

Dr. Brandt-Rauf's Lecture

# The Earth As Transformed by Human Action

Global and Regional Changes in the Biosphere  
over the Past 300 Years

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## 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.<sup>1</sup> 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.

### 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

Table 7-1 *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	15,000
		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.

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 7-1). 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).<sup>2</sup>

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 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.<sup>3</sup> 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. 7.1).

#### **Eighteenth-Century Quickening: Britain Emerges**

The first example of urban-led economic growth that brought urbanization levels above 10% was that of the Nether-

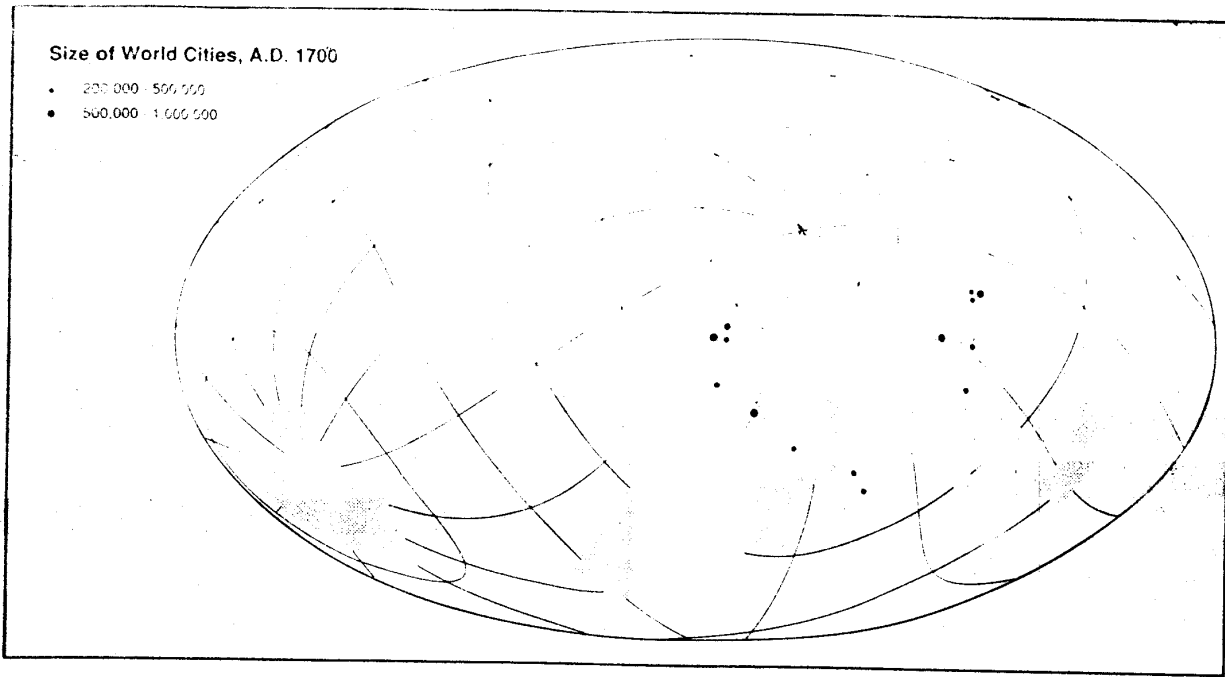


Figure 7.1 The world cities in A.D. 1700.

Percentage of population living in urban areas

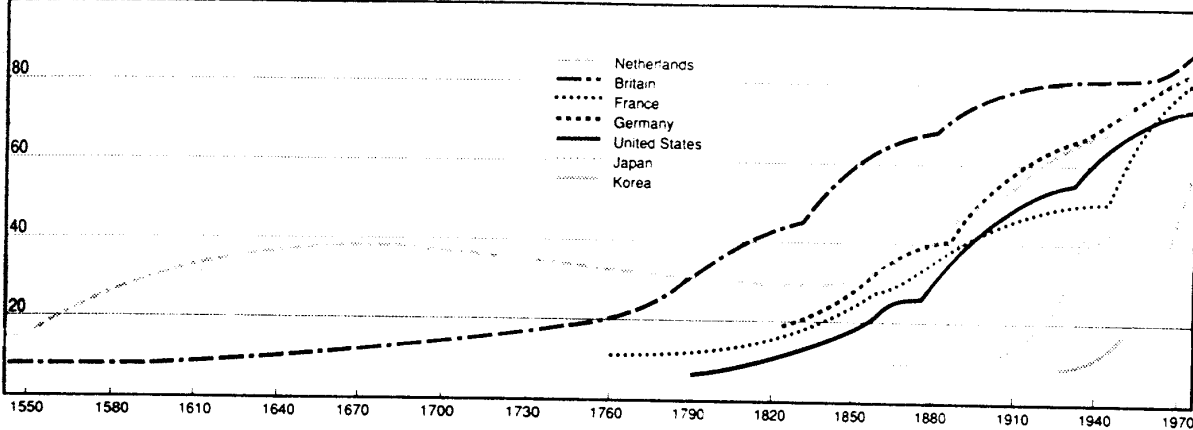


Figure 7.2 Changing levels of urbanization, 1550-1980: The Netherlands, Britain, the United States, France, Germany, Japan, and Korea.

lands from the early sixteenth century through their great age of economic supremacy in the seventeenth century (Braudel 1984; DeVries 1981; also see Fig. 7.2). 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 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. 7.3). 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 in-

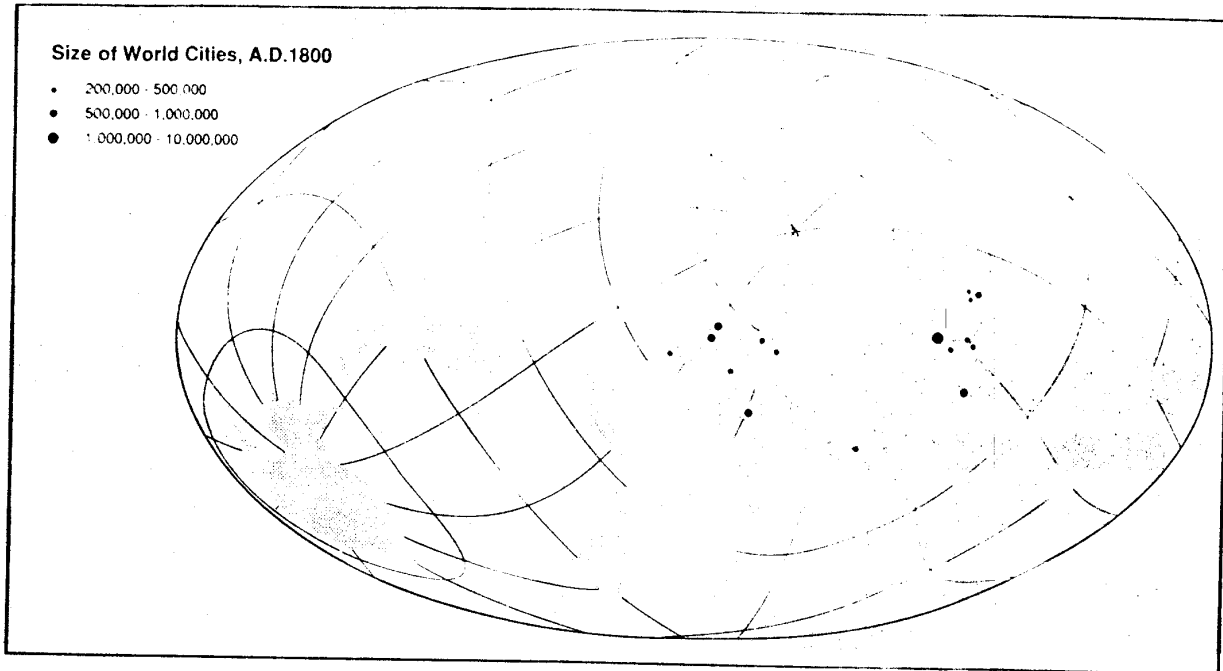


Figure 7.3 The world cities in A.D. 1800.

Table 7-2 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 <sup>a</sup>	34	14	5			
1800 <sup>a</sup>	50	17	6	1		
1900 <sup>a</sup>	287	142	43	16	1	
1950 <sup>b</sup>	950	N.E.	179	76	N.E.	
1975 <sup>a</sup>	N.E.	N.E.	422	191	7	1
2000 <sup>b</sup>	1,699	N.E.	859	440	N.E.	N.E.

<sup>a</sup> Adapted from Chandler 1987: 521.

<sup>b</sup> United Nations 1980.

N.E.: not estimated.

creased only from 29 to 44 (Tables 7-2 and 7-3).

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 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

Table 7.3 Major Cities in the World Economies of 1800

Britain*		British Empire		Portugal		Austria-Hungary	
London	861,000 (959,000)	Lucknow	240,000	Lisbon	237,000	Vienna	231,000
Dublin	165,000	Murshidabad	190,000	Oporto	67,000	Venice	148,000
Glasgow	84,000	Benares	179,000			Prague	77,000
Edinburgh	82,000	Hyderabad	175,000	Holland			
Manchester	81,000 (89,000)	Patna	170,000	Amsterdam	195,000		
Liverpool	76,000 (83,000)	Calcutta	162,000	Rotterdam	60,000	Russia	
Birmingham	71,000 (74,000)	<b>Bombay</b>	<b>140,000</b>	Ottoman Empire		Moscow	248,000
		Surat	120,000	Constantinople	570,000	St. Petersburg	220,000
		Madras	110,000	Smyrna	125,000		
		Dacca	106,000	Damascus	90,000	Japan	
				Adrianople	80,000	Yedo	685,000
				Aleppo	72,000	Osaka	383,000
				Chinese Empire		Kyoto	377,000
				Peking	1,100,000	Nagoya	92,000
				Canton	800,000	Kanazawa	71,000
				Hangchow	387,000	Marathas and Rajputs	
				Soochow	243,000	Delhi	140,000
				Sian	224,000	Ujjain	100,000
				Kingtehchen	164,000	Ahmedabad	89,000
				Wuchang	160,000	Baroda	83,000
				Tientsin	130,000	Jodhpur	75,000
				Foshan	124,000	Bharatpur	75,000
				Chengdu	97,000	Nagpur	74,000
				Langchow	90,000	Burma	
				Changsha	85,000	Amarapura	175,000
				Ningpo	80,000	Korea	
				Kaifeng	80,000	Seoul	194,000
				Hsuehchow	75,000	Pyongyang	68,000

Source: Chandler 1987.

\*The alternative populations placed in parentheses are those appearing in Wrigley 1987: 160.

ash for the alkalis 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 teasing 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