Chapter Three

# POPULATION DISTRIBUTION: TRENDS AND ENVIRONMENTAL IMPLICATIONS

"Population distribution" refers to the arrangement of population across space, or population's relative geographic location. Population density (population divided by land area) is often used to indicate variation in distribution across regions, and, as such, population distribution is closely related to population size; population density actually represents population size as bounded by a specific locale.

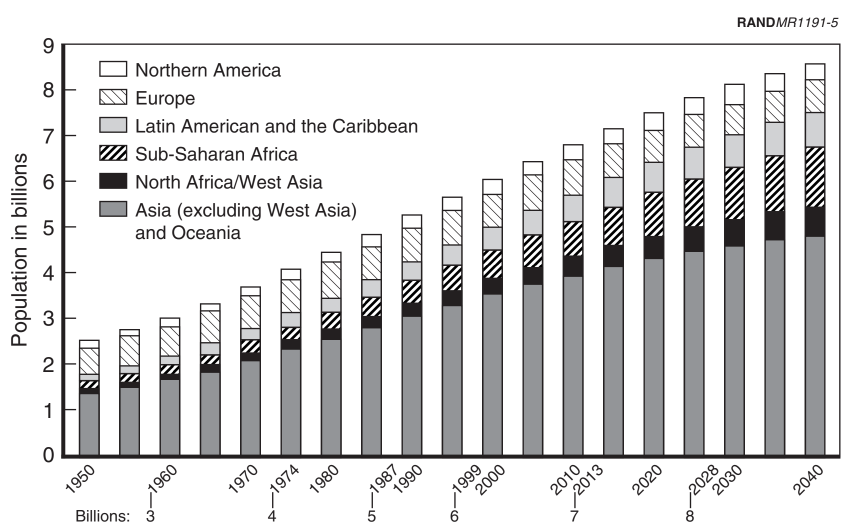
Population distribution has important environmental implications, particularly because many environmental changes are felt locally. As reviewed in this chapter, the environmental implications of population distribution are evidenced by (1) the increased pressure placed on overextended resources in many less-developed nations as a result of relative increases in population densities, (2) the ecological strain put on coastal resources as a result of amenity-driven migration in the United States, and (3)the ecological effects of urbanization, including concentration of pollutants and land-use conversion.

There are many potential policy responses to the environmental implications of local population pressure. Population-oriented policy may aim to reduce local population growth through fertility reduction, thereby lessening pressure on resources. It is important to recognize, however, that political response to the implications of population distribution need not be population-oriented. Rather, policies related to land use, consumption, and production processes have the potential to mitigate localized population-induced environmental change—some through influence on migration patterns, others through influence on production technologies. As examples, localized environmental impact stemming from population distribution and redistribution can be constrained through restrictions on local land use through zoning regulations, designation of conservation areas, or technology mandates in urban industrial regions.

## POPULATION DISTRIBUTION TRENDS AND PATTERNS

Changes in population distribution are due to two factors: (1) variations in natural increase that shift the relative proportions of population across locales and (2) migration. The past 40 years have witnessed remarkable changes in the distribution of humans across the globe. In particular, the increasingly urban concentration of population is a prominent contemporary demographic trend.

As for relative distribution of population across the globe, continued high fertility levels in many less-developed regions, coupled with low (or declining) mortality, is resulting in increasingly greater shares of the global population residing in less-developed areas (see Figure 3.1). According to the United Nations, by late 1999, the population of




SOURCE: United Nations, 1998c.

**Figure 3.1—Regional Distribution of Population**

less-developed regions had grown to 4.8 billion, representing 80 percent of the world's population—a 10 percentage point increase since 1960 (UNFPA, 1999b). As a more specific example, Africa's share of global population is projected to rise to 20 percent in 2050, as compared to only 9 percent in 1960 (UNFPA, 1999b).

Population distribution is also influenced by migration, a complex process driven by many factors. Individuals can be motivated to migrate by the "pull" factors of possible destination areas, including improved employment prospects, the possibility of joining family members, or other desirable economic or noneconomic amenities. On the other hand, a lack of employment opportunities at home or other negative characteristics can act as "push" factors motivating out-migration (Martin and Widgren, 1996). In recent years, global transportation and communication have increasingly allowed individuals to respond to the "push" and "pull" forces of migration, resulting in both migration across national borders (international migration) and migration within countries (internal migration).

As for international migration, numbers are at an all-time high. The net flow of international migrants is currently estimated at 2 million to 4 million annually, and a total of 125 million individuals live outside their country of birth (Martin and Widgren, 1996). The significance of internal migration as a force in population redistribution can be illustrated by U.S. patterns. During 1996–1997, fully 42.1 million Americans moved to a different dwelling unit, representing 16 percent of the population. More than 6 million of these migrants changed states (Faber, 1998). While migration is often seen as a response to the changing geography of economic opportunity, noneconomic motivations are becoming increasingly important. In fact, within rural areas of the United States, environmental amenities, such as climate, topography, and water-related opportunities, drive much of rural population change (McGranahan, 1999). Fueled in large part by this amenity migration, including retirees fleeing cold winters, 71 percent of the 2,305 rural counties in the United States gained population between 1990 and 1998 (PRB, 1999a).

Urbanization represents another striking pattern of contemporary population redistribution. During the past four decades, global population has experienced a massive urban transition. As recently as 1960, only one-third of the world's population lived in urban areas. In 1999, this proportion had increased to nearly half (47 percent, 2.8 billion people) (UNFPA, 1999b).[1] Although some progress has been made in reducing urban fertility levels, natural increase continues to account for about half of urban population growth (UNFPA, 1999b). In addition, the industry and commerce of cities act as magnets to many migrants who are drawn by perceived opportunities and the availability of services. At present, the pace of urbanization is highest in developing regions—the proportion of people in developing countries who live in cities nearly doubled between 1960 and 1990, from less than 22 percent to more than 40 percent (UNFPA, 1999b).

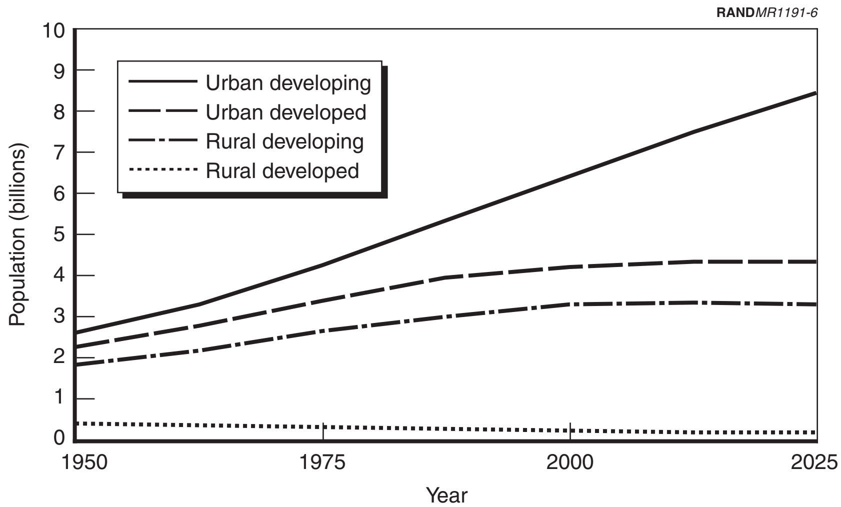
The process of urbanization is projected to continue well into the twenty-first century. Between 1990 and 2025, the number of people who live in urban areas is expected to double, with the vast majority of this urban growth taking place in developing countries (United Nations, 1998c; see Figure 3.2). By 2030, it is expected that nearly 5 billion (61 percent) of the world's people will live in cities (UNFPA, 1999b).

As a result of this high level of urban concentration, several cities have reached unprecedented levels of concentration (see Table 3.1). The number of "megacities" with 10 million or more inhabitants is increasing rapidly, mostly in developing nations. In 1960, only New York and Tokyo had more than 10 million people. By 1999, 17 cities had reached this level of concentration, 13 of them in less-developed regions (UNFPA, 1999b).

## THE ENVIRONMENTAL IMPLICATIONS OF POPULATION DISTRIBUTION

Several categories of environmental implications can be related to population distribution and redistribution. First, as less-developed regions cope with an increasing share of global population, pressure will be intensified on already dwindling proximate environmental

[1]According to the Population Reference Bureau, "urban" is typically defined as those areas with 2,000 or more inhabitants or national or provincial capitals (1998a).




NOTE: Developed regions include North America, Japan, Europe, and Australia and New Zealand; developing regions include Africa, Asia (excluding Japan), South America, Central America, and Oceania (excluding Australia and New Zealand). The European successor states of the former Soviet Union are classified as developed regions, while the Asian successor states are classified as developing regions.

SOURCE: United Nations, 1998c.

**Figure 3.2—Urban Population Growth, 1950–2025**

resources. Second, the redistribution of population through migration also brings shifts in relative human-induced environmental pressures—perhaps easing localized environmental change in some areas while increasing such change in others. Finally, rapid urbanization particularly in less-developed regions simply outpaces the development of infrastructure and environmental regulations, often resulting in high levels of air and water pollution. Each of these relationships is discussed below.

As for resource pressure, many areas in less-developed regions are already facing shortages of arable land, clean water, and sufficient fuelwood; increases in local population densities will likely exacerbate these scarcities. In the early 1980s, wood supplied the vast majority of household energy for domestic cooking and heating in many less-developed regions—82 percent in Nigeria, 92 percent in

**Table 3.1**

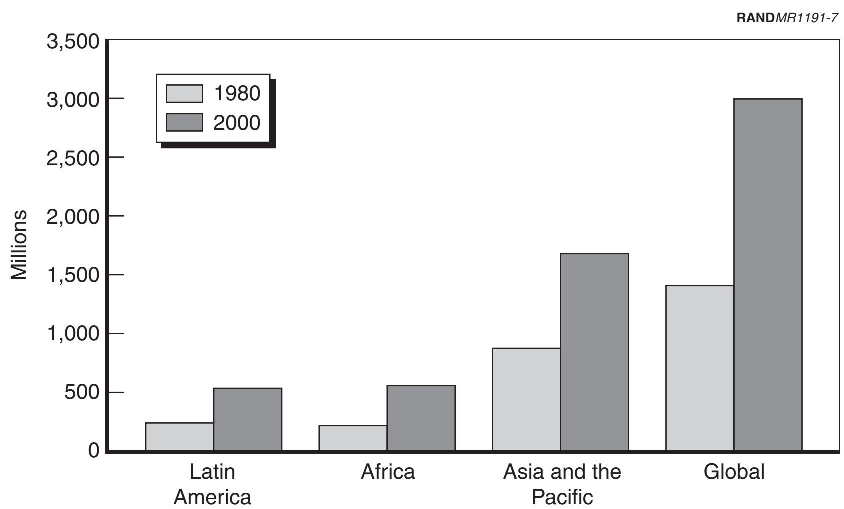
**The World's Twenty-Five Largest Cities, 1995**

| | Population (millions) | Average Annual Growth Rate 1990–1995 (percent) |
|---|---|---|
| Tokyo, Japan | 26.8 | 1.4 |
| Sao Paulo, Brazil | 16.4 | 2.0 |
| New York, U.S. | 16.3 | 0.3 |
| Mexico City, Mexico | 15.6 | 0.7 |
| Bombay, India | 15.1 | 4.2 |
| Shanghai, China | 15.1 | 2.3 |
| Los Angeles, U.S. | 12.4 | 1.6 |
| Beijing, China | 12.4 | 2.6 |
| Calcutta, India | 11.7 | 1.7 |
| Seoul, Republic of Korea | 11.6 | 2.0 |
| Jakarta, Indonesia | 11.5 | 4.4 |
| Buenos Aires, Argentina | 11.0 | 0.7 |
| Tianjin, China | 10.7 | 2.9 |
| Osaka, Japan | 10.6 | 0.2 |
| Lagos, Nigeria | 10.3 | 5.7 |
| Rio de Janeiro, Brazil | 9.9 | 0.8 |
| Delhi, India | 9.9 | 3.8 |
| Karachi, Pakistan | 9.9 | 4.3 |
| Cairo, Egypt | 9.7 | 2.2 |
| Paris, France | 9.5 | 0.3 |
| Metro Manila, the Philippines | 9.3 | 3.1 |
| Moscow, Russian Federation | 9.2 | 0.4 |
| Dhaka, Bangladesh | 7.8 | 5.7 |
| Istanbul, Turkey | 7.8 | 3.7 |
| Lima, Peru | 7.5 | 2.8 |

SOURCE: UN Population Division, 1995.

Tanzania, and 94 percent in Nepal. Even with current population pressure, the fuelwood demand in many countries simply outpaces sustainable supplies—wood is being cut faster than it can be replenished through natural growth. Consumption exceeds sustainable supply by 70 percent in Sudan, by 150 percent in Ethiopia, and by 200 percent in Niger. Increasing population densities result in even less supply per capita, and although other factors play a role in wood shortages (e.g., failure to encourage afforestation and/or the use of alternative energy sources), nearly 75 percent of the increase in wood demand from 1980–2000 was estimated to be caused by local population growth (see Figure 3.3; UNFPA, 1991, p. 49).

Arable land resources also feel the squeeze of population pressure. In rural Guatemala, when high fertility levels and falling mortality rates increased local population densities, the need for agricultural land intensified. Two primary responses emerged: fragmentation of land resources as small family holdings were divided among heirs and out-migration, often resulting in deforestation of other rural areas to expand agricultural production. The results: increasingly smaller agricultural holdings, some too small to provide sufficient subsistence production, in conjunction with high levels of deforestation—between 1950 and the mid-1980s, roughly half of the forested area was cleared. In this case, heightened population pressures, in conjunction with land tenure policies, brought about land-use changes in response to scarcity, changes that further endangered dwindling land and forest resources (Bilsborrow and Stupp, 1997).




SOURCE: Adapted from UNFPA, 1991, p. 48.

**Figure 3.3—Population Experiencing Fuelwood Deficit, 1980 and 2000**

As reviewed in Chapter Six, related scenarios play out in other regions of the world.[2]

Population redistribution through migration can affect environmental conditions, particularly when high levels of demographic pressure are exerted on fragile ecosystems. The coastal zones of the United States are an example. Although coastal counties (excluding Alaska) constitute only 11 percent of U.S. land area, they are home to 53 percent of the population (Culliton et al., 1990; Culliton, 1998). Coastal population is expected to reach 165 million by 2015, an average daily increase of 3,600 people (Culliton, 1998). California, Florida, Texas, and New York consistently account for a significant portion of coastal population growth. Yet, recent increases in migration fueled by recreation and retirement are also bringing rapid growth to the barrier islands of the Mid-Atlantic states and parts of the Gulf Coast (Frey, 1995). From 1980 to 1990, Florida counties experienced net growth of up to 781 percent (to 294 persons per square kilometer), counties of the central Atlantic coastal barriers had growth rates of up to 300 percent (to 294 persons per square kilometer), and Gulf Coast counties associated with the barriers of Louisiana and Texas had growth rates up to 155 percent (to 47 persons per square kilometer) (Bartlett, Mageean, and O'Connor, 1999). In North Carolina, the narrow coastal islands of Bodie and Hatteras absorbed most of Dare County's 280 percent growth, adding an additional 16 persons per square kilometer (Bartlett, Mageean, and O'Connor, 1999).

These increases in coastal population densities bring reduced vegetation cover, habitat loss, and resulting declines in species diversity (McAtee and Drawe, 1981). Greater levels of human activity in coastal areas also result in other significant ecological changes, such as declining beach elevation and changes in soil pH and average soil temperature—all having ultimate impacts on ecosystem sustainability (McAtee and Drawe, 1981). Figure 3.4 illustrates where high

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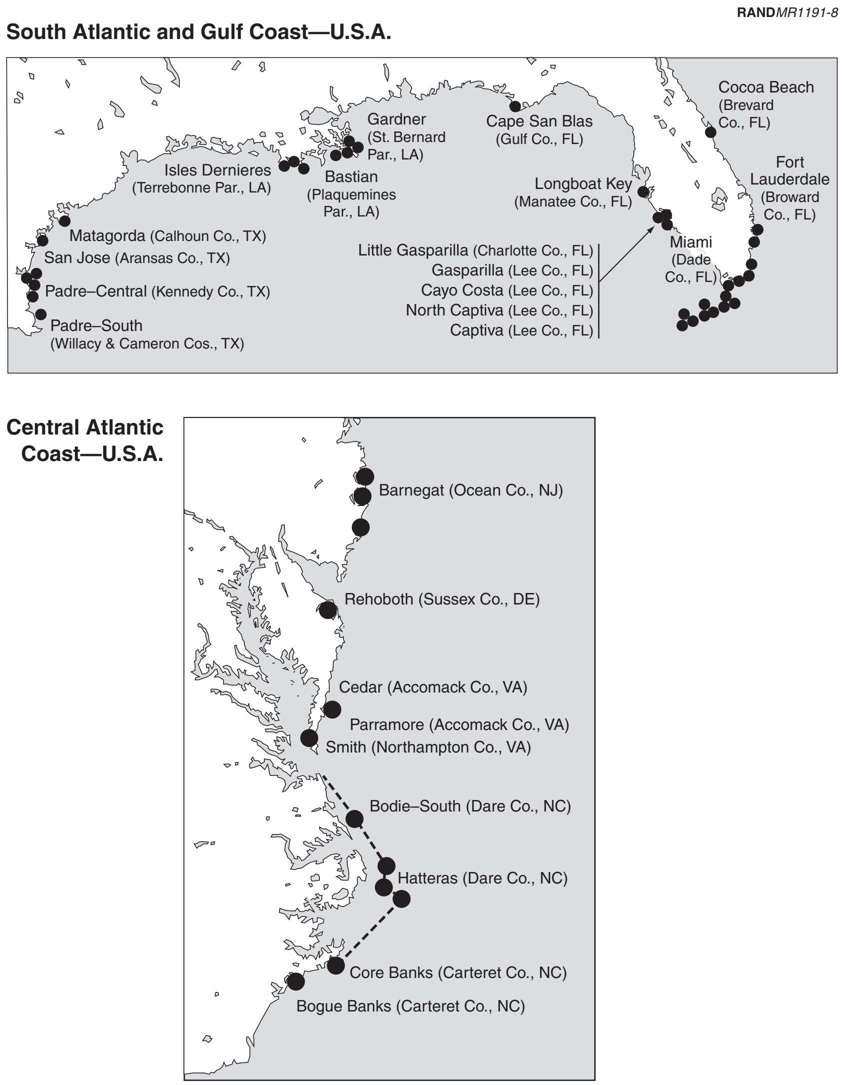
[2]For additional case studies demonstrating land-use changes resulting from land shortages see DeWalt, Stonich, and Hamilton, 1993, May 1995, and Bilsborrow and Hogan, 1999. For discussions of the role of water shortages in population-landscape interactions, see various publications by Falkenmark and colleagues (e.g., Falkenmark, 1991, 1994, Falkenmark and Suprapto, 1992; Falkenmark and Widstrand, 1992). The importance of accessible fuelwood is discussed in DasGupta, 1995.




SOURCE: Bartlett, Mageean, and O'Connor, 2000.

**Figure 3.4—Coastal Barrier Dune Ecosystems Experiencing High Levels of Population Change, Central and South Atlantic and Gulf Coasts, United States**

levels of population pressure overlap with coastal barrier dune ecosystems along the South Atlantic, Central Atlantic, and Gulf Coasts of the United States, therefore putting these areas at risk of human-induced ecological decline.

The final aspect of population distribution to be related to the environment is urbanization, the environmental implications of which can be considered either positive or negative depending on which particular impact is being examined (Pebley, 1998). On the positive side, cities promote efficiencies in transportation, housing, utilities, distribution of goods, and provision of services (Southwick, 1996). In addition, the recycling of inorganic materials can be easier in cities because the population is concentrated (Qutub, 1992). Finally, assuming urban sprawl is controlled, high-density settlements can help preserve natural habitat outside of urban areas. Imagine, for instance, if all the urban dwellers in the world were scattered over the landscape at very low densities (Southwick, 1996).

On the negative side, however, at least four general areas of environmental consequences result from the high population densities accompanying urban development. First, the waste produced by such densities is beyond that readily absorbed by the surrounding environment, resulting in high concentrations of pollutants (Benneh, 1994). The high levels of air pollution characterizing many megacities testifies to the inability of the environment to absorb the wastes produced by high densities of consumers and production processes (see Table 3.2; also see Brennan, 1996).

Second, the rapid pace of urban growth occurring in developing regions, in addition to the sheer size of megacities, greatly hinders the development of adequate infrastructure or regulatory mechanisms to handle the environmental impacts of human concentration. As an example, rapidly increasing population densities completely overwhelmed the sewage system in Karachi, Pakistan (population 10 million), often operating at only 15 percent capacity as a result of breakdowns and clogged pipes. Much of the sewage eventually contaminated drinking-water wells because it had leaked into the surrounding soil (Rahman, 1995). Such contamination is responsible for many waterborne diseases, including diarrheal disease, cholera, typhoid, and hepatitis A and E. Especially in developing regions,

**Table 3.2**

**Status of Pollutants in the Megacities, 1992**

| City | $SO_2$ | SPM | Pb | CO | $NO_2$ | $O_3$ |
|---|---|---|---|---|---|---|
| Bangkok | ○ | ★ | ● | ○ | ○ | ○ |
| Beijing | ★ | ★ | ○ | — | ○ | ● |
| Bombay | ○ | ★ | ○ | ○ | ○ | — |
| Buenos Aires | — | ● | ○ | ★ | — | — |
| Cairo | — | ★ | ★ | ● | — | — |
| Calcutta | ○ | ★ | ○ | — | ○ | — |
| Delhi | ○ | ★ | ○ | ○ | ○ | — |
| Jakarta | ○ | ★ | ● | ● | ○ | ● |
| Karachi | ○ | ★ | ★ | — | — | — |
| London | ○ | ○ | ○ | ● | ○ | ○ |
| Los Angeles | ○ | ● | ○ | ● | ● | ★ |
| Manila | ○ | ★ | ● | — | — | — |
| Mexico City | ★ | ★ | ● | ★ | ● | ★ |
| Moscow | — | ● | ○ | ● | ● | — |
| New York | ○ | ○ | ○ | ● | ○ | ● |
| Rio de Janeiro | ● | ● | ○ | ○ | — | — |
| São Paulo | ○ | ● | ○ | ● | ● | ★ |
| Seoul | ★ | ★ | ○ | ○ | ○ | ○ |
| Shanghai | ● | ★ | — | — | — | — |
| Tokyo | ○ | ○ | — | ○ | ○ | ★ |

RAND*MR1191-T2*

★ Serious problem, WHO guidelines exceeded by more than a factor of two

● Moderate to heavy pollution, WHO guidelines exceeded by up to a factor of two (short-term guidelines exceeded on a regular basis at certain times)

○ Low pollution, WHO guidelines normally met (short-term guidelines are exceeded occasionally)

— No data available or insufficient data for assessment

NOTE: $SO_2$ is sulfur dioxide; SPM is suspended particulate matter; Pb is lead, CO is carbon monoxide, $NO_2$ is nitrous oxide, and $O_3$ is ozone.

SOURCES: WRI, 1994, p. 198.

many waterborne diseases are the principal causes of infant and child mortality. For example, diarrheal disease, the major waterborne disease, ranks as the leading cause of morbidity in the world and is estimated to be responsible for over 3 million child deaths in 1990 (WHO, 1998c).

Third, urbanization often results in alteration of local climate patterns. Concentrations of artificial surfaces, such as brick and concrete, replace natural ground and alter heat exchange patterns, thereby creating "heat islands." In cities with more than 10 million people, the mean annual minimum temperature can be as much as 4 degrees Fahrenheit higher than in nearby rural areas, and these changes can affect climate, water flows, and plant and animal diversity, as well as human health (Berry, 1990).

Finally, poorly planned urban development can result in significant conversion of land from habitat or other purposes, such as agriculture. The consequences of such development patterns are especially apparent in the extended metropolitan regions resulting from urban sprawl in the United States. During 1992–1997, 16 million acres of forest, cropland, and open space were converted to urban and other uses, representing an 18 percent increase in the nation's developed land area (USDA, 1999a).[3] The land developed during this five-year period was greater than the total land developed during the 10-year period 1982–1992 (13 million acres), suggesting an increase in the pace of sprawling development (USDA, 1999a). In the Chesapeake Bay area, development pressures have reduced tree canopy from 51 percent to 37 percent in just the past 25 years (USDA, 1999b). In California, much prime agricultural land is adjacent to rapidly expanding urban areas. About 250,000 acres (4.5 percent of California cropland) were lost to development during the period 1982–1992 (USDA, 1999b).[4] Watersheds in the San Joaquin Valley have been especially affected, with the level of land conversion ranking among the top 2 percent of the nation's more than 2,100 watersheds (USDA, 1999b).[5]

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[3]The developed land category includes large tracts of urban and built-up land; small tracts of built-up land, less than 10 acres in size; and land outside of these built-up areas that is in roads, railroads, and associated rights-of-way (USDA, 1999).

[4]As stated previously, the density of urban areas can also be considered positive in the sense of preserving habitat. The difference here is one of planning and appropriate infrastructure development.

[5]Watersheds are defined as U.S. Geological Survey Hydrologic Cataloging Units (8-digit) (USDA, 1999b).