before this century presented rounded contours and grew as puff-ball swells; the modern Great City looks like something that has burst an intolerable envelope and splashed . . .the mere first rough expedient of far more convenient and rapid developments. . . .We are . . .in the early phase of a great development of centrifugal possibilities . . .[A] city of pedestrians is inexorably limited by a radius of about four miles . . .a horse-using city may grow out to seven or eight . . .[I]s it too much . . .to expect that the available area for even the common daily toilers of the great city of year 2000 . . .will have a radius of over one hundred miles? . . .[T]he city will diffuse itself until it has taken up . . .many of the characteristics of what is now country . . .[T]he country will take itself many of the qualities of the city. The old antithesis will . . .cease, the boundary lines will altogether disappear.[5]

These predictions were certainly realized in the United States. After 1950, growth of the service sector, increase in the number of "footloose" industries (including final processing of consumer goods using manufactured parts, and the aircraft, aerospace, and defense industries), rapid emergence of a "quaternary" sector of the economy (involving, for example, the research and development industry), expansion and interregional migration of the non-job-oriented population (for example, of retirees to Florida, Arizona, and California), rising governmental expenditures and overall rising real incomes, plus modern highways and the automobile – all served to produce yet another transformation of the economy and the urban system that confirmed H. G. Wells' forecasts. Not only did urban areas grow and disperse into sprawling metropolitan regions; advantages for economic growth were found during the fourth Kondratiev in former hinterland regions around the "outer rim" of the country as changing communications technology reduced the time and costs involved in previous heartland-hinterland relationships.

The changes were cumulative. First, regional growth within the context of the national pattern of heartland and hinter-land brought outlying regions to threshold sizes for local production of a wide variety of goods and services. But then, they developed alternative bases of expansion as changes in the definition of urban resources made their rapid advance, free of the traditional constraints of heartland-hinterland leverage, possible. Hence, the explosive metropolitan growth of the South, Southwest, and West, led by the tertiary and quaternary sectors. The outcome was that it became possible, by the end of the 1960s, to interpret the spatial structure of the United States as a pattern consisting of (1) metropolitan areas and (2) the intermetropolitan periphery. Except for thinly populated parts of the American interior, the inter-metropolitan periphery included "all the areas that intervened among metropolitan regions and that were the reverse image of the trend towards large scale concentrated settlement. . . .Like a devils' mirror . . .the periphery . . .developed a socioeconomic profile that perversely reflects the very opposite of metropolitan virility" (Friedmann and Miller 1965).

Even by 1960, much of the United States territory was covered by the daily commuting areas of its metropolitan centers, as the far-flung suburbs made possible by the automobile and by superhighway construction spread across the national landscape. The Greek planner Constantinos A. Doxiadis called these urban regions *daily urban systems* (Berry 1968). The coalescence of expanding metropolitan areas along the northeastern seaboard of the United States led Jean Gottman (1961) to coin a new term for the phenomenon – *megalopolis* – and a later author, somewhat facetiously, to call three such alleged developments "BosWash," "ChiPitts," and "SanSan," Peter Hall (1973) went on to document the extent of megalopolitan development elsewhere in the world, arguing that similar processes were unfolding in every economically advanced area.

It is these metropolitan regions that have been the subjects of extensive environmental analysis in the past half century, and it is from this analysis that we have been able to develop an understanding of the impacts of urbanization upon the biosphere.

Environmental Effects of Metropolitan Growth

Urban modification of the atmospheric environment can occur at three geographic scales (Berry and Horton 1974):

1. Locally, by alterating in the nature of the effective surface: the replacement of the natural surface of soil, grass, and trees by the multiplicity of urban surfaces of brick, concrete, glass, and metal at different levels above the ground. These artificial materials change the nature of the reflecting and radiating surfaces, the heat exchange near the surface, and the aerodynamic roughness of the surface.
2. Regionally, by generating large amounts of heat artificially and by altering the composition of the atmosphere via emission of gaseous and solid pollutants. At certain times of the year in mid-latitude cities, artificial heat input into the atmosphere by combustion and metabolic processes may approach or even exceed that derived indirectly from the sun. The heat island that results serves as a trap for pollutants.
3. Potentially, globally, through urban contributions to the sulfur budget or to CO_2, and thus to the greenhouse effect, to global warming, and to sea-level changes that are likely to be of greatest consequence for major coastal cities.

Leopold (1968) records four interrelated but separable effects of local land-use changes on the hydrology: changes in peak-flow characteristics; changes in total runoff; changes in water quality; and changes in hydrologic amenities. Stream flows following rainstorms may be characterized by

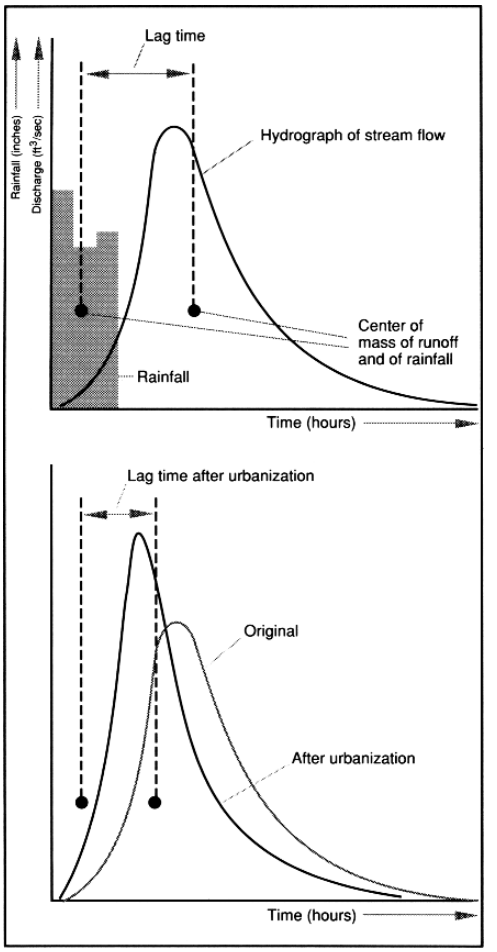

Fig. 10 Unit hydrographs before and after urbanization

unit hydrographs that capture both the peakedness and the lags in the rainfall-discharge relationship (Fig. 10). After urbanization, runoff occurs more rapidly and with a greater peak flow than under nonurban conditions. Urbanization increases the impervious land area, and the urban area may be served by storm sewers. Both increase the peak discharge: maximum sewerage and imperviousness results in peak discharges that are more than six times greater than in unurbanized conditions. In their turn, sharper peak discharges increase flood frequencies (Fig. 11) and the ratio of overbank flows. Urbanization, then, increases the flood volume, the flood peak, and the flood frequency, and the flushing effect increases turbidity and pollutant loads, although sediment loads may fall and the channel response will therefore shift from aggradation to bank erosion (Wolman 1967). Water pollution, in its turn, changes the quality of the downstream resource, the ecology of the riverine environment, and the amenity value of the river bank or estuary. The effects become pronounced downstream of the larger cities, where natural flushing is incapable of preventing long-term damage.

At the scale of the metropolitan region, Landsberg's 1981 summary of the major changes in climates is, of course, well known (Table 4), but it needs to be discussed because it provides on-average estimates rather then insights into variations with city size.

The most dramatic effect of metropolitan growth is the creation of the urban heat island, which serves as a trap for atmospheric pollutants. Ceteris paribus, the temperature differential between the city core and the rural periphery increases with city size; the differences are small and ephemeral in places of 250,000 or less population, but are both substantial and longer-lasting in larger places. The

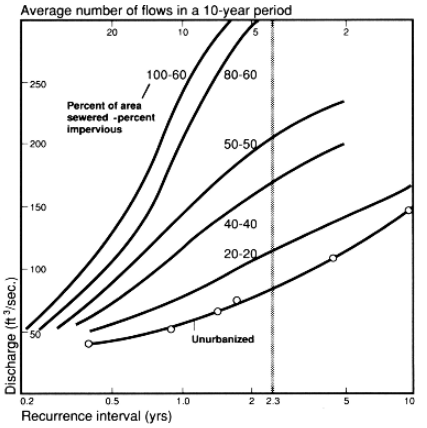

Fig. 11 Increasing flood frequencies as urbanization progresses

Table 4 On-Average Effects of Urbanization on the Climate of Cities

Element	Compared to rural environs
Contaminants	
Condensation nuclei	10 times more
Particulates	50 times more
Gaseous admixtures	5–25 times more
Radiation	
Total on horizontal surface	0–20% less
Ultraviolet, winter	30% less
Ultraviolet, summer	5% less
Sunshine duration	5–15% less
Cloudiness	
Clouds	5–10% more
Fog, winter	100% more
Fog, summer	30% more
Precipitation	
Amounts	5–15% more
Days with less than 5 mm	10% more
Snowfall, inner city	5–10% less
Snowfall, lee of city	10% more
Thunderstorms	10–15% more
Temperature	
Annual mean	0.5–3.0° C more
Winter minimums (average)	1–2° C more
Summer maximums	1–3° C more
Heating degree days	10% less
Relative Humidity	
Annual mean	6% less
Winter	2% less
Summer	8% less
Wind Speed	
Annual mean	20–30% less
Extreme gusts	10–20% less
Calm	5–20% more

Source: Landsberg 1981.

heat island expands and intensifies as the city grows, and stronger and stronger winds are needed to overcome it. Wind speeds of $5\,\mathrm{m/sec^{-1}}$ can eliminate the heat island in a city of 250,000, but speeds of $10\,\mathrm{m/sec^{-1}}$ are required when the size reaches 1,000,000, and $14\,\mathrm{m/sec^{-1}}$ at 10,000,000. Yet the surface roughness of the city serves to reduce wind speeds and inhibit this ventilation: average wind speed may be reduced as much as 30% by the big city. In the larger cities over 10,000,000, the mean annual minimum temperature may be as much as $4^{\circ}\,\mathrm{F}$ higher than that of the surrounding rural periphery. This difference is much greater in summer than in winter.

The causes are twofold, both of which are seasonally dependent. (1) In summer, the tall buildings, pavement, and concrete of the city absorb and store large amounts of solar radiation, and less of this energy is used for evaporation than in the country because of the high runoff. The stored energy is released at night, warming the urban air. (2) In winter, manmade energy used for heat and light produces the warming, yet the blanket of emissions reduces incoming radiation by as much as 20%. If the BosWash megalopolis reaches a population of 50–60 millions by the year 2000, it will be characterized by heat rejection of $65\,\mathrm{cal/cm^2/d}$. In winter, this is 50%, and in summer, 15%, of the heat received by solar radiation on a horizontal surface. In Manhattan, the heat produced by combustion alone in winter has been estimated to be two and one-half times the solar energy reaching the ground. This energy is trapped by the blanket of pollutants over the city, including particulates, water vapor, and carbon dioxide, and is reemitted downward to warm the ambient air.

In addition to the heat island, other climatic effects of urbanization – all increasing with city size – include greater cloudiness, fog, dust, and precipitation, but lower humidity. And as wind dissipates the heat island, a downwind urban heat plume is detectable in the atmosphere. Along this plume, there are increased precipitation, thunderstorm and hail probabilities. Beyond such regional-scale consequences, urban activities are a major source of CO_2 and of the fluorocarbons that, in combination, may affect future global climates and sea levels.

Urbanization and Environment in the Years Ahead

The local- and regional-scale environmental effects of urbanization are all big-city, high-density, maximum-imperviousness consequences of million-plus, core-oriented, high-rise concentrations. Between 1975 and 2000, the number of million-plus cities is expected to more than double, from 190 to 440 (Table 2). Where they coalesce into larger agglomerations, the environmental effects converge at even broader regional scale – one graphic example of which is provided by a schematic

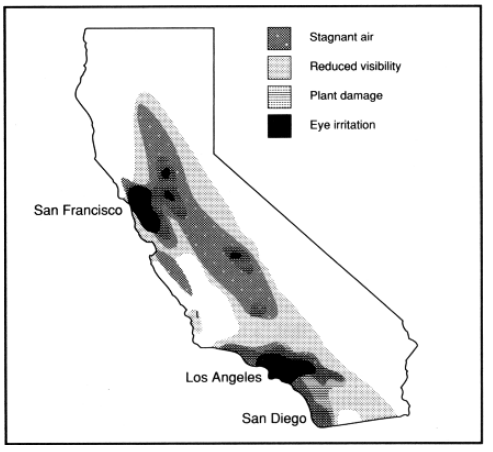

Fig. 12 The extent of air pollution in California

Table 5 The World's Urban Population, 1950–1985 (in thousands)

	1950		1960		1970		1975		1980		1985	
	pop.	%	pop.	%	pop.	%	pop.	%	pop.	%	pop.	%
World total	726,673	100	1,019,847	100	1,368,169	100	1,573,913	100	1,809,439	100	2,084,844	100
Percentage of total pop.	28.9		33.7		37.2		39.0		41.0		43.2	
Annual growth rate (%)			3.4		3.0		2.8		2.8		2.9	
Africa	32,434	4.5	50,416	4.9	80,644	5.9	103,832	6.6	134,951	7.5	174,829	8.4
Percentage of total pop.	14.8		18.4		22.8		25.6		28.8		32.1	
Annual growth rate (%)			4.5		4.8		5.2		5.4		5.3	
Latin America	67,465	9.3	106,520	10.4	162,075	11.8	197,250	12.5	238,283	13.2	285,274	13.7
Percentage of total pop.	41.2		49.5		57.3		61.2		64.7		67.8	
Annual growth rate (%)			4.7		4.3		4.0		3.9		3.7	
North America	106,018	14.6	133,280	13.1	159,493	11.7	170,167	10.8	181,433	10.0	194,871	9.3
Percentage of total pop.	63.8		67.1		70.5		72.0		73.7		75.4	
Annual growth rate (%)			2.3		1.8		1.3		1.3		1.4	
East Asia	112,638	15.5	199,855	19.6	276,808	20.2	322,530	20.5	371,199	20.5	425,010	20.4
Percentage of total pop.	16.7		24.5		28.2		30.3		32.7		35.3	
Annual growth rate (%)			5.9		3.3		3.1		2.9		2.7	
South Asia	112,507	15.5	158,717	15.6	234,924	17.2	286,228	18.2	352,827	19.5	437,409	21.0
Percentage of total pop.	15.9		18.3		21.2		22.8		24.8		27.2	
Annual growth rate (%)			3.5		4.0		4.0		4.3		4.4	
Europe	217,205	29.9	256,023	25.1	302,276	22.1	323,465	20.6	340,785	18.8	357,588	17.2
Percentage of total pop.	55.4		60.2		65.8		68.2		70.5		72.6	
Annual growth rate (%)			1.7		1.7		1.4		1.0		1.0	
Oceania	7,741	1.1	10,451	1.0	13,680	1.0	15,519	1.0	17,245	1.0	19,098	0.9
Percentage of total pop.	61.2		66.2		70.8		73.4		75.7		78.0	
Annual growth rate (%)			3.0		2.7		2.6		2.1		2.1	
USSR	70,765	9.7	104,589	10.3	138,270	10.1	154,923	9.8	172,715	9.5	190,765	9.2
Percentage of total pop.	39.3		48.8		56.7		60.9		64.8		68.2	
Annual growth rate (%)			4.0		2.8		2.3		2.2		2.0	

Source: United Nations 1980.

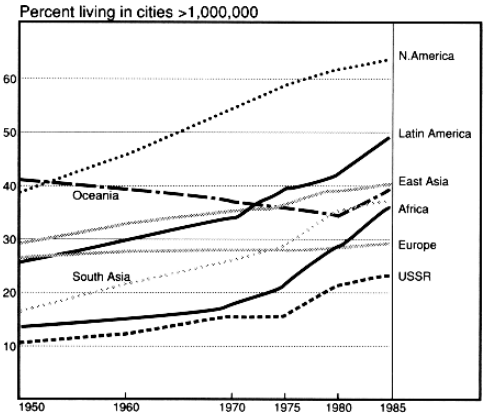

Fig. 13 Increases in the percentage of urban population living in million-plus cities

illustration of the extent of air pollution in California (Fig. 12; Berry and Horton 1974: 83). But the regional distribution of large agglomerations is changing rapidly, suggesting a new locus for such regional-scale environmental effects. Urbanization is increasing most speedily in Latin America, Africa, and South Asia (Table 5), and it is there that the most rapid increases in the proportion of the population concentrated in million-plus cities are taking place (Fig. 13). Between 1950 and 1985, Europe and North America's share of the world's urban population dropped from 45% to 26%, even while the numbers in their cities grew from 325 to 500 million. In the rest of the world, the urban population jumped from 400 million to almost 1,600 million. During the next Kondratiev, much of the world can be expected to urbanize as completely as the more developed regions, and what this means is that the Third World will have large numbers of very large urban regions. At the end of the Great Depression, the world's more developed regions were barely 40% urbanized, but by the 1980s the percentages were in the 70s. Today, the world's less developed regions are approaching the 40% level, and their urban growth is still accelerating.

For the next half century, much of the world will be experiencing the process of population concentration that has already ended in North America and western Europe. In the economically advanced regions, urbanization is not a stationary process, however; there is change in the nature of change, the environmental consequences of which are unclear. As metropolitan regions have rushed outward, urban densities and inner-city populations have dropped, leaving behind the most disadvantaged people in and around the former cores, inheriting the urban environments produced by earlier rounds of growth. Major reversals of patterns and reshaping of urban systems have been unfolding: what I have called a *process of counterurbanization* and what others have called *polarization reversal* or the *urban turnaround* (Ogden 1985; Richardson 1980; Vining and Kontuly 1978; Vining and Strauss 1977). Thus, in 1976 I wrote that "a turning point has been reached in the American experience. Counterurbanization has replaced urbanization as the dominant force shaping the nation's settlement patterns. . . .The process of counterurbanization has as its essence decreasing size, decreasing density, and decreasing heterogeneity: *counterurbanization is a process of population deconcentration; it implies a movement from a state of more concentration to a state of less concentration*." Counterurbanization is occurring in most of the world's advanced economies, often helped along by planning policies designed to stem big-city growth, and in the socialist world, by attempts to create the "city of socialist man" (Berry 1981).

One explanation for the turnaround is the existence of urban disamenities: that premiums have to be paid to do business in larger urban agglomerations, where the social costs and environmental burdens of urban living are greater. On the one hand, larger urban areas have been places of greater productivity, but on the other, they have been the locus of growing disamenities. If the disamenities

Table 6 Nodes of the Global Polycenter

Region (Urban complex)	Headquarters	Population
North America		
New York	90	17,100,000
Chicago	28	7,600,000
Los Angeles	22	8,900,000
San Francisco	15	4,400,000
Philadelphia-Wilmington	14	5,200,000
Dallas–Fort Worth	14	2,400,000
Houston	13	2,100,000
St. Louis	10	2,200,000
Detroit	9	4,800,000
Pittsburgh	9	2,000,000
Asia		
Tokyo	88	23,000,000
Osaka-Kobe	37	15,500,000
Seoul	9	6,800,000
Europe		
London	63	10,500,000
Paris	39	9,400,000
Ruhrgebiet	21	5,500,000
Frankfurt	13	1,600,000
Randstadt	9	2,000,000
Rome	4	3,600,000

keep growing and technological change reduces the productivity advantages of agglomeration, the point will be reached where a turnaround will occur and growth will disperse, and as growth disperses, the disamenities should be ameliorated. Some have argued that what is emerging are *urban civilizations without cities*. New technologies are compressing time and space and accelerating change, lessening the need for face-to-face contact because of instantaneous electronic communications in the new age of the computer. Populations are therefore moving into high-amenity areas newly endowed with electronic access, reducing the local- and regional-scale pressures that result in environmental modification at those scales. A new kind of much more harmonious relationship with natural environments that are valued appears to be emerging in such civilizations.

This is, however, not the end of the story. Other forces are beginning to exert their influences: (1) the reemergence of external economies as primary locational factors; (2) the rise of flexible production systems; (3) as a consequence, the reagglomeration of production in new regions in which the settlement pattern is polycentric; (4) the connection of these polycentric urban networks into a global system or polycenter organized by a limited number of complexes of multinational headquarters. One way to characterize the resulting urban systems is as dynamic networks. No longer are vertical hierarchies arranged regionally into heartlands and hinterlands; instead, the "cores" are centers of creativity and entrepreneurial activity wherever they may be located, and are linked into transnational networks. The important decisions are made in some 500 major private corporations, whose headquarters are dispersed throughout 19 great urban regions. These regions, tightly interlinked, constitute the polycenter of the global urban network (Table 6 and Fig. 14). This polycenter controls networks of interdependent specialists, and wherever such networks have penetrated, the old models of neat urban hierarchies topped by big cities, of heartlands and hinterlands, and of metropolitan and nonmetropolitan spaces have vanished. Yet we do not know if the environmental effects of the new-form settlements will be regional-scale disruptions of the biosphere (California style), or if they will signal an amelioration of the worst of the environmental effects of the large, core-oriented metropolis.

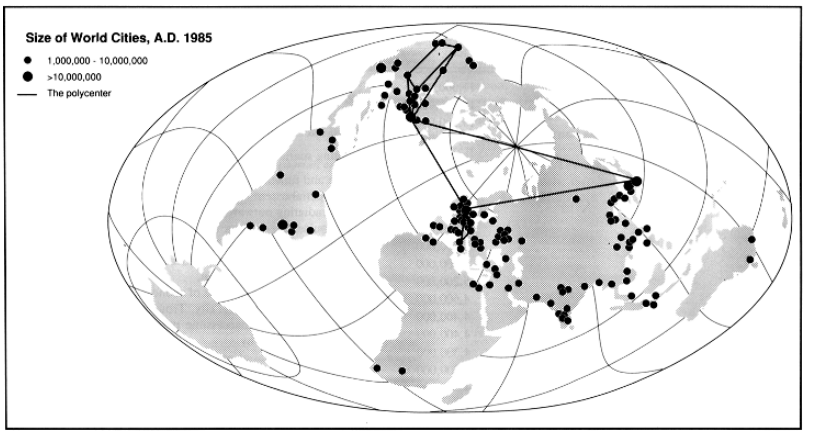

Fig. 14 The polycenter and the periphery. A. D. 1985

Meanwhile, in the world periphery beyond the polycenter, there is a growing list of very large cities in which the process of population concentration accompanied by local- and regional-scale environmental modification is being repeated. In 1975, Chandler's list included 19 urban regions that already had exceeded 4 million in population (Table 7). Another 46 had exceeded 2 million. As the dispersed polycenter continues to evolve in the First World, it is in these massive urban agglomerations, peripheral to the main chanels of global interdependence, that the greatest modifications of the biosphere will occur, changing the regional environments within which a growing proportion of the world's population will live marginal lives, pressed to the threshold of subsistence. The scale of Third World urban growth is such that even if First World environmental impacts are significantly reduced, the reductions will be swamped by the increases occurring elsewhere. It is from the Third World's economic growth and urban concentration that the most serious regional threats to the global environment will come.

Table 7 Urban Regions outside the Global Polycenter with Populations Exceeding 4,000,000 in 1975

Mexico City	11,300,000
Moscow	10,700,000
Sao Paulo	10,000,000
Buenos Aires	8,400,000
Cairo	8,400,000
Rio de Janeiro	8,300,000
Shanghai	8,000,000
Calcutta	7,800,000
Bombay	7,000,000
Manila	5,400,000
Jakarta	5,300,000
Peking	5,200,000
Tientsin	4,600,000
Karachi	4,400,000
Delhi	4,400,000
Bangkok	4,300,000
Leningrad	4,200,000
Tehran	4,300,000
Madrid	4,100,000

Source: Chandler 1987: 511.

Notes

1. The city sizes used in this chapter are those reported by Chandler 1987.
2. Chinese cities were built according to cosmological principles derived from Han Confucianism (Wheatley 1971). They were always walled cities, constructed according to a preconceived plan, in a regular and formalized pattern, an ecological symbolization of the cosmic order: first, as an *axis mundi* symbolizing the powerful centripetal forces in the universe; second, with the most important buildings arranged along a cardinally oriented ceremonial axis (the "celestial meridian writ small"; Wheatley 1971: 456); third, centered on a sacred enclave; fourth, walled in the form of a square; fifth, facing in the propitious southerly direction. The physical design was embedded in a cosmology that incorporated explicit views about the wholeness of humankind and nature (Eisenstadt and Shachar 1987: 140). In contrast to the emergent Western views of humans' dominion over nature that structured environmental attitudes as growing urban demands in Europe sparked both agricultural development and imperial expansion. Han Confucianism advanced ideas of the organic unity of humankind and nature, ineluctably and physically inter-dependent, with an order that had to be maintained by tradition and ritual.
3. The key elements of Japanese urban design also were determined by the Chinese urban model. At the core of the capital was the emperor's residence and the principal courts and temples, encircled by downwardly sloping gradients of status arranged with respect to a cardinally oriented square-grid design, reinforcing the fundamental principles of centrality and concentration, of the stability of social hierarchies, and of the unity of existence.
4. The overall pattern was one of the city-centered organization of economic activities along three dimensions:

    1. A heartland-hinterland arrangement of industrial and resource regions linked by intermetropolitan flows.
    2. A system of cities within each region, arranged in a hierarchy according to the functions performed by each.
    3. Corresponding areas of urban influence or urban fields surrounding, each of the cities in the system.

    Within this framework, impulses of economic change and of environmental modification and exploitation were transmitted simultaneously along three planes:

    1. Outward from heartland centers to those of the regional hinterlands on a national scale.
    2. From each regional capital to centers of lower level in the hierarchy, in a pattern of "hierarchical diffusion" within each of the regions.
    3. Outward from urban centers into their urban fields, radiating "spread effects" into the surrounding countryside.

    The resulting spatial patterns were these:

    1. The size and functions of a central city, the size of its urban field, and the spatial extent of development and environmental "spread effects" radiating outward from it were proportional.
    2. Since impulses of economic change were transmitted in order from higher to lower centers in the urban hierarchy, continued innovation in large cities remained critical for extension of growth over the complete economic system.
    3. The resulting spatial incidence of economic growth was a function of distance from the central city. Troughs of economic backwardness lay in the most inaccessible peripheries of the lowest-level centers in the hierarchy.
    4. The growth potential of any area situated along an axis between two cities became a function of the intensity of interaction between them, which in turn was a function of their relative location and the quality of transportation arteries connecting them.

5. Similar ideas had been expressed by Adna Weber in 1899: "the 'rise of the suburbs' it is, which furnishes the solid basis of a hope that the evils of city life, so far as they result from overcrowding, may in large part be removed. If concentration of population seems destined to continue, it will be a modified concentration which offers the advantages of both city and country life . . .a complete fusion of their different modes of life and combination of the advantages of both, such as no country in the world has ever seen." (Weber 1899: 475)

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