Chapter 3
Defining Urban Areas

John R. Weeks

What is an urban area? How do we know it when we see it? And how do we measure the concept of urban, so that we can study it? This chapter reviews the many dimensions of urbanness in an attempt to synthesize the vast literature that exists on the topic, but focuses especially on issues of classifying places as urban or rural in such a way that changes over time in the characteristics of a place can be adequately captured by the researcher.

Learning Objectives

Upon completion of this chapter, you should be able to:

1. Articulate how places are defined as urban
2. Describe how the urbanness of a place could be measured
3. Explain how urbanness is used as a predictor of human behavior

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3.1 What Is Urban?

We all know an urban place when we see it, but defining it is not as easy as it might seem. In other writings, I have defined urban as being a characteristic of place, rather than of people (Weeks 2008). Places are typically defined as "urban," and on the basis of that definition the people living there are thought of as being part of the urban population. But, we do not usually apply the term "urban" to a person. The personal adjective "urbane," still occasionally used to describe a person, is defined by the Oxford English Dictionary as "having the qualities or characteristics associated with town or city life; esp. elegant and refined in manners, courteous, suave, sophisticated"

J.R. Weeks (✉)
Department of Geography, San Diego State University, 5500 Campanile Dr., San Diego, CA 92182-4493, USA
e-mail: john.weeks@sdsu.edu

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(Brown 1993: pp 3527). Of course, you might well question how well that describes the average urban dweller in the modern world.

If we agree that urban is a place-based characteristic, then we can proceed to define an urban place as a spatial concentration of people whose lives are organized around nonagricultural activities. The essential characteristic here is that urban means nonagricultural; whereas rural means any place that is not urban. A farming village of 5,000 people should not be called urban, whereas a tourist spa or an artist colony of 2,500 people may well be correctly designated as an urban place. You can appreciate, then, that "urban" is a fairly complex concept. It is a function of (1) sheer population size, (2) space (land area), (3) the ratio of population to space (density or concentration), and (4) economic and social organization. As I will discuss below, the changes occurring throughout the world might well call into question this definition that relies on non-agricultural activity as a major criterion, because urban characteristics of place – especially those related to infrastructure – are increasingly (and deliberately) showing up in places that used to be strictly agricultural in nature. In other words, the urban–rural divide is becoming less obvious as the world population grows, as the fraction of humans living in cities increases, and as technology continues to transform human society.

"urban" is a place-based characteristic that incorporates elements of population density, social and economic organization, and the transformation of the natural environment into a built environment

Urban places are now home to virtually one of every two human beings and, by the middle of the twenty-first century, nearly two out of every three people will be urban dwellers (United Nations Population Division 2008). This is a truly remarkable transformation when you consider that as recently as 1850 only 2% percent of the entire population of the world lived in cities of 100,000 or more people. By 1900 that figure had edged up to 6%, and it had risen to 16% by 1950 (Davis 1972). Today the world is dotted by places with 100,000 or more people, and it is so commonplace that a city of that size is considered to be very small. "The present historical epoch, then, is marked by population redistribution as well as by population increase. The consequences of this redistribution – this "urban transition" from a predominantly rural, agricultural world to a predominantly urban, nonagricultural world – are likely to be of the same order of magnitude as those of the more widely-heralded increase in world population" (Firebaugh 1979: pp 199).

So pervasive is the lure of urban places that governments of many developing countries have promoted schemes to bring urban infrastructure to traditionally agricultural villages, in an attempt to keep migrants from overwhelming cities that are already crowded beyond the limits of the infrastructure. "In Vietnam the government is attempting to promote rural industrialization through the encouragement of sideline productions with the slogan 'leaving the land without leaving the village'" (Rigg 1998: pp 502). As non-agricultural work gradually soaks up a larger fraction of a village's labor force, the social and economic life of the village changes and of course the place becomes essentially more urban. "As the relationship between city and countryside becomes ever more entwined, it is becoming ever harder to talk of discrete 'rural' and 'urban' worlds" (Rigg 1998: pp 515).

It is not a coincidence that the urban transition has occurred in concert with the worldwide increase in population over the past 200 years. The urban transition is an inextricable part of the demographic transition because they both have roots in the same sets of technological advances that have rocked the world. The root cause of modern population growth is the massive drop in death rates that has been brought about by scientific control of disease, and by the provision of more and better food, shelter, and clothing. These are part and parcel of the industrial changes occasioned by technological advance. Modern technology allowed an increase in agricultural output per worker, which permitted more people to be freed from agricultural activity and were thus available to move to jobs being created in cities. Technology also helped improve the health of the population, which led eventually to cities being demographically self-sustaining (i.e., having a positive rate of natural increase and thus not being completely dependent upon migration for population increase). At the same time, technology was expanding the possibilities for city size and structure because premodern technology did not permit buildings to be very high or very deep – they were physically restricted to being close to the surface which clearly limits the potential population density and thus city size because: (1) cities had to be compact enough to be traversed easily on foot; (2) roads did not have to be very wide or regular in shape because they did not have to accommodate fast-moving motorized traffic; (3) population size was limited by the ability to supply the city with water and with some way of getting rid of human waste; (4) population size was limited by the ability to supply the city with food, which in the absence of refrigeration limited locations of cities to those places near a ready agricultural supply; and (5) economic activity was labor-intensive and so there were no special spatial advantages to having manufacturing done in the city; rather it could be "farmed" out to people living outside the city, meaning that cities were largely service (including government and finance) and commercial centers, which limited the variability in land use.

urban transition is an inextricable part of the demographic transition and both are related to advances in modern technology

Technology has led to a larger population worldwide through its impact on controlling mortality, but has also led to the need for that population to be increasingly urban – to get out of the way of the mechanization of agriculture which is required to feed the larger population. Thus, only in modern times has it been not only possible but also necessary for any but a small fraction of the population to live in cities. Technology has led to the ability of food to be preserved and shipped farther distances, thus expanding the geographic scope of where cities can be located – thereby creating greater possibilities for the creation of city systems. Technology first led to the ability to house a larger number of people in the same urban space as before and therefore permitted an increase in city size through densification. Technology then, as discussed in Chapter 2, permitted the population of cities to spread out spatially

the limits of technology in the preindustrial era represented constraints on the location and size of cities, and led to a greater variety in the organization of social life

as transportation improved, leading to spatial extensification of urban areas, associated often with a decline in the population density in central areas. The spread of cities beyond traditional core areas is also encouraged by the reluctance to tear down old buildings and widen narrow streets, thus pushing economic activity into newer places where a built environment can be created that is more accommodating of modern technology.

Overall, the limits of technology in the preindustrial era represented constraints on the location and size of cities, and thus on the complexity of the city systems that could develop in any given region. Modern technology, on the other hand, has virtually demanded the growth of the urban population both numerically and as a fraction of the total population, and has given rise to numerous new forms of urban structure in the process. Therefore, we should expect that, all other things being equal, modern technology will be associated with considerably more complex forms of city systems than was true in the preindustrial era. However, once again technology potentially alters the expectation because improved communication means that the advantages and disadvantages of particular city systems are evaluated quickly and that information can be disseminated in a way that can influence policy makers and market forces in the same way in disparate places. In preindustrial societies the slowness of communication led to a greater variety of cultural responses to the organization of social life and to a much slower diffusion of innovations.

Technology and Self-Sufficiency

The importance of modern technology is that it provides us with a set of clues about how to redefine, or at least improve our definition of, an urban place. Urban places are increasingly characterized by the kinds of infrastructure they provide to their residents. To a degree, this is a function of self-sufficiency. A truly non-urban place is one in which its residents are completely self-sufficient, in that they grow their own food, have their own water supply, create their own energy (largely from wood fires) and deal with their own waste products. This mode of living represents the life that most humans who have ever lived were born into. Yet, it is also a life that is precarious, because it is associated with high death rates and low levels of innovation. At the other end of the continuum is a place in which residents are completely dependent upon strangers for virtually all of their needs – piped water, piped sewage, landfills beyond the city limits, food brought to them from elsewhere in the world, and energy sources that are generated from outside the region.

3.2 Urban–Rural Is Not Really a Dichotomy

The idea of a continuum suggests that urban and rural are, in fact, ends of a continuum, rather than representing a dichotomy. Nevertheless, most countries employ a dichotomy in the definition of urban. "Of the 228 countries for which the United Nations (UN) compiles data, roughly half use administrative considerations – such as residing in the capital of the country or of a province – to designate people as urban dwellers. Among the other countries, 51 distinguish urban and rural populations based on the size or density of locales, 39 rely on functional characteristics such as the main economic activity of an area, 22 have no definition of 'urban,' and 8 countries define all (Singapore, for example) or none (several countries in Polynesia) of their populations as living in urban areas" (Brockerhoff 2000: Box 1).

urban and rural are ends of a continuum

In the United States in the nineteenth and early twentieth centuries, rural turned into urban when you reached streets laid out in a grid. Today, such clearly defined transitions are rare. Besides, even living in a rural area in most industrialized societies does not preclude your participation in urban life. The flexibility of the automobile combined with the power of telecommunications put most people in touch with as much of urban life (and rural life, what is left of it) as they might want. In the most remote areas of developing countries, radio and satellite-relayed television broadcasts can make rural villagers knowledgeable about urban life, even if they have never seen it in person (Critchfield 1994). There is probably more variability among urban places, and within the populations in urban places, than ever before in human history. This variability has important consequences for the relationship between human populations and the environment, because populations become urban through the transformation of the natural environment into a built environment, and as urban places evolve, the subsequent changes in the built environment may well have forward-linking influences on human behavior: Humans transform the environment; and are then transformed by the new environment.

people create an urban place, and then are influenced by the place that has been created

As long ago as 1950, when less than 30% of the world lived in urban places, the United Nations Population Division was already making the case that a rural–urban continuum would be preferable to a rural/urban dichotomy (Smailes 1966). "We recognize, of course, that there will undoubtedly always be political and administrative uses to which dichotomies such as urban/rural and metropolitan/non-metropolitan will be put, but we argue that such dichotomies are increasingly less useful in social science research. Instead, we must move more intensively to the construction of a variable – a continuum or gradient – that more adequately and accurately captures the vast differences that exist in where humans live and thus how we organize our lives" (Weeks et al. 2005: pp 267).

In order to build an ecological model of the rural–urban continuum, we must recognize that most social science literature that describes the nature and character of urban populations focuses almost exclusively on the measurement of the social environment, often drawing upon census data to describe this milieu. But variations in the social environment are dependent, at least in part, upon variability in the built environment. For example, high population density – an index that is often used as a measure of urbanness – can be achieved with some kinds of physical structures, but not others. The idea that people create an urban place, and then are influenced by the place that has been created, leads to the hypothesis that some variability in human behavior may be captured in surrogate form by knowledge of the variability of the built environment, along with data from the census that provide surrogate measures of the social environment. In this conceptualization, the built and social environments are intimately entwined, but not completely dependent upon one another. The same built environment can host variation in the social environment, and the same social environment can exist within a range of built environments, but I would suggest that a relatively narrow range of combined values of the built and social environments will describe a unique set of urban populations.

3.3 Remotely-Sensed Data as Proxies for the Built Environment

Census and survey data provide most of the knowledge that we have of the social environment of places. Yet, one of the difficulties of using only census or survey data is that people are enumerated or surveyed at their place of residence. Since urban residents typically work in a different location than where they live, this spatial mismatch has the potential to produce a bias in the classification of the urbanness of place. An example might be a central business district which has only a small residential population, characterized largely by lower-income persons in single-room occupancy hotels. Census data might yield an index that indicates a relatively low degree of urbanness, based on a fairly small population and/or low density. Yet, the daytime population might represent a large number of commuting workers, and if they were to be counted the place would score much higher on an urban index. However, to accommodate that daytime population there must be a substantial built environment that includes a range of structures, infrastructures and other features indicative of urban lifestyle.

The built environment could be described by databases that document the type of structures and infrastructures comprising each parcel of land in every place. The cost of generating and maintaining such a database is enormous, however, and we do not really expect that any but the wealthiest of cities will be in a position to do that. In the meantime, it turns out that remotely-sensed data offer a way of generating reasonable proxy variables of the built environment, and thus of an important part of the way that places differ from one another with respect to urbanness. The modification of the physical environment that is characteristic of urban places can be inferred from the classification of multispectral and panchromatic satellite images. A place that is distinctly urban can be determined from the imagery regardless of the characteristics of the residents and we then have an indirect way to capture the characteristics both at the place of residence and at the presumptive place of work.

remotely-sensed data offer indirect ways to measure the urbanness of a place regardless of who resides in that place

the creation of an urban–rural gradient requires a knowledge of how urban or how rural a place is

The creation of an urban–rural dichotomy requires that the researcher decide upon the criteria that will go into an algorithm for assigning each place to either the urban or rural category. The creation of an urban–rural gradient requires that we adapt such an algorithm to tell us how urban or how rural a place is (a "soft" classification), rather than simply assigning it to one category or the other (a "hard" classification). There are several issues that must be dealt with in the creation of an index, including: (1) the spatial unit of analysis to be used; (2) the variables to be combined in the index; and (3) how the variables will be combined to create an index.

3.3.1 What Spatial Unit of Analysis Should Be Used?

If we are able only to circumscribe some large geographic zone (e.g., the contiguously built-up area in a region) then the ends of the rural–urban spectrum will be relatively close to one another. On the other hand, if we are able to define the attributes for relatively small and regular zones, such as a half-kilometer grid of land, then we could better understand variability both between and within human settlements. Furthermore, if we had a clearly defined spatial grid, then we could more accurately measure change over time – to understand the process of urban change and evolution that almost certainly has an important impact on human attitudes and behavior. However, the preliminary set of calculations that helps to establish the utility of this approach must of necessity be based on geographically irregular administrative boundaries because the census data that we are using in the creation of the index are readily available only at the level of those administrative boundaries.

3.3.2 What Variables Should Be Used to Define Urbanness?

I have suggested elsewhere (Weeks et al. 2005) that the urban index should combine census and survey data (to capture aspects of the social environment) with data from remotely-sensed imagery (to capture aspects of the built environment). Let me focus here on the latter part of the equation. The classification of an image is done at the level of the individual picture element (pixel), but in the creation of an index of urbanness we are less interested in each pixel than we are in the *composition* and *configuration* of all of the pixels within a defined geographic region (read further discussions in Chapters 5 and 12). This is the realm of landscape metrics, which are quantitative indices that describe the structure of a landscape by measuring the way in which pixels of a particular land cover type are spatially related to one another (Herold et al. 2002; Lam and DeCola 1993; McGarigal et al. 2002). The structure of a scene is inferred by calculating indices that measure composition and configuration of the pixels within an area.

3.3.3 How Will the Variables Be Measured?

Composition refers to the proportional abundance in a region of particular land cover classes that are of interest to the researcher. We employed Ridd's (1995) V-I-S (vegetation, impervious surface, soil) model to guide the spectral mixture analysis (SMA) of medium-resolution multi-spectral images for Cairo for 1986 and 1996, in a manner similar to methods used by Phinn and his colleagues for Brisbane, Australia (Phinn et al. 2002), and by Wu and Murray (2003) for Columbus, Ohio. The classification methods are described elsewhere (Rashed and Weeks 2003; Rashed et al. 2001, 2003, 2005; Roberts et al. 1998) and so will not be discussed here in any detail. The V-I-S model (see Chapter 6) views the urban scene as being composed of combinations of three distinct land cover classes. An area that is composed entirely of bare soil would be characteristic of desert wilderness, whereas an area composed entirely of vegetation would be dense forest, lawn, or intensive fields of crops. At the top of the pyramid is impervious surface, an abundance of which is characteristic of central business districts, which are conceptualized as the most urban of the built environments.

the built environment is quantified by measures of composition and configuration of land cover within an area

We added another component to Ridd's physical model – shade/water – following the work of Ward et al. (2000) suggesting that the fourth physical component improves the model in settings outside of the United States. When combined with impervious surfaces in urban areas it becomes a measure of the height of buildings (based on the shadows cast by buildings). When combined with vegetation it provides a measure of the amount of water in the soil and the shade cast by tall vegetation (largely trees that may serve as windbreaks in agricultural areas). In combination with bare soil it is largely a measure of any shadows cast by trees, although there could be some component of shade from large buildings in heavy industrial areas. Spectral mixture analysis permits a "soft" classification of a pixel into the likely fraction of the pixel that is composed of each of the four physical elements of vegetation, impervious surface, soil, and shade. By summing up these fractions over all pixels contained within each area of interest, we have a composite measure of the fraction (the "proportional abundance") of the area that is covered by each of the four land cover types.

These compositional metrics build on the qualitative sense that each of us has about what an urban place "looks like." Even today in highly urbanized countries in Europe and North America it is visually very evident when you move from a largely rural to a predominantly urban place and, of course, the change in the built environment is the principal index of that. Even within non-urban areas it is usually quite evident when you have passed from a wilderness area into a largely agriculture area. Once again, it is the configuration of the environment that provides the clue. Figure 3.1 shows this in a schematic way. Wilderness areas can, at the extreme, be expected to be composed especially of bare soil, since deserts tend to

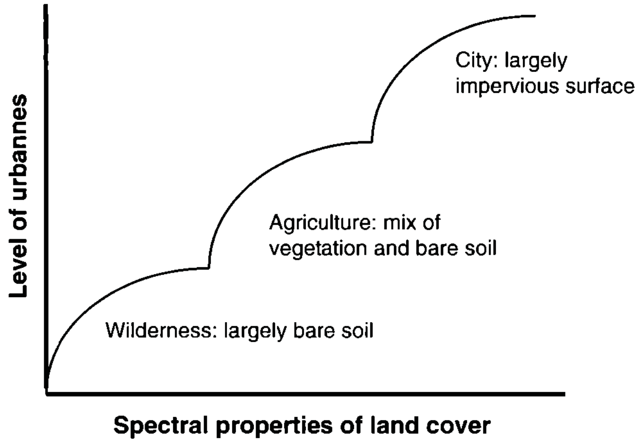

Fig. 3.1 The urban gradient may be discontinuous

be the places least habitable by humans. As the fraction of vegetation increases, there is an implicit increase in the availability of water and where there is sufficient water the possibility of agricultural increases and agriculture creates a signature on the ground that is typically distinct from areas that have not been modified by humans. However, the nature of urban places is that the built environment is dominant, and so cities are distinctly noticeable from the air because vegetation gives way immediately, discontinuously, to impervious surfaces.

The proportional abundance of impervious surface is the baseline measure of urbanness, as suggested by the Ridd V-I-S model, but shade is also a factor, especially in areas dominated by tall buildings. Thus, in areas that are generally urban, the simple addition of the impervious surface and shade fractions should provide an appropriate measure of the proportional abundance of land cover most associated with an urban place. In agricultural areas, where shade may indicate canopy cover or water-saturated ground, it would be less appropriate to combine the impervious surface with the shade fraction.

The other aspect of landscape metrics is the quantification of the spatial configuration of the patches comprising each land cover class. We may know that 60% of a given area is covered by impervious surface (the measure of composition), but we would also like to know how those patches are arranged within the area under observation. McGarigal et al. (2002) notes that configuration is much more difficult to assess than composition and over the years a large number of measures have been developed in an attempt to capture the essence of landscape configuration. However, it is important to keep in mind that most measures of landscape configuration were developed for the purpose of describing landscape ecology and have only recently been shown to have an adaptation to the measurement of the urban environment (Herold et al. 2002). One of the more interpretable measures in the context of urban places is the contiguity index, which is a measure of the "clumpiness" of land cover classes. In particular, we are interested in the clumpiness of impervious surfaces because we hypothesize that high levels of clumpiness (where pixels of the impervious surface land cover class are all in close proximity to one another) represent one or only a few buildings, characteristic of central cities and other dense areas. On the other hand, low levels of clumpiness of impervious surface should represent a disaggregation of pixels of the same land cover class, representing a greater number of buildings, associated with lower density, more suburban areas.

Two areas might have identical fractions of impervious surface, but the one with a high contiguity index would probably represent a "more urban" area than the one with the lower contiguity index. In general, we would expect that city centers would have the highest abundance of impervious surface and also the highest level of contiguity of that impervious surface. At the other extreme, a place that is not very urban will have a low proportion of impervious surface, but that surface might be highly contiguous (one small building) or only moderately so (three small buildings), but the degree of contiguity would matter less than it would when the proportion of impervious surface is high. This suggests that the configuration of the pixels increases in importance as the proportional abundance of impervious surface increases, implying the existence of an exponential relationship.

The way in which these several measures of composition and configuration can be most satisfactorily put together is still under investigation (see Weeks 2004; Weeks et al. 2005). However, the research conducted thus far suggests the utility of this approach to the creation of an urban index that can be combined with census data to characterize the nature of urbanness of a place.

3.4 Using the Urban Index as a Predictor Variable

An urban index of the type that I have suggested may be of inherent interest on its own, but its greatest value in social science research is almost certainly that it provides a way of contextualizing the environments in which people live. Places that are different in terms of urbanness are likely to be different in other ways that will affect the lives of the people there. Similarly, changes over time in urbanness can be expected to be related, both causally and consequentially, to the lives of the people who comprise the residents and/or workers in those changing environments.

As long as the researcher is careful to use the same measurements from the satellite imagery and census data over space and time, then differences in the urban index can be proxies for differences between places and changes over time in the social and economic aspects of the people being studied. This characteristic of a place can than be introduced into a regression analysis as a predictor variable, or even into multi-level analyses as a community-level factor that may be related to individual behavior taking place in different places and/or at the same place at different times.

Chapter Summary

Urban is a place-based characteristic that describes the degree to which the lives of a spatial concentration of people are organized around nonagricultural activities. The urbanness of a place is determined based on a range of elements encompassing population size and density, social and economic organization, and the transformation of the natural and agriculture environments into a built environment. Because of the spatial and temporal variability of such elements, the degree of urbanness varies across space (and through time), suggesting that urban and rural are, in fact, ends of a continuum, rather than representing a dichotomy. The idea of an urban–rural continuum or gradient lends itself to the development of indices to help describe how urban (or how rural) a place is at a given point of time. This chapter has introduced you to one of such indices, an urban index that combines census and survey data (to capture aspects of the social environment) with data from remotely sensed imagery (to capture aspects of the built environment). Focusing mainly on the latter part of the equation, this chapter has discussed several issues to be considered in using remote sensing to define the urbanness of a place, including: (1) the spatial unit of analysis to be used (pixel versus zonal units); (2) the variables to be combined in the index (composition and configuration of the built environment); and (3) how the variables will be combined to create an index (spectral mixture analysis and landscape metrics).

Learning Activities

Internet Resources

- Explore the changing nature of urbanness
  - The Timeline of New Urbanism http://www.nutimeline.net/. Features several way to search key events in the history of new urban since the nineteenth century.
  - USGS Urban Dynamics Program.
  - http://landcover.usgs.gov/urban/intro.asp. Features temporal maps and data resources, animations, articles, and timelines for selected metropolitan regions in the United States.

- Explore the different ways used to define the urbanness of places:
  - The World's Bank urban environmental indicators http://www.worldbank.org/urban.
  - The Human Settlements page on the website of International Institute for Environment and Development http://www.iied.org/HS/index.html. Features several discussions of and resources for the rural–urban divide and free access to the international journal of Environment and Urbanization.
  - The Global Urban Indicator Program at the UN-HABITAT http://www.unchs.org/programmes/guo/guo_indicators.asp.
- Links to some regional and country-specific urban indicators programs:
  - Central and Eastern Europe http://greenpack.rec.org/urbanisation/seeing_a_city/05-01-03.shtml
  - Canada
    - Montreal http://www.ecoplan.mcgill.ca/?q=node/view/102
    - Toronto http://tui.evcco.com/
  - India http://www.cmag-india.org/programs_urban_indi_prog.htm
- FRAGSTAT for landscape metrics http://www.umass.edu/landeco/research/fragstats/fragstats.html

Study Questions

- What do you understand about the terms "urban" and "self-sufficiency? How do they connect to each other?
- Use census data to plot the population of your own city or a city of your choice over time. Identify and explain significant trends. Using two or more of remotely sensed images of the same city, identify urbanization trends in the city and whether they correspond to population trends. Use the procedures described in Weeks et al (2005) and Rashed et al (2005) to develop an index of urbaness at one or more points of time for your study city.

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