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[Main index](#) > <http://habitat.aq.upm.es/boletin/n21/almum.en.html>

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The Natural History of Urbanization

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Chicago, 1956.^[2]

The Emergence of the City

The natural history of urbanization has not yet been written, for only a small part of the preliminary work has been done. The literature of the city itself, until a half-century ago, was barren to the point of nonexistence; and even now the ecologists of the city, dealing too largely with a late and limited aspects of urbanism, have hardly staked out the ground that is to be covered. Our present purpose, accordingly, is to make use of such studies as have so far been made in order to ask more pointed questions and so, incidentally, to indicate further fields of profitable study.

Whether one looks at the city morphologically or functionality, one cannot understand its development without taking in its relationship to earlier forms of cohabitation that go back to non-human species. One must remember not only the obvious homologies of the anthill and the beehive but also the nature of fixed seasonal habitations in protected sites, like the breeding grounds of many species of birds. Though permanent villages date only from Neolithic times, the habit of resorting to caves for the collective performance of magical ceremonies seems to date back to an earlier period; and whole communities, living in caves and hollowed-out walls of rock, have survived in widely scattered areas down to the present. The outline of the city as both an outward form and an inward pattern of life might be found in such ancient assemblages. Whatever the aboriginal

impetus, the tendency toward formal cohabitation and fixed residence gave rise, in Neolithic times, to the ancestral form of the city: the village, a collective utility brought forth by the new agricultural economy. Lacking the size and complexity of the city, the village nevertheless exhibits its essential features: the encircling mound or palisade, setting it off from the fields; permanent shelters; storage pits and bins, with refuse dumps and burial grounds recording silently past time and spent energy. At this early stage, at least, Mark Jefferson's observation [*Jefferson, 1931*] holds true: urban and rural, city and country, are one thing, not two things.

Though the number of families per acre in a village is greater than the number per square mile under a pastoral economy, such settlements bring with them no serious disturbance in the natural environment; indeed, the relation may even be favorable for building up the soil and increasing its natural productivity. Archeological explorers in Alaska have been able to detect early settlements by noting the greenness of the vegetation around the otherwise submerged village sites, probably due to the enrichment of the soil from the nitrogenous human and animal waste accumulated near by. Early cities, as we find them in Mesopotamia and Egypt, maintain the symbiotic relation with agriculture that we find in the village. In countries like China, still governed by the principles of village economy, even contemporary cities with high population density, such as Keyes describe, exhibit the same reciprocal relations: «The most concentrated highly developed agriculture is just outside the walls of cities» [*Keyes, 1951*]. King estimated that each million city dwellers in China account for more than 13,000 pounds of nitrogen, 2,700 pounds of phosphorus, and almost 4,500 pounds of potassium in the daily night soil returned to the land [*King, 1927*]. Brunhes' description of cities under «unproductive occupation of the soil» does not altogether hold for the earliest types or, as I shall show, for the latest types of city [*Brunhes, 1920*].

The emergence of the city from the village was made possible by the improvements in plant cultivation and stock-breeding that came with Neolithic culture; in particular, the cultivation of the hard grains that could be produced in abundance and kept over from year to year without spoiling. This new form of food not merely offered insurance against starvation in the lean years, as was recorded in the famous story of Joseph in Egypt, but likewise made it possible to breed and support a bigger population not committed to food-raising. From the standpoint of their basic nutrition, one may speak of wheat cities, rye cities, rice cities, and maize cities, to characterize their chief source of energy; and it should be remembered that no other source was so important until the coal seams of Saxony and England were opened. With the surplus of manpower available as Neolithic man escaped from a subsistence economy, it was possible to draw a larger number of people into other forms of work and service: administration, the mechanical arts, warfare, systematic thought, and religion. So the once-scattered population of Neolithic times, dwelling in hamlets of from ten to fifty houses [*Childe, 1954*], was concentrated into «cities», ruled and regimented on a different

plan. These early cities bore many marks of their village origins, for they were still in essence agricultural towns: the main source of their food supply was in the land around them; and, until the means of transport had greatly improved and a system of centralized control has developed, they could not grow beyond the limit of their local water supply and their local food sources.

This early association of urban growth with food production governed the relation of the city to its neighboring land far longer than many observers now realize. Though grains were transported long distances (even as special food accessories like salt had circulated in earlier times), cities like Rome, which drew mainly on the distant granaries of Africa and the Near East (to say nothing of the oyster beds of Colchester in England) were exceptions down to the nineteenth century. As late as fifty years ago large portions of the fruits and vegetables consumed in New York and Paris came from nearby market gardens, sometimes on soils greatly enriched, if not almost manufactured, with urban refuse, as Kropotkin pointed out in *Fields, Factories and Workshops* [**Kropotkin, 1899**]. This means that one of the chief determinants of large-scale urbanization has been nearness to fertile agricultural land; yet, paradoxically, the growth of most cities has been achieved by covering over and removing from cultivation the very land (often, indeed, the richest alluvial soils) whose existence at the beginning made their growth possible. The tendency of cities to grow along rivers or near accessible harbors was furthered not alone by the need for easy transportation but by the need to draw on aquatic sources of food to supplement those produced by the soil. This rich and varied diet may itself have contributed to the vital energy of city dwellers as contrasted with the more sluggish ways of hinterlanders and perhaps may also have partly offset the bad effect of close quarters in spreading communicable diseases. While modern means of transport have equalized these advantages, they have not yet hastened the migration of urban populations to upland sites on poorer soils, though often these present more salubrious climates and better living conditions.

The village and the small country town are historic constants. One of the outstanding facts about urbanization is that, while the urban population of the globe in 1930 numbered around 415,000,000 souls, or about a fifth of the total population, the remaining fourfifths still lived under conditions approximating that of the Neolithic economy [**Sorre, 1952**]. In countries as densely peopled as India, as late as 1939, according to the *Statesman's Yearbook*, less than 10 per cent of the total population lived in cities. These «Neolithic» conditions include the utilization of organic sources of energy, vegetable and animal, the use of local supply of drinking water, the continuous cultivation of land within walking distance of the village, the partial use of human dung along with that of the animal for fertilizer, a low concentration of inorganic refuse, like glass and metals, and an absence of air pollution. In many parts of the world, village settlements, far from encroaching on arable land, occupy barren hill sites of little use for agriculture; the stony outcrop of an Italian hill town involves only a slightly more symmetrical arrangement of the original rock strata. The chief weakness of these settlements, particularly in parts of the world long cultivated, notably in Spain,

Greece, or China, is due to the peasant's begrudging the land needed for forest cover; he thus tends, by overtillage, to promote erosion and to create a further imbalance among the bird, insect, and plant population. But, just as the early village economy was indebted to the astronomical calendar produced in the temple cities for the timely planting of their crops, so the present development of ecological knowledge, which has led to increasing concern and care for the woodland preserves in highly urbanized countries, may in time counteract the otherwise destructive effects of earlier stages in urban settlement.

Urban Symbiosis and Dominance

With the first growth of urban populations in ancient Mesopotamia, the symbiotic relations that originally held between village and land were not greatly altered. «The city», as Childe describes its earliest manifestations, is girt with a brick wall and a fosse, within the shelter of which man found for the first time a world of his own, relatively secure from the immediate pressure of raw, external nature. It stands out in an artificial landscape of gardens, fields, and pastures, created out of reed swamp and desert by the collective activity of preceding generations in building dykes and digging canals» [*Childe, 1942:94*]. Though these cities represented «a new magnitude in human settlements», the populations of Lagash, Umma, and Khafaje are «reliably estimated to have been 19,000, 16,000, and 12,000 respectively during the third millennium». The Levitical cities described in the Bible, confirmed by modern excavations of Gezer, had a town area of about 22 acres, with pasture land, permanently reserved, amounting to about 300 acres [*Osborn, 1946*]. More than four thousand years later, as late as the sixteenth century, the characteristic size of the city in western Europe ranged from 2,000 to 20,000 people; it was only in the seventeenth century that cities of more than 100,000 began to multiply. In both the Near East in ancient times and in western Europe in the Middle Age, cities prudently retained some portion of the land within their walls for gardens and the harboring of animals for food in case of military siege. Even the vast domains of Babylon must not mislead us into looking upon it as comparable in density to modern London. A map drawn in 1895 by Arthur Schneider, and republished by [*Hassert, 1907*], shows that Babylon covered an area big enough to contain Rome, Tarentum, Syracuse, Athens, Ephesus, Thebes, Jerusalem, Carthage, Sparta, Alexandria and Tyre, together with almost as much open space between these cities as they occupied in their own right. Even in Herodotus's time, Babylon had many of the aspects of an overgrown village.

The Neolithic economy appears to have been a co-operative one. The

concentration upon plant cultivation in small neighborly communities, never with a sufficient surplus of food or power to promote too much arrogance in man's relation with other men or with nature, established a natural balance between fields and settlements. In Europe, as Élisée Reclus long ago noted, country towns and villages tended to spread evenly, as far as topography allowed, about the space of a day's walk apart. With the introduction of metallurgy, during the succeeding period of urbanization, came technological specialization, caste differentiation, and heightened temptations to aggression; and with this began a disregard for the welfare of the community as a whole and, in particular, a tendency to ignore the city's dependence upon its local resources. Excess of manpower abetted an excessive belief in the power of man ---a belief deepened, no doubt, by the efficacy of the new edged weapons and armor in giving control to aggressive minorities who took the law into their own hands. With the development of long-distance trading, numerical calculation, and coinage, this urban civilization tended to throw off its original sense of limits and to regard all forms of wealth as purchasable by trade or procurable by a demonstration of military power. What could not be grown or produced in the local region could be, by theft or exchange, obtained elsewhere. In time this urban economy made the mistake of applying the pragmatic standards of the market place to the environment itself: the process began of building over the interior open spaces and building out over the surrounding land.

Until modern times the extensions of a city's walls marked its growth as surely as does each additional ring of a tree. The wall had perhaps a formative role in the transformation of the village into the city; when made of heavy, permanent materials, surrounded by a moat, it gave the city a means of protection the little village could not afford. Not merely was it capable of military defense, but the city, through its surplus population, could muster enough manpower to hold against a large army of attackers. The earliest meaning of «town» is an inclosed or fortified place. The village that, because of its defensible site, offered protection against predators of all kinds would in times of peril attract families from more exposed areas and so, with a larger, mixed population, would turn into a city. Thus the temple citadel would add to its original population and, even after the danger had passed, would retain some of those who sought shelter and so become a city. In Greece, at least, the city comes to the existence, historically, as such a synoecism.

But the morphological difference between the village and the city is not simply the result of the latter's superior site or of the fact that its geographic situation enables it to draw on a wider area for resources, foods, and men and in turn to export their products to a larger market, though both are facts conducive to population growth and economic expansion. What distinguish city from village are mainly two facts. The first of these is the presence of an organized social core, around which the whole structure of the community coheres. If this nucleation may begin in the village stage, as remains of temples seem to indicate, there is a general shift of household occupations and rituals into specialized collective institutions, part of the intensified social division of labor brought in with

civilization itself. But, from the standpoint of the city's relation to the earth, the important point to notice is that, in this social core or nucleus, the sharpest departures from the daily habits and the physical structure of the village take place. Thus the temple, unlike the hut, will be built of permanent materials, with solid stone walls, often plated with precious stones or roofed with rare timber taken from a distant quarry or forest, all conceived on a colossal scale, while the majority of dwelling houses will still be built of clay and reed, or wattle and daub, on the old village pattern. While the temple area will be paved the streets and alleys of the rest of the city will remain unpaved. As late as imperial Rome, pavement will be introduced first into the Forum, while most of the arteries remain uncovered, to become sloughs of mud in rainy weather. Here too, in the urban palace, as early as Akkad, such technological innovations as baths, toilets, and drains will appear ---innovations that reaming far beyond the reach of the urban populations-at-large until modern times.

Along with this bold aesthetic transformations of the outward environment, another tendency distinguishes the city from the village ---a tendency to loosen the bonds that connect its habitants with nature and to transform, eliminate, or replace its earth-bound aspects, covering the natural site with an artificial environment that enhances the dominance of man and encourages an illusion of complete independence from nature. The first age of the «urban revolution», to use Childe's term, had little extrahuman power and few machines. Its technological heritage, once it had learned to smelt copper and iron, was in every sense an static one; and its major skills, weaving aside, were concentrated on fashioning utensils and utilities (pots, jars, vats, bins) and on building great collective works (dams, irrigation systems, buildings, roads, baths) and, finally, cities themselves. Having learned to employ fire of relatively high intensity to glaze and smelt ores, these early civilizations offset its danger by creating a fireproof environment. The importance of this fact, once papyrus and paper were in use, can hardly be overestimated. In this general transformation from the transient to the fixed, from fragile and temporary structures to durable buildings, proof against wind, weather, and fire, early man emancipated himself likewise from the fluctuations and irregularities of nature. Each of the utilities that characterized the new urban form ---the wall, the durable shelter, the arcade, the paved way, the reservoir, the aqueduct, the sewer--- lessened the impact of nature and increased the dominance of man. That fact was revealed in the very silhouette of the city, as the traveler beheld it from the distance. Standing out in the vegetation-clad landscape, the city became an inverted oasis of stone or clay. The paved road, a man-made desert that speeds traffic and makes it largely independent of the weather and the seasons; the irrigation ditch, a man-made river system that releases the farmer from irregularities of seasonal rainfall; the water main, an artifial brook that turns the parched environment of the city into an oasis; the pyramid, an artificial mountain that serves as symbolic reminder of man's desire for permanence and continuity ---all these inventions record the displacements of natural conditions with a collective artifact of urban origin.

Physical security and social continuity were the two great contributions for the city. Under those conditions every kind of conflict and challenge became possible without disrupting the social order, and part of this new animus was directed into a struggle with the forces of nature. By serving as a secure base of operations, a seat of law and government, a repository of deeds and contracts, and a marshaling yard for manpower, the city was able to engage in long-distance activities. Operating through trade, taxation, mining, military assault, and road-building, which made it possible to organize and deploy thousands of men, the city proceeded to make large-scale transformations of the environment, impossible for groups of smaller size to achieve. Through its storage, canalization, and irrigation, the city, from its earliest emergence in the Near East, justified its existence, for it freed the community from the caprices and violences of nature --- though no little part of that gift was nullified by the further effect of subjecting the community more abjectly to the caprices and violences of men.

Urban Displacement of Nature

Unfortunately, as the disintegration of one civilization after another reminds us, the displacement of nature in the city rested, in part, upon an illusion ---or, indeed, a series of illusions--- as to the nature of man and his institutions: the illusions of self-sufficiency and independence and of the possibility of physical continuity without conscious renewal. Under the protective mantle of the city, seemingly so permanent, these illusions encouraged habits of predation or parasitism that eventually undermined the whole social and economic structure, after having worked ruin in the surrounding landscape and even in far-distant regions. Many elements supplied by nature, necessary for both health and mental balance, were lacking in the city. Medicine, as practiced by the Hippocratic School in the great retreats, like that at Kos, concerned with airs, waters, and places, seems at an early age to have employed in therapy natural elements that were depleted or out of balance even in the relatively small Aegean cities of the fifth century B.C., though their ruling classes spent no small part of their leisure in the exercise of the body. Through the ages the standard prescription for most urban illnesses ---and perhaps as effective as more specific remedies--- is retreat to some little village by seacoast or mountain ---that is, restoration to a pre-urban natural environment. In times of plague the retreat repeatedly has taken on the aspects of a rout. Though man has become the dominant species in every region where the city has taken hold, partly because of the knowledge and the system of public controls over both man and nature he exercises there, he has yet to safeguard that position by acknowledging his sustained and inescapable dependence upon all his biological partners. With the ecological implications of

this fact, I shall deal later.

Probably no city in antiquity had a population of much more than a million inhabitants, not even Rome; and, except in China, there were no later Romes until the nineteenth century. But, long before a million population is reached, most cities come to a critical point in their development. That occurs when the city is no longer in symbiotic relationship with its surrounding land; when further growth overtaxes local resources, like water, and makes them precarious; when, in order to continue its growth, a city must reach beyond its immediate limits for water, for fuel, for building material used in manufacture; and, above all, when its internal birth rate becomes inadequate to provide enough manpower to replace, if not to augment, its population. This stage has been reached in different civilizations at different periods. Up to this point, when the city come to the limits of sustenance^[3] in its own territory, growth takes place by colonization, as in a beehive. After this point, growth takes place, in defiance of natural limitations, by a more intensive occupation of the land and by encroachment into the surrounding areas, with the subjugation by law or naked force of rival growing cities bidding for the same resources.

Most of the characteristics of this second form of urban growth can be observed in the history of Rome. Here the facts are better documented than they are for most ancient cities; and the effects upon the landscape have remained so visible that they suggested to George Perkins Marsh the principal lines of his investigation of *The Earth as Modified by Human Action* [Marsh, 1864][Marsh, 1874]. Rome of the Seven Hills is an acropolis type of city, formed by a cluster of villages united for defense; and the plain of the Tiber was the original seat of their agriculture. The surplus population of this region conquered first the neighboring territories of the Etruscans and then those of more distant lands. By systematic expropriation, Rome brought wheat, olive oil, dried fish, and pottery back to the original site to sustain its growing population. To facilitate the movement of its legions and speed up the processes of administration, it carved roads through the landscape with triumphant disregard of the nature of the terrain. These roads and viaducts went hand in hand with similar work of engineering, the aqueducts and reservoirs necessary to bring water to Rome. By short-circuiting the flow water from mountainside to sea, the city monopolized for its special uses a considerable amount of runoff; and, to offset some of the effects of metropolitan overcrowding, it created a cult of the public bath that in turn imposed a heavy drain upon the fuel supplied by the near-by forest areas. The advance of technology, with central hot-air heating, characteristically hastened the process of deforestation, as was later to happen in the glass- and ironmaking and shipbuilding industries of northern Europe and to be repeated today in the heavy industrial demand for cellulose. Meanwhile, the sewers of Rome, connected to public toilets, polluted the Tiber without returning the precious mineral contents to the soil, though even in imperial Rome dung farmers still collected most of the night soil from the great tenements of the proletariat. At this stage the symbiotic relation turns into a parasitic one; the cycle

of imbalance begins, and the mere massing of the demand in a single center results in denudations and desiccations elsewhere. The more complete the urbanization, the more definite is the release from natural limitations; the more highly the city seems developed as an independent entity, the more fatal are the consequences for the territory it dominates. This series of changes characterizes the growth of cities in every civilization: the transformation of eopolis into megalopolis. If the process wrought damage to the earth even in the ancient world, when cities as big as Rome, Carthage, and Alexandria were the exception rather than the rule, we have good reason to examine carefully the probable consequences of the present wave of urbanization.

Modern Forces of Expansion

Let me sum up the observations so far made with respect to the natural history of cities. In the first stage of urbanization the number and size of cities varied with the amount and productivity of the agricultural land available. Cities were confined mainly to the valleys and flood plains, like the Nile, the Fertile Crescent, the Indus and the Hwang Ho. Increase of population in any one city was therefore limited. The second stage of urbanization began with the development of large-scale river and sea transport and the introduction of roads for chariots and carts. In this new economy the village and the country town maintained the environmental balance of the first stage; but, with the production of grain and oil in surpluses that permitted export, a specialization in agriculture set in and, along with this, a specialization in trade and industry, supplementing the religious and political specialization that dominated the first stage. Both these forms of specialization enabled the city to expand in population beyond the limits of its agricultural hinterland; and, in certain cases, notably in Greek city of Megalopolis, the population in smaller centers was deliberately removed to a single big center -- a conscious reproduction of a process that was taking place less deliberately in other cities. At this stage the city grew by draining away its resources and manpower from the countryside without returning any equivalent goods. Along with this went a destructive use of natural resources for industrial purposes, with increased concentration on mining and smelting.

The third stage of urbanization does not make its appearance until the nineteenth century, and it is only now beginning to reach its full expansion, performance, and influence. If the first stage is one of urban balance and cooperation, and the second is one of partial urban dominance within a still mainly agricultural framework, behind both is an economy that was forced to address the largest part of its manpower toward cultivating the land and improving the whole landscape for human use. The actual amount of land

dedicated to urban uses was limited, if only because the population was also limited. This entire situation has altered radically during the last three centuries by reason of a series of related changes. The first is that world population has been growing steadily since the seventeenth century, when the beginning of reasonable statistical estimates, or at least tolerable guesses, can first be made. According to the Woytinskys [*Woytinskys, 1953*], the average rate of population increase appears to have gone up steadily: 2.7 per cent from 1650 to 1700; 3.2 per cent in the first half of the eighteenth century and 4.5 per cent in the second half; 5.3 per cent from 1800 to 1850; 6.5 per cent from 1850 to 1900; and 8.3 per cent from 1900 to 1950. As the Woytinskys themselves remark, these averages should not be taken too seriously; yet there is a high probability that an acceleration has taken place and hardly any doubt whatever that the world population has doubled during the last century, while the manpower needed to maintain agricultural productivity in mechanized countries has decreased.

By itself this expansion might mean no more than that the less populated parts of the earth would presently acquire densities comparable to those of India and China, with a great part of the increase forced to undertake intensive cultivation of the land. But this increase did not take place by itself; it was accompanied by a series of profound technological changes which transformed the classic «age of utilities» into the present «age of the machine» and a predominantly agricultural civilization into a urban one ---or possibly a suburban one. These two factors, technical improvement and population growth, have been interacting since at least the sixteenth century, for it was the improvement in the sailing ship and the art of navigation that opened up the almost virginal territory of the New World. The resulting increase of food supply, in terms of added tillage, was further augmented by New World crops like maize and the potato. Meanwhile, the increased production of energy foods ---vegetable oils, animal fats, and sugar cane and sugar beet--- not merely helped support a large population but in turn, through the supply of fat, turned soap from a courtly luxury to a household necessity; and this major contribution to hygiene ---public and personal--- probably did more to lower death rate than any other single factor. From the beginning of the nineteenth century the surplus population made it possible for old cities to expand and new cities to be founded. As Webber long ago pointed out [*Webber, 1899*], the rate was even faster in Germany in the second half of the nineteenth century than it was in the United States.

This wave of urbanization was not, as is sometimes thought, chiefly dependent upon the steam engine or upon improvements in local transportation. The fact is that the number of cities above the 100,000 mark had increased in the seventeenth century, well before the steam engine or the power loom had been invented. London passed the million mark in population by 1810, before it had a mechanical means of transportation or the beginning of an adequate water supply (in parts of London piped water was turned on only twice a week). But a marked change, nevertheless, took place in urban growth during the nineteenth century.

At this moment the four natural limits on the growth of cities were thrown off: the nutritional limit of an adequate food and water supply; the military limit of protective walls and fortifications; the traffic limit set by slow-moving agents of reliable transportation like the canalboat; and the power limit to regular production imposed by the limited number of water-power sites and the feebleness of the other prime movers ---horse and wind power. In the new industrial city these limits ceased to hold. While up to this time growth was confined to commercial cities favorably situated at the merging point of two or more diverse regions with complementary resources and skills, urban development now went on in places that had easy access to the coal measures, the iron-ore beds, and the limestone quarries. Pottery towns, cotton towns, woolen towns, and steel towns, no longer held down in size, flourished wherever the tracks for steam locomotives could be laid and the steam engine established as a source of power. The only limitation on the spread and multiplication of towns under this regime was the disability of the steam locomotive to operate efficiently on grades of more than 2 per cent. Whereas the water power and wind power of the eotechnic period had tended to distribute industry in the coastal cities of high winds or along fast-running upland streams, coal power tended to group industry in the valleys near the mine pits or along the railroad lines that constituted a continuation of the mine and the mining environment [*Mumford, 1934*]. Industry, like agriculture, competes for the heavy lowland soils. As for the railroad itself, it is one of the greatest devourers of land and transformers of landscape. The marshaling yards of its great urban terminal put large areas out of urban or agricultural use.[\[4\]](#)

Growth of the Conurbation

Up to the middle of the nineteenth century, water-power sites, the seats of earlier industrial improvements, continued to attract industries into mill villages; but, with the coming of the railroad, industries grouped together in cities in order to take advantage of the surplus labor that accumulated there. From this time on, whole districts, such as Elberfeld-Barmen, Lille-Roubaix, the Black Country, and the Delaware Valley, become urbanized, and the limits of city growth are reached only when one city, by its conversion of farmland into building lots, coalesces with another city engaged in the same process. Growth of this kind, automatic and unregulated, a result of the railroad and the factory, has never been possible before; but now the agents of mechanization not merely created their own environment but set a new pattern for the growth of already existing great cities. Looking at Bartholomew's population map of Britain early in the present century, Patrick Geddes discovered that urbanization had taken a new form: urban areas, hitherto distinct, both as political units and as topographic features, had in fact

flowed together and formed dense population masses on a scale far greater than any of the big cities of the past, forming a new configuration as different as the city itself was from its rural prototypes [*Geddes, 1915*]. He called this new kind of urban grouping the «conurbation». This new urban tissue was less differentiated than the old. It presented an impoverished institutional life; it showed fewer signs of social nucleation; and it tended to increase in size, block by block, avenue by avenue, «development» by «development», without any individuality of form and, most remarkable of all, without any quantitative limits [*West Midland Group, 1948*].

This concentration of industry had marked effects upon the entire environment. The new source of power-coal; the new industrial processes, massed in the new steelworks and coke ovens; the new chemical plants for manufacturing chlorine, sulfuric acid, and hundreds of other potentially noxious compounds: all poured their waste products into the air and waters on a scale that made it impossible for the local environment to absorb them as it might have absorbed the effluvia of a village industry or the organic waste of a tannery or a slaughter-house. Streams hitherto well stocked with fish, salubrious for bathing, and even potable became poisonous sewers: while the fall of soot, chemical dust, silica, and steel particles choked vegetation in what open ground remained and left their deposits in human lungs. The effects of this pollution, and the possibility of more radical and irretrievable pollution to come through the use of atomic reactors, are dealt with in chapters that follow [in the original book, N. of the E.]. Here the point to mark is that it was a natural penalty of overconcentration. The very ubiquity of the new type of city, coupled with its density, increases, for example, the threat of a lethal fog from chemicals normally in the air, such as wiped out over five thousand lives in a single week in London in 1952; a mass exodus by cars, at the low speed imposed by a heavy fog, would itself add to the deadly gases already in the air.

The extension of the industrial conurbation not merely brings with it the obliteration of the life-sustaining natural environment but actually creates, as substitute, a definitely antiorganic environment; and even where, in the interstices of this urban development, land remains unoccupied, it progressively ceases to be of use for either agriculture or recreation. The removal of topsoil, or its effacement by buildings and slag piles, brings on no temporary denudation; it results in deserts that, even if every effort suggested by science were made, might take centuries to redeem for human occupancy, to say nothing of more organic forms of cultivation. Though the conurbation came into existence through the dense industrial occupation of a whole region rather than through the overgrowth of a single dominate city, the two types overlap. In England, Birmingham itself, though the center of congeries of smaller towns, has passed the million mark, to become the second city in Britain. By offering a big local market, the great conurbations, in addition to attracting the consumption trades and industries, have brought in petroleum refineries, chemical plants, and steelworks, which gravitate to the cheaper land of the edge of metropolitan areas. This tends to create industrial defilement at the point where Sir John Evelyn, in 1661 in his

pamphlet *Fumifugium* [**Evelyn, 1933!**], proposed to create a protective green belt, filled with aromatic shrubs, to purify the already noisome air of London. This extension of the area of industrial pollution into the very land that the overgrown city needs for mass recreation ---accessible to sunlight, to usable ocean, river front, and woodland--- likewise lessens the advantage of the only form of temporary escape left: retreat to the suburb.

From the very nature of the city as a market, a workshop, and a place of civic assemblage, there is a direct relation between its growth and the growth of transportation systems, though, in the case of seaways and airways, the latter may be visible only in the increase of harbor facilities and storehouses. In general, one may say that, the heavier the urbanization, the heavier the transportation network, not merely within but without. From ancient Rome to recent times, the fifteenfoot roadway remained the outsize. But, with the eighteenth century, land transportation takes a new turn. In 1861, Wilhelm Heinrich Riehl noted it in the change from the rural highroads of the old town economy to the new *Landstrasse*, planned in more systematic fashion by the new bureaucracy ---wider by three feet, more heavily paved, and often lined with trees, as in the beautiful highway lined with ancient lindens between Lübeck and Travemunde [**Riehl, 1935!**]. With the coming of railroad transportation, the width of the new kind of permanent way again increased; the railroad made fresh demands for large areas of flat, low-lying land to serve as marshaling yards, adjacent to the city or even cutting a great wedge through it. The economy of the water-level route again turned to a non-agricultural use of precisely the land that was often the most fertile available and spoiled even its recreational value. With the introduction of the motorcar, even secondary roads demanded pavement, and arterial roads both widened and multiplied, with the result that around great metropolises six-, seven-, and eight-lane highways with two-hundred-foot rights of way become increasingly common. They are further complicated by great traffic circles or clover-leaf patterns of overpass and underpass to permit the continuous flow of traffic at intersections, however wasteful of land these junctions may be. In the case of park-ways planned to follow the ridges, like the Taconic State Parkway in New York State, the land given over to the road may be of minor value either for agricultural or for civic use; but where the highway engineer ignores the contours, follows the valleys, and cuts through hills to maintain his level, the motorway maybe an active agent both in eroding the soil and in disrupting the habitat. The yielding of water navigation to land transport has aggravated this damage; and every further congestion of populations leads to still more highway-building of a permanent and costly kind of accommodate the mass week-end exit of motorist. Thus the city, by its incontinent and uncontrolled growth, not merely sterilizes the land it immediately needs but vastly increases the total area of sterilization far beyond its boundaries.

The Suburban Overspill

At this point we are confronted with two special phenomena known only in embryonic form in other urban cultures: the production of a new kind of urban tissue, in the open pattern of the suburb, and the further development of a mass transportation by means of self-propelled, individual vehicles, trucks, and motorcars. The first change, the result of seeking an environment free from noise, dirt, and overcrowding of the city, actually antedated the means that made it possible on a mass scale. In London this suburban movement began as early as Elizabethan times as a reaction against the overbuilding and overcrowding that had then taken place in the center of the city; and at the end of the eighteenth century a similar exodus occurred among merchants who could afford a private coach to take them into the city. With increased facilities of transportation offered by the public coach and the railroad, this suburban movement became more common through the nineteenth century, as witness the growth of St. John's Wood, Richmond, and Hampstead in London, of Chestnut Hill and Germantown in Philadelphia, and of the Hudson River suburbs in New York. But, up to 1920, it was mainly the upper-income groups that could afford the luxury of sunlight, fresh air, gardens, open spaces, and access to the open country. The new open-type plan, with houses set in gardens, at densities of from two houses to ten or twelve per acre, had long been characteristic of American country towns, most notably those of New England; indeed, this open pattern dominated west of Alleghenies. But this standard now became universalized in the upper-class suburb, though its economic base lay outside the area of the suburb occupied and from the beginning demanded a heavy sacrifice of man-hours in commuting to the distant metropolis. The low cost of the suburban land and the possibility of economizing in local utilities like roads and sewers encouraged luxurious standards of space and gave those who could afford to escape a superior biological environment and perhaps, if Thorndyke is correct [*Thorndyke, 1939*], a superior social one. The initiative of a few farsighted industrialist, like Lever (Port Sunlight, 1887) and Cadbury (Bournville, 1895), proved that similar standards could be applied to building working-class quarters when land was sufficiently cheap.

Since 1920 the spread of private motor vehicles has completed the work of enlarging potential suburban territory, an expansion already well begun in the 1900's by interurban electric transit. The exodus to suburbia has taken in wave after wave of city dwellers, at lower and lower income levels, seeking to escape the congested and disordered environment of the big city. This removal from the city has not been accompanied by any equivalent decentralization of industry; rather it has served to sustain an antiquated pattern of concentration. The pattern of population distribution around great cities has been the product, not of social foresight for public ends, but mainly of private initiative for private profit, though it could not have taken place on its present scale in America without a vast public

investment in highways, expressways, bridges, and tunnels. The result of this uncontrolled spread of the suburb has been to nullify the very purposes that brought the movement into existence.

But suburban agglomeration cannot be treated as a fact in itself; it carries with it, through the demands of motorcar, both for private transportation and for the movement of goods, an enormous increase in paved roads, which eat into the surviving agricultural and wilderness areas and permanently sterilize ever larger quantities of land. The filling-up of marshes, the coverage of rich soils with buildings, the felling of woodlands, the clogging of local brooks and streams, and the abandonment of local springs and wells were all secondary disturbances of the early type of metropolis, even when it reached a population of a million people. When Rome was surrounded by the Aurelian wall in A.D. 274, it covered, according to [*Carcopino, 1940*], a little more than 5 square miles. The present area of Greater London is about a hundred and thirty times as great as this, while it is roughly six hundred and fifty times as great as the area, namely, 677 acres, surrounded by its wall in the Middle Ages. The metropolitan area of New York is even more widespread; it covers something like 2,514 square miles; and already a good case could be made out for treating a wide coastal strip from Boston to Washington as one continuous conurbation, geographically speaking [...]. This difference in magnitude between every earlier type of urban development and that characterizing our own age is critical. What is more, as population increases, the percentage of the population in cities increases, too, and the ratio of those going into metropolitan areas is even higher. Even in England, though the amount of land occupied by cities, «built-over land», is low (2.2 per cent) in proportion to the entire land area of the British Isles, this is more than half the area of «first-class» land available for agriculture and is a tenth of the «good land» available, according to Sir L. Dudley Stamp's classification [*Stamp, 1952*]. Since requirements for manufacture and urban development are for accessible, graded land, these demands conflict with the needs of the farmer; they compete for the same good soils, and only government intervention in England, since 1932, has saved this misuse of valuable agricultural land.

Under modern technical conditions the open pattern of the residential suburb is not confined to domestic needs alone. The demand for large land areas characterizes modern factory organization, with its horizontally ordered assembly lines, housed in spreading one-story structures, and, above all, airports for long-distance flights, whose demand for landing lanes and approaches on the order of miles has increased with the size and speed of planes. In addition, the noise of planes, especially jets, sterilizes even larger areas of land for residential use as both hazardous to life and dangerous to health. There are many urban regions, like that tapped by the main-line railroads from Newark, New Jersey, to Wilmington, Delaware, where urban tissue has either displaced the land or so completely modified its rural uses as to give the whole area the character of a semiurban desert. Add to this, in every conurbation, the ever larger quantity of land needed for collective reservoir systems, sewage works, and garbage-disposal plants as

dispersed local facilities fall out of use.

As a result of population increase and urban centralization, one further demand for land, unfortunately a cumulative one, must be noted: the expansion of urban cemeteries in all cultures that maintain, as most «Christian» nations do, the Paleolithic habit of earth burial. This has resulted in the migration of the burying ground from the center to the outskirts of metropolitan areas, where vast cemeteries serve, indeed, as temporary suburban parks, until they become a wilderness of stone monuments. Unless the custom of periodically emptying out these cemeteries as was done in London and Paris with the bones in old churchyards, takes hold, or until cremation replaces burial, the demand for open spaces for the dead threatens to crowd the quarters of the living on a scale impossible to conceive in earlier urban cultures.

Urban-Rural Balance

Whereas the area of the biggest cities, before the nineteenth century, could be measured in hundreds of acres, the areas of our new conurbations must now be measured in thousands of square miles. This is a new fact in the history of human settlement. Within a century the economy of the Western world has shifted from a rural base, harboring a few big cities and thousands of villages and small towns, to a metropolitan base whose urban spread not merely has engulfed and assimilated the small units, once isolated and self-contained, as the amoeba engulfs its particles of food, but is fast absorbing the rural hinterland and threatening to wipe out many natural elements favorable to life which in earlier stages balanced off against depletions in the urban environment. From this, even more critical results follow. Already, New York and Philadelphia, which are fast coalescing into a single conurbation along the main-line railroads and the New Jersey Turnpike, find themselves competing for the same water supply, as Los Angeles competes with the whole state of Arizona. Thus, though modern technology has escaped from limitations of a purely local supply of water, the massing of populations makes demands that, even apart from excessive costs (which rise steadily as distance increases), put a definable limit to the possibilities of further urbanization. Water shortages may indeed limit the present distribution long before food shortages bring population growth to an end.

This situation calls for a new approach to the whole problem of urban settlement. Having thrown off natural controls and limitations, modern man must replace them with an at least equally effective man-made pattern. Though alternative proposals may be left to that portion of this volume dealing with the future, one

new approach has fifty years of experience behind it and may properly be dealt with under the head of history. In the last decade of the nineteenth century two projects came forth relating to the need, already visible by then, to achieve a different balance among cities, industries, and natural regions from that which had been created by either the old rural economy, the free town economy, or the new metropolitan economy. The first of these suggestions was the work of the geographer Peter Kropotkin. His book *Fields, Factories, and Workshops* [**Kropotkin, 1899**] dealt with the alteration in the scale of technically efficient enterprise made possible by the invention of the electric motor. The other book, *Tomorrow* [**Howard, 1898**], embodied a proposal to counteract the centralization of the great metropolis by reintroducing the method of colonization to take care of its further growth. Howard proposed to build relatively self-contained, balanced communities, supported by their local industry, with a permanent population, of limited number and density, on land surrounded by a swath of open country dedicated to agriculture, recreation, and rural occupation. Howard's proposal recognized the biological and social grounds, along with the psychological pressures, that underlay the current movement to suburbia. It recognized the social needs that were causing an exodus from rural regions or drab, one-industry towns into the big city. Without disparaging such real advantages as the concentrated activities and institutions of the city offered, Howard proposed to bring about a marriage between town and country. The new kind of city he called the «garden city», not so much because of its internal open spaces, which would approach a sound suburban standard, but more because it was set in a permanent rural environment.

Besides invoking the Aristotelian ideas of balance and limits, Howard's greatest contribution in conceiving this new garden city was provision for making the surrounding agricultural area an integral part of the city's form. His invention of a horizontal retaining wall, or green belt, immune to urban building, was a public device for limiting lateral growth and maintaining the urban-rural balance. In the course of twenty years two such balanced communities, Letchworth (1903) and Welwyn (1919), were experimentally founded by private enterprise in England. The soundness of the garden-city principle was recognized in the «Barlow Report» [**Barlow, 1940**] on the decentralization of industry. Thanks to World War II, the idea of building such towns on a great scale, to drain off population from the overcrowded urban centers, took hold. This resulted in the New Towns Act of 1947, which provided for the creation of a series of new towns, fourteen in all, in Britain. This open pattern of town-building, with the towns themselves dispersed through the countryside and surrounded by permanent rural reserves, does a minimum damage to the basic ecological fabric. To the extent that their low residential density, of twelve to fourteen houses per acre, gives individual small gardens to almost every family, these towns not merely maintain a balanced micro-environment but actually grow garden produce whose value is higher than that produced when the land was used for extensive farming or grazing [**Block, 1954**].

On the basis of the garden-city principle, Stein and others have put forth the possibility of establishing a new type of city by integrating a group of communities into an organized design that would have the facilities of a metropolis without its congestion and loss of form [*Stein et alii*, 1951]. The basis of this kind of grouping was laid down in the survey of the state of New York made by the Commission of Housing and Regional Planning, of which Stein was chairman, and was published with Henry Wright in 1926. Wright, the planning adviser, here pointed out that the area of settlement was no longer the crowded terminal metropolitan areas of the railroad period but that electric power and motor transportation had opened up a wide belt on each side of the railroad trunk lines, equally favorable for industry, agriculture, and urban settlement. The most fertile soil and the most valuable geological deposits were almost entirely in the areas below the thousand-foot level; and, in planning for the new urban settlement, the reservation of forest areas for water catchment and recreation, for lumber, and for electric power was important. Instead of treating the city as an intrusive element in a landscape that would finally be defaced or obliterated by the city's growth, this new approach suggested the necessity of creating a permanent rural-urban balance. In the regional city, as Stein conceived it, organization would take the place of mere agglomeration and, in doing so, would create a reciprocal relation between city and country that would not be overthrown by further population growth ([*Mumford*, 1925] [*Mumford*, 1938] [*MacKaye*, 1928] [*Stein et alii*, 1951]).

With this statement of the problems raised for us today by the natural history of urbanization, our survey comes to an end. The blind forces of urbanization, flowing along the lines of least resistance, show no aptitude for creating an urban and industrial pattern that will be stable, self-sustaining, and self-renewing. On the contrary, as congestion thickens and expansion widens, both the urban and the rural landscape undergo defacement and degradation, while unprofitable investments in the remedies for congestion, such as more superhighways and more distant reservoirs of water, increase the economic burden and serve only to promote more of the blight and disorder they seek to palliate. But however difficult it is to reverse unsound procedures that offer a temporary answer and immediate (often excessive) financial rewards, we now have a prospect of concrete alternatives already in existence in England and partly established in a different fashion by the regional planning authority for the highly urbanized Ruhr Valley in Germany. With these examples before us, we have at least a hint of the future task of urbanization: the re-establishment, in a more complex unity, with a full use of the resources of modern science and techniques, of the ecological balance that originally prevailed between city and country in the primitive stages of urbanization. Neither the blotting-out of the landscape nor the disappearance of the city is the climax stage of urbanization. Rather, it is the farsighted and provident balancing of city populations and regional resources so as to maintain in a state of high development all the elements (social, economic, and agricultural) necessary for their common life.

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2: [N.E.: This work first appeared in William L. Thomas, jr (Ed.), *Man's Role in the Changing the Face of the Earth*. Chicago & London: University of Chicago Press, 1956. The new notes of the present edition will be into square brackets.]

3: [To be noted the 1956's «sustenance» concept, N. of E.]

4: [Nowadays, the railroad has been substituted by the motorway in that role. N. of the E.]

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