Spatial Demography ***2014*** 2(2): In Press
http://spatialdemography.org

SPATIAL DEMOGRAPHY
ISSN 2164-7070 (online)

RESEARCH

Urban Estimates and Projections at the United Nations: the Strengths, Weaknesses, and Underpinnings of the World Urbanization Prospects

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ABSTRACT

For about five decades, the United Nations Population Division has produces a comprehensive demographic account of the global urbanization process, now known as the biennial "World Urbanization Prospects". This article describes the evolution of this unique data source from its inception to its 19th issues as the 2011 Revision and gives an overview about the statistical data sources used for the estimation of past and future trends, the models used for estimation and projection and the tools that have been developed to carry out the tasks. The article finally discusses the as yet unsuccessful demand for more compatible and comparable statistical definition or urban and city populations, addresses some alternative approaches and offers some ideas about possible improvements to the current methodology.

KEYWORDS: United Nations, urbanization, World Urbanization Prospects, history, urban agglomerations, cities, projection methodology, estimation, statistical concepts of urbanization.

INTRODUCTION

Based on earlier preparatory work, the United Nations Population Division (herein, Population Division) began in the 1960s to produce series of assessments of the global urbanization process. After exploring several options of measuring, estimating and projecting this complex phenomenon, the *World Urbanization Prospects*, as the report has been entitled since the 1990 *Revision*, has established itself as a regular and important part of the work programme of the United Nations Population Division. It has served as an important source of information about one the defining transformations of current societies. Altogether, the *World Urbanization Prospects* have been revised 19 times over about 50 years since its inception.

Over its past, the *World Urbanization Prospects* has been periodically revised: (1) to included newly formed countries or areas; (2) to include additional urban locations[1] for evaluation and publication; (3) to revise or refine the projection methods; and (4) to extend the projection horizon. Some *Revisions* contained additional estimates and projections for urban and rural population by age and sex. Currently[2], the *World*

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1 The generic term location is used for what is commonly referred to as towns, cities, urban agglomerations or metropolitan areas, as the case may be for a particular country.

2 The actual revision available at the time this article was written was the 2011 Revision of World Urbanization Prospects (United Nations, 2012a, b)

Urbanization Prospects provides time series for 231 countries and areas, covering 100 years, from 1950 to 2050 for urban and rural populations, and for larger cities from 1950 to 2025.

This paper provides a short historical account of the data and methods used to produce the global estimates and projections in the *World Urbanization Prospects* and a discussion of current constraints. It concludes with a brief discussion of what could be added, revised or changed to the exercise in order to make it more informative for its users.

A short history of the *World Urbanization Prospects*

Over the past five decades, the Population Division has published numerous revisions of its *World Urbanization Prospects* (herein *Revision*). Over time, content, format, coverage and methodology of this global account of the process of urbanization was changed in response to needs, increased availability of basic data and increasing computing power. In the early years, *Revisions* were not only spread over several volumes, but were sometimes limited in distribution[3]. It took many years before the *World Urbanization Prospects* evolved into its current format.

At a time of exceptionally high population growth in developing countries, the United Nations Population Division began to explore the feasibility to create an instrument monitoring urbanization on a global scale. The 1963 *Revision* of *World Urbanization Prospects* was the first attempt of the Population Division to provide a comprehensive account of the global urbanization process. Based on the 1963 *Revision* of *World Population Prospects*[4] (United Nations 1966), it consisted of two reports, one journal article and a conference paper. (United Nations 1967, 1968, 1969, 1970a). For the most part, it had the appearance of an exploratory exercise.

A first volume provided time series of the growth of the world's urban and rural populations from 1920 to the year 1960, as well as figures for 263 cities with populations of 500,000 inhabitants or more for the same period and for a total of 98 countries. Projections were made for the total urban population, the agglomerated population (people living in urban localities of 20,000 inhabitants and more) and rural and small-town populations (localities of less than 20,000 inhabitants) up to the year 2000 (United Nations 1969). (Data collection for the City Database is discussed in greater detail below.). The calculation of an independent urbanization index by aggregating all urban locations above a certain population size – the agglomerated population – was an attempt to avoid the shortcomings of nationally defined urban populations. A comparison between time series of national definitions with the alternative indicator showed differences, but did not exhibited different trends (United Nations 1987b, p. 72).

The subsequent 1968 *Revision* (United Nations 1970b, 1971, 1972a, 1972b) was again issued in four publications that contained estimates and projections for the urban and rural populations of individual countries between 1950 and 1985 and for regions and major areas up to the year 2000. Estimates for urban and rural population by age and sex for the year 1960 and estimates and projections for cities with one million and more inhabitants for the years 1950-1985 followed (United Nations 1972a, 1972b).

Like its two predecessors, the 1973 *Revision* was also published in four volumes, consisting of three working papers (United Nations 1975a, 1975b, 1979) and a substantive report (United Nations 1980a) that included methodological developments and analysis of social and economic aspects of urbanization. Estimates and projections for urban and rural areas were presented for countries, regions and major areas from 1950 through 2000. Also included were time series of urban locations with 100,000

3 For a more detailed account of the early years of the *World Urbanization Prospects*, see United Nations (1987b).

4 Like the *World Urbanization Prospects*, the *World Population Prospects* had different titles in their earlier *Revision*. The 1963 *Revision*'s title is "*World Population Prospects* as Assessed in 1963"

inhabitants and more from 1950 to 2000.

The 1978 *Revision* (United Nations 1980) – an interim *Revision* - was published as a single working paper and was the last one with a projection horizon for urban and rural populations ending in the year 2000.

The 1980 *Revision* (United Nations 1982a, 1982b) extended the projections of urban and rural populations to the year 2025. It also included estimates and projections for the thirty-five largest urban agglomerations up to the year 2000. The 1982 *Revision* provided estimates and projection for only the 25 largest urban agglomeration between 1950 and 2000, but added tabulations of city size classes for the period 1950 to 2025 (United Nations 1985). The 1984 and the 1988 *Revisions* published time series of estimated and projected populations in agglomerations with 2 million or more inhabitants in 1985 for the period 1950-2000 (United Nations 1987, 1989). The subsequent 1990 and 1992 *Revision* further lowered the threshold of published cities to 1 million and more (in 1990), and provided projections to the year 2000 and 2010, respectively (United Nations 1991, 1993). The 1994 *Revision* lowered the threshold of published cities to 750,000 inhabitants in 1990 (United Nations 1995).

The 1996 *Revision* extended the projection horizon to 2030 for urban and rural populations and to 2015 for populations of urban locations, a setting that remained unchanged through the 1999, 2001 and 2005 *Revision*. The 2007 *Revision* extended the projection horizon of urban and rural population to a 100 year period, from 1950 to 2050 and of its urban location series to the year 2025. These settings have remained unchanged until the 2011 Revision, the last as of this writing.

The results are tabulated for five year periods and for years that can be divided by 5, but the actual calculations are performed for single calendar years. Annual time series are also made available. Since the 2005 Revision, results are published only electronically on the website of the Population Division, mostly in their working paper series.

Data, Methodology, Tools

To produce the estimates and projections of world urbanization, three elements must be available: sufficient empirical evidence or data, an appropriate methodology to analyze the data, generate estimates and produce projections of plausible future trends, and suitable and efficient tools to perform the necessary work. These three elements are briefly described next.

Data

The preparation for each new *Revision* starts with the gathering of data. There are two prime data sources used for input into the estimation and projection of the indicators included in each *Revision*: The Demographic Yearbook published by the United Nations and, in addition, publication of National Statistical Offices. The latter have become increasingly available on the internet and are sometimes more up-to-date than the information collected by the United Nations Statistics Division, which publishes the annual Demographic Yearbook. A variety of other data sources, such as the web site CityPopulation[5], are also considered.

As data for populations in urban places as well as for population in urban locations exists in a great variety of statistical definitions, the description of the data that form the empirical basis of the population estimates and projections starts with a summary of definitions used for a recent *Revision* of *World Urbanization Prospects*.

Populations in urban and rural areas

Countries define urban and rural populations by applying criteria that are suitable for their own internal purposes. This practice poses a challenge to the comparative analysis of the global urbanization process. In practical terms, the

5 Thomas Brinkhoff: City Population, http://www.citypopulation.de

various national definitions of urban places have been summarized in the *World Urbanization Prospects* into four broad and distinct groups: Administrative criteria, economic criteria, population-related criteria and urban criteria related to the functional nature of urban locations. Administrative criteria, for example as found in the 2011 *Revision*, consist of "Localities proclaimed as urban" (as in the case of Swaziland); population-related criteria may either specify population size or population density, such as "localities with 10,000 inhabitants or more" (e.g., as is used by Benin or Italy), or "a population density of at least 400 persons per square kilometre at the previous census" (as is the partial criteria used by Canada); economic criteria are typically specified as significant presence of non-agricultural activities; and criteria based on urban functions may be defined as the existence of paved streets, water-supply and sewer systems or electric lighting and so forth.

Most countries use a simple approach to define urban areas. In the 2011 *Revision* (Table 1), 121 countries used only one criterion for determining urban areas. Sixty-four countries applied administrative criteria, 48 countries defined their urban areas solely based on population-related criteria, and nine countries used exclusively criteria related to the functional nature of urban areas. No country was defining its urban areas using economic criteria alone.

Combining several criteria to define urban areas better reflects the complex nature of urbanization: 65 countries combined two of the four categories, eleven used three categories and just eight countries combined all four categories. Lastly, 26 countries did not fall into these chosen categories, either because all of their population is already urban (nine countries), or none of it is. For 14 countries, no definition was available.

For each *Revision* of *World Urbanization Prospects*, information about the proportion of urban population over time is collected for all countries and added to the database. These data are evaluated for their consistency with existing data, including the definition used. The empirical data points that have passed the evaluation are the basis for calculating past estimates by interpolating between given data points. For many countries, in order to have time series starting at 1950, a back projection must be performed that uses the earliest available data points. In a final step, the time series of the proportion urban is projected forward using the modified United Nations method.

As a minimum, the United Nation method requires just two empirical data points, usually from two subsequent censuses, for either projecting the proportion urban and the city population back to 1950 or forward from the latest observed data point. Only with such a minimalistic requirement was it possible in the early years of the exercise to produce estimates and projections of urban and rural populations for all countries of world. With each Revision, and each new census, more data have been added, so that the database has accumulated significantly more empirical data for each country.

Having obtained complete time series of the proportion urban, the urban population for each country is then calculated by multiplying the proportion urban with the total population taken from the most recent *Revision* of *World Population Prospects*. The rural population is simply calculated as the difference between the total population and the urban population.

Populations in urban locations

In addition to estimates and projections of the urban and rural population, most past *Revisions* of the *World Urbanization Prospects* collected data of and created estimates and projections for cities of various sizes and definition. (This is elsewhere referred to as the UN City Database (National Research Council 2003).) As earlier described, the Population Division has limited the publication of its estimates and projection to urban locations above a certain threshold. This was mainly due to a lack of resources to perform a thorough analysis and quality assessments of

Table 1. Distribution of countries according to the criteria sued in defining urban areas, 2011 *Revision*

	Criteria	**Sole use**
1 criteria	Administrative	64
	Economic	-
	Population size/density	48
	Urban characteristics	9
2 criteria	Administrative and population size/density	24
	Administrative and economic	-
	Administrative and urban characteristics	11
	Economic and population size/density	15
	Economic and urban characteristics	-
	Population and urban characteristics	15
3 criteria	Administrative, economic and population size/density	10
	Administrative, economic and urban characteristics	-
	Administrative, urban characteristics and population size/density	1
	Economic, urban characteristics and population size/density	-
4 criteria	Administrative, economic, population size/density and urban characteristics	8
Other	Entire population urban	9
	No urban population	3
	No definition	14
	Total number of countries or areas	231

Source: United Nations (2012a, p. 32).

the numerous urban location of smaller population size. Indeed, earlier *Revisions* of *World Urbanization Prospects* included individual cities only if they were among the largest urban location in the world or were capitals of countries. Beginning with the 1984 *Revision*, a uniform size criterion was applied to select an urban location for inclusion into the published reports, datasets and online databases. Beginning with a threshold of 2 million inhabitants in the 1984 *Revision*, it was subsequently lowered several times to the 750,000 inhabitants that have been used since the 1994 *Revision*. The most recent 2011 *Revision* includes complete time series of population for 633 urban locations that had 750,000 inhabitants or more in 2010.

Except for its earliest reports, the *World Urbanization Prospects* have focused on urban agglomerations and metropolitan areas. Lately, the focus has shifted, for some countries, to cities defined as city proper (Table 2). This was especially the case when the nationally defined urban agglomeration became so large and including so many distinct urban centers as to lose a geographic and spatial distinction. It must be noted that the usage patterns reported in Table 2 of urban location definitions used by the

World Urbanization Prospects are not necessarily reflecting national practice, as many countries provide statistics for more than one definition at the same time. Therefore, the frequency of definitions shown in table 2 is reflecting to a substantial extent the choices of the Population Division and the availability of complete and consistent time series for an urban location.

In the 2011 *Revision* (Table 2), the most frequent definition used was city proper. 98 countries reported population according to this definition exclusively, while for 86 countries urban locations were shown as urban agglomerations. Estimates and projection for 14 countries were for metropolitan areas. For the remaining 29 countries, data in the 2011 *Revision* of *World Urbanization Prospects* are a combination of two or all three definitions, often because the capital city, which is included in the tabulation without size restrictions, is given with a different definition. For three countries, definition could not be obtained, and one country (Tokelau[6]) did not have a definition.

As in the estimation of urban and rural populations, the estimation and projection of the populations in cities, urban agglomerations or metropolitan areas starts with the collection of empirical data. The database currently holds information about 5,000 cities, urban agglomerations metropolitan areas in its database. The 2011 *Revision* published only cities with a population of 750,000 or more in 2011, a total of 633 cities.

The United Nations Urbanization Revisions do not provide a full account of all urban settlements in the world. Historically, the *World Urbanization Prospects* began collecting data on the largest urban locations and then progressed gradually to urban locations of smaller population size. Cities with fewer than 100,000 inhabitants are incomplete in the database, and even cities between 100,000 and half a million may not be completely covered for all countries. Cities larger than with 500,000 inhabitants, however, are considered as completely covered[7]. In order to give an approximate account of urban dweller by city size class, the "missing" category of cities with less than 500,000 inhabitants has been calculated as a residual between the total urban population of the world and the sum of the population of all cities with 500,000 and more inhabitants (Table 3, figure 1). But even with this crude estimate, some interesting observations can be made.

More than half of all urban dwellers live in cities with less than 500,000 inhabitants, which unfortunately are not yet sufficiently covered by the database. The largest number of cities in the database is in the size class of 500,000 to fewer than 1 million people. The inhabitants in these cities amounted to about 10 per cent of the global urban population. The number of cities in the next category, having between 1 million and five million inhabitants, is significantly lower – just 388 urban settlements, accounting for 21 percent of the total urban population. There were only 23 cities in 2010 in the largest category - Megacities with 10 million and more inhabitants. It is evident that a large majority of urban dwellers live in cities of modest or small size. And, as the figures in Table 3 seem to suggest, more than half of all urban dwellers worldwide live in cities with less than 500,000 people.

METHODOLOGY

6 Tokelau is, according to United Nations definition, a Non-Self Governing Territory, administered by New Zealand.

7 There is no complete list available with all urban locations in all countries. Current United Nations census recommendations recommend that countries tabulate only principal localities and urban agglomerations, that is urban locations above a specified size, as defined by each country (United Nations 2008c, p.263). Also recommended is a listing of population by size-class of locality, which includes all settlements, but does not provide data on individual settlements (ibid. p. 262). The Demographic Yearbook of the United Nations provides only population data on cities or urban agglomerations with 100,000 or more inhabitants, while the Population Division's collection of city populations has traditionally limited its published urban settlements to 750,000 at the time of the revision. A complete coverage of all cities in the Population Division's database is therefore currently not possible.

Table 2. Distribution of countries according to the criteria used in defining city population (capitals and cities with 750,000 and more inhabitants)

	Criteria	Sole use
One criterion	City proper[1]	98
	Urban agglomeration[2]	86
	Metropolitan area[3]	14
Multiple criteria	Capital is urban agglomeration; other cities are city proper, urban agglomerations or metropolitan areas	14
	Capital is city proper; other cities are city proper, urban agglomerations or metropolitan areas	6
	Capital is metropolitan area; other cities are city proper, urban agglomerations or metropolitan areas	9
	Not defined	3
	Total number of countries or areas	230

Source: United Nations (2012a, p. 34).

1 City proper is a locality defined according to legal/political boundaries and an administratively recognized urban status that is usually characterized by some form of local government.

2 Refers to the de facto population contained within the contours of a contiguous territory inhabited at urban density levels without regard to administrative boundaries. It usually incorporates the population in a city or town plus that in the sub-urban areas lying outside of but being adjacent to the city boundaries.

3 Metropolitan areas include both the contiguous territory inhabited at urban levels of residential density and additional surrounding areas of lower settlement density that are also under the direct influence of the city (e.g., through frequent transport, road linkages, commuting facilities etc.).

Table 3. Distribution of urban locations and their populations by size class, estimates 2010.

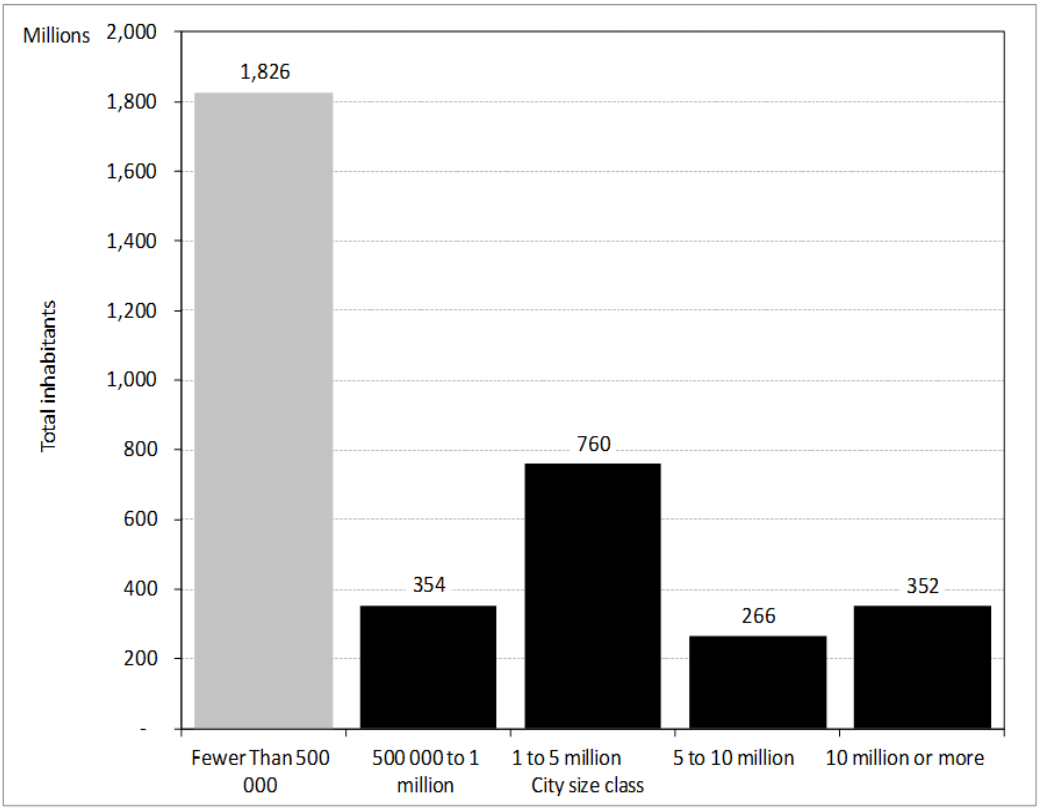
Size class	Population		Number of urban locations
	millions	percent	
<500,000[4]	1,826	51%	…
500,000-1 Mio.	354	10%	513
1-5 Mio	760	21%	388
5-10 Mio	266	7%	38
10 Mio+	354	10%	23
Total	**3,559**	**100%**	…

Source: United Nations (2012b) [5]

4 File 17d: Population in Cities Classified by Size Class of Urban Settlement, Major Area, Region and Country, 1950-2025; File 17b: Number of Cities Classified by Size Class of Urban Settlement, Major Area, Region and Country, 1950-2025

5 Population in this size class estimated as a residual between the total urban population in 2010 and the sum total off all urban settlements in the Population Divisions database with 500,000 and more inhabitants.

Figure 1. Distribution of the city population by size class, estimates 2010



Source: see table 3.

The methodology used in the United Nations *World Urbanization Prospects* reflects its global focus, its special attention to developing countries, and the actual availability of the relevant data. Its rationale, as well as its theoretical and empirical foundations, has been documented in several United Nations manuals and reports (United Nations 1971, 1974, 1980, 2012). Its merits and shortcomings have been discussed, inter alia, by Ledent (1980, 1982, and 1986), Rogers (1982b), National Research Council (2003), Bocquier (2005), O'Neill et al. (2001), O'Neil and Scherbov (2006), and Cohen (2006a, b). The following section will only provide a brief summary of the evolution of the methodology used by United Nations Population Division and its main characteristics, as applied to the urban projections. The methodology used for cities is, at its core, the same; specific adjustments for the case of city projections are noted when applicable.

The *World Urbanization Prospects* use a simple methodology that has changed four times over the past 40 decades. Initially, urban populations were projected using fixed growth rates[8], specified for major areas and regions (United Nations 1969).

This approach was subsequently replaced by what has become known as the United Nations method (United Nations, 1974, 1980b). This method models the proportion urban, i.e. the proportion of the population living in urban areas to the total population. The dynamics of the proportion urban, which can only take values between zero and 100 per cent, are readily formalized by transforming it into the difference between the growth rate of the urban and the rural population, which itself takes the form of a logistic function (United Nations 1974). Indeed,

8 The final projections of agglomerated populations (e.g. of populations living in urban locations with 20,000 inhabitants or more) was carried out by calculating a weighted average of four different scenarios, each with a plausible of constant future growth rate, UN 1969, p. 56.

the transition from a predominantly rural to an increasingly urban population can be seen as diffusion process (Pumain 2004, p. 232; see also Fujita et al. 1999), for which a logistic function is a convenient choice.

The United Nations method itself has been revised twice: In its initial formulation, constant urban-rural growth differentials were used for projections of urban and rural populations (United Nations 1970a). The initial assumption of constant growth differentials was modified in the 1973 *Revision* such that the urban-rural growth difference was linearly altered from its last observed value to approach a common value of 0.0275 at the end of the projection horizon for all countries, thus reflecting on empirical observations that the pace of urbanization slows down as the proportion of the of the urban population grows (United Nations 1975a). With the 1980 *Revision*, the United Nations method was amended again[9]. Instead of assuming fixed and uniform growth differentials for all countries at one point in the future, the urban-rural growth differential is allowed to change over time and approach a hypothetical norm that depends on the level of urbanization at the beginning of the projections (United Nations 1980, pp.10-11). With few modifications regarding the parameters of the global norm, this method has been in use ever since.

The projection of urban locations uses the same approach as the one used for urban and rural populations, with the urban-rural growth difference replaced by the city-urban growth difference[10]. As with the projection of urban and rural populations, the initial growth differential is gradually changed to approach a hypothetical value, or global norm.

An important feature of the implementation of the United Nations method is that it enforces consistency with its other set of periodic demographic estimates and projections – the *World Population Prospects* – by applying the proportion urban obtained by applying the United Nations method to the total population of the most recent set of global population estimates and projections. The most recent *2011 Revision* of *World Urbanization Prospects* (United Nations 2008), for instance, is consistent with the *2010 Revision* of *World Population Prospects* (United Nations 2011). Consistency between estimates and projections of urban population and the population in urban locations is obtained by calculating populations in urban locations in a two-stage process: First, each city is independently projected by the United Nations method (including the growth constraints implied by the global norm, described above). Second, the population in urban locations is adjusted proportionally if it exceeds the total population in urban areas. The adjustment maintains the rank and growth differential between urban locations[11].

Tools

Since the *2001 Revision* of *World Urbanization Prospects*, the Population Division is preparing the *World Urbanization Prospects* using a modern client-server computing environment. Both the empirical data and the estimated and projected data are stored in a powerful SQLServer database named "ProUrban" that uses a rich and flexible relational data model (briefly described below). The estimation and projection software is configured as a client of a central database server, allowing several analysts to work simultaneously. The client software provides easy access to the empirical and generated data, metadata, analytical functions and the graphical display of various trends.

The database was designed such that each empirical and estimated data point could be extensively documented. This enables analysts to make informed and appropriate decisions when analyzing past trends and modeling future trends.

9 For a discussion of urban growth in developing countries, see Preston (1979). Samuel Preston was also a main contributor to the development of the United Nations method.

10 The difference between the growth rate of a particular city and the growth rate of the total urban population.

11 Adjusting projected excess growth of city population relative to the total urban population is a rare phenomenon and occurs only in countries with few but large cities.

Table 4. Data attributes for empirical data in the ProUrban database

Attribute	**Definition or Field Categories**
Location	Unique identification of each location (country, sub national unit or urban location)
Time reference	The exact date the data point refers to. For events, beginning of the observation/reporting period
Time period	Duration of the event. Zero for stock indicators like population
Indicator	Unique identification of the statistical indicator (Total population, proportion urban, population in urban location, growth rate of the urban population, etc.)
Data generating process	Unknown, census, register, sample survey, estimate
Statistical concept	Unknown, city proper, urban agglomeration, metropolitan area, others [for urban locations]; de-jure, de-facto [for populations]
Data status	Unknown, final, final/adjusted, provisional, Provisional/adjusted
Data reliability	Unknown, Complete/ high quality, Incomplete/ questionable quality
Data source	Link to a table with the Title, the Year, the Institution and Comments of a particular source associated with a data point

In addition, the database maintains past *Revisions* of *World Urbanization Prospects* thus allowing for easy comparison between individual *Revisions*.

The core data model for empirical data contains nine attributes that identify location, time, statistical indicator, quality and status attributes as well as the data source for each individual data point (Table 4). The attributes are coded numerically; together they form the unique key[12] to a particular value. In addition, the analyst can add ad-hoc comments for each data point in a free text format and link it to this table.

The database takes into account the hierarchical nature of the urban system. In order to identify urban locations unambiguously, each urban location is linked first to the sub national administrative unit it belongs to. Then, to close the identification, each subnational administrative unit – for example federal states, provinces or departments – is itself associated with the country it is part of. Given the implicit spatial resolution and relatively large population size of locations in the database, it is believed that this process results in unambiguous identification – Paris, (Paris), France is unambiguously distinguishable from Paris, Texas, USA, for instance.

12 The primary key for this table is a composite key consisting of all 9 fields. The database ensures referential integrity by enforcing that only one entry/row in the database can have a particular combination of these nine fields. Duplicate entries are therefore impossible.

DISCUSSION

The estimates and projections of the United Nations *World Urbanization Prospects* have been used widely and found generally to be very useful (National Research Council 2004; World Bank 2008). Nevertheless, these estimates and projections also have limitations and shortcomings, caused by the scarcity and incompatibility of nationally reported empirical data, the required coverage of all countries for a relatively long period of time and, related to that, the limited capacities and resources to cover more dimensions of urbanization beyond population size and to expand coverage, especially for smaller urban settlements.

Besides the incompatibility of nationally-defined

urbanization indicators (discussed below), some other limitations of the United Nations World Urbanization Prospects have been discussed. Among them are the reduction of the process of urbanization into a dichotomy of urban-rural (Champion and Hugo 2003; Hugo et al. 2003); the lack of a measure of projection uncertainty (O'Neill and Scherbov 2006) and the absence of an explicit spatial dimension (Balk et al. 2006; Montgomery and Balk 2008).

From its inception, the *World Urbanization Prospects* have been confronted with the lack of international standard definitions of urban and rural areas and locations, and thus of urban and rural populations. This may still be a surprise for the casual user, but it has been a constant source of frustration for scholars and serious users. These deficiencies have been extensively discussed and documented in various United Nations reports and elsewhere (United Nations 1969, 1974, 1980b; see also Zlotnik 2002).

Already the working paper that was at the beginning of the United Nations World Urbanization Projections, published in 1967, stated "…from the smallest to the largest units, the distinction or delimitation of urban areas poses problems, and these have been diversely dealt with in different countries. *The diversity in treatment, at the national level, has important reasons depending on concrete historic, administrative, economic and transportation condition in each instance.* Admittedly, international comparison is thereby rendered difficult." (United Nations 1967, p. 5, emphasis added). Chapter 1 in the United Nations' *Manual VIII* on "Methods for Projections of Urban and Rural Population" contains an extensive examination of these aspects of the problem: definitions of urban and rural population that vary from country to country; definition that vary within a country over time; and, several such definitions within one country supplied concomitantly. It states: "Urbanization being both a quantitative and qualitative process, different criteria of 'urbanism' gain or lose relevance as time progresses (United Nations 1974, p. 9). The 1980 report on "Patterns of urban and rural population growth" also acknowledged the great variety of criteria used to define urban areas or locations: "Numerous descriptive criteria can be used to set cities apart from settlements of the rural type. No catalogue of possible description, however, will result in a unique definition of all cities, valid throughout time and space." (United Nations 1980, p. 1).

Despite numerous calls by geographers, demographers and statisticians for international comparable definitions of urban areas and urban populations, the many different national definitions have not shown any tendency to converge to common one. What are the reasons?

In many other branches of demography, the underlying statistical concepts are relatively straightforward. Births and deaths are relatively easy identified and counted (although their definition is not exempt from refinement or change). The population of a country or area, be it of the actual (de-facto) or administrative (de-jure*)* type, foreign born or native, also seems to be relatively easy to identify and count. In contrast, defining urban and rural populations is challenging because of the many criteria playing a role in identifying urban places or urban populations. In addition, these criteria depend on concrete but changing historic, administrative, economic and transportation conditions. It is not only the complexity inherent in quantitatively measuring urbanization that has hindered national practice to converge on an international standard. When discussing the obstacles for a comparable metric to measure urbanization, one should also consider that international comparability in measuring urbanization in a particular country is likely not a major concern for national authorities. Instead, national practices in applying certain concepts to measure urbanization are more likely driven by a need to be consistent over time within the country, as planning and resource allocation are a predominantly national concern. The data on urban locations face similar challenges. Like urban and rural areas, administrative definitions are dominant, but capture only partially the spatial-temporal complexities and dynamics of

settlements. Other, more comprehensive approaches like the concept of urban extent using remote night time images obtained from satellites (for example the GRUMP project, see Balk, 2010) are not easily translated into the administrative and statistical realities on the ground.

For all these reasons, the *World Urbanization Prospects* came to accept that different countries use, for their own purposes, different definitions, thereby rendering accurate international comparison difficult (United Nations 1987).

There have been several attempts to find alternatives that avoid some or most of the problems inherent in accepting diverse statistical practices: the 1963 *Revision*, for instance, proposed a complementary und transparent definition of urban areas by assuming, as urban population, all populations in settlements with 20,000 inhabitants and more (United Nations 1967). Subsequent *Revisions*, however, did not continue this approach.

A more sophisticated and complex approach was recently put forward by the World Bank (2009a, p. 55), which calculated an "agglomeration index" based on population size density and travel time for estimating the level of urbanization[13]. The World Bank's approach integrates multiple spatial data, including georeferenced population data, to generate a new, multi-dimensional measure of urbanization. The agglomeration index is, by and large, in line with the estimates produced by the United Nations *World Urbanization Prospects*. For example, the proportion of urban population in the year 2000 was estimated at 46.7 percent by the 2011 *Revision* (United Nations, 2012), while the World Bank's agglomeration index was 52 percent for the same year. But what this approach offers in terms of better comparability between countries it lacks in terms of documenting past trends, as it would be very difficult to establish such index for the past. Similarly, the World Bank's approach appears to pose great difficulties for projecting future trends, as density and travel time - the added spatial dimension - need also to be included into the projection model. The agglomeration index is, as the authors of the World Bank report state themselves, a useful addition to data series such as the ones produced by the *World Urbanization Prospects*, not an alternative (ibid.).

Should the pursuit of a common, comparable definition of urban populations and urban areas be continued? Perhaps, but as the past has shown, it is unlikely that international compatible concepts and definitions will emerge soon, if at all. The answer to the challenge of comparability may be found by including other information that supplements and enhances the estimates and projections of *World Urbanization Prospects*. What could that be?

One feasible approach would be to add additional metrics relevant for the process of urbanization to the current data series. It seems feasible, for instance, to add tabulations of urban locations by population size class and compare it to the level of urbanization in any given country as an alternative measure of the level of urbanization at any given time. A size-class metric would have the advantage that most National Statistical Offices publish tabulations of city populations by size class.

Another avenue of approaching more accurate and comparable measurements of urbanization could compare population in urban locations as nationally defined with estimates of urban extent that take into account information from remote sensing of night lights and the corresponding populations that transcend administrative boundaries (Montgomery and Balk 2008; Gamba and Herold 2009; Balk 2010). Information on populations living in urban extents (instead of administratively defined urban locations) offers a number of advantages. It places the urban population firmly into the natural geography and therefore is extremely useful for gauging the interactions between people and the environment, and it also avoids most of the

13 The thresholds are: population size (settlement with 50,000 or more inhabitants), population density (150 people per square kilometer) and travel time (60 minutes or less to the nearest large city).

problems associated with incompatibility of nationally defined urban statistics as used by the UN. However, the addition of an explicit spatial dimension also poses a formidable challenge to the projection of urban populations: In addition to finding a suitable model for future population trends, the GRUMP approach would require finding ways to project the urban extent. Hence, the GRUMP database (Balk 2010) is not a replacement of the population estimates produced by the United Nations. Like the agglomeration index suggested by the World Bank, the two datasets are complementing each other by adding either space (GRUMP) or time (UN).

Finally, it seems about time to treat the time series in the United Nation urban database in a probabilistic way, thus adding a measure of uncertainty to the estimates and projections. To move from a strictly deterministic process model to a probabilistic model seems also feasible, as the underlying variables are few (time series of proportion urban and urban location population size), and a promising approach has already been implemented by the Population Division for the much more complex World Population Prospects (Alkema et al. 2011a, b, Raftery et al. 2012, 2013),

The outlook just presented would be incomplete without a cautionary note. The suggested additions to the *World Urbanization Prospects* will add complexity and demand resources. It will take time to identify the most promising avenue and to implement it. Collaboration with researchers and scholars working in the field of urbanization may help overcome limits in resources and would be of mutual benefit to the United Nations and to those who use urban projections in their work.

Declaration of Conflicting Interests

This article was mostly written while the author was with the United Nations before his retirement in 2011. Still, the view and opinions expressed in this paper are those of the author and do not necessarily reflect those of the United Nations.

References

Alkema L, Sultana R, Gerland P, Buettner T (manuscript in preparation; poster presentation at the Annual meeting of the Population Association of America, 2011a); "Probabilistic projections of urbanization for all countries". http://paa2011.princeton.edu/papers/110768

Alkema L, Raftery AE, Gerland P, Clark SJ, Pelletier F, Buettner T, Heilig GK. (2011b). "Probabilistic Projections of the Total Fertility Rate for All Countries." Demography, 48:815-839. doi:10.1007/s13524-011-0040-5

Balk, D. (2010). More than a name: Why is global urban population mapping a GRUMPy proposition? In P. Gamba and M. Herold (Eds.), *Global mapping of human settlement: experiences, datasets, and prospects*. (pp. 145-162). CRC Press, Boca Raton.

Balk, D. L., U. Deichmann, G. Yetman, F. Pozzi, S. I. Hay, and A. Nelson. (2006). Determining Global Population Distribution: Methods, Applications and Data. In I. H. Simon (Ed.), *Advances in Parasitology: Global Mapping of Infectious Diseases: Methods, Examples and Emerging Applications*. (pp. 120-151). Elsevier, Oxford, UK.

Bocquier, P. (2005). World Urbanization Prospects: an alternative to the UN model of projection compatible with the mobility transition theory. *Demographic Research*, Vol. 12 (9), pp. 197-236.

Champion, A. G., T. Champion, and G. Hugo, (Eds.). (2004). *New forms of urbanization: beyond the urban-rural dichotomy*. Ashgate Publishing, Aldershot, Hants, England; Burlington, VT.

Cohen, B. (2006a). Urban Growth in Developing Countries: A Review of Current Trends and a Caution Regarding Existing Forecasts. *World Development*, Vol. 32 (1), pp. 23-51.

Cohen, B. (2006b). Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in Society*, Vol. 28 (1-2), pp. 63-80.

Fujita, M., P. Krugman, and T. Mori. (1999). On the evolution of hierarchical urban systems. *European Economic Review*, Vol. 43, pp. 209-251.

Gamba, P., and M. Herold (2009). *Global mapping of*

human settlement: experiences, datasets, and prospects. CRC Press, Boca Raton, FL.

Hugo, G., A. G. Champion, and A. Lattes. (2003). Toward a new conceptualization of settlements for demography. *Population and Development Review*, Vol. 29 (2), pp. 277-297.

Ledent, J. (1980). *Comparative Dynamics of three demographic models of urbanization*. Laxenburg, Austria: IIASA. RR-80-1.

Ledent, J. (1982). Rural-Urban Migration, Urbanization, and Economic Development. *Economic Development and Cultural Change*, Vol. 30 (3), pp. 507-538.

Ledent, J. (1986). A Model of Urbanization with Nonlinear Migration Flows. *International Regional Science Review*, Vol. 10 (3), pp. 221-242.

Montgomery, M. R., and D. L. Balk (2008). The Urban Transition in Developing Countries: Demography Meets Geography. In E. Birch and S. Wachter (Eds.), *Global Urbanization in the 21st Century*. University of Pennsylvania Press, Philadelphia, PA.

National Research Council (2003). *Cities Transformed: Demographic Change and Its Implications in the Developing World*. By Montgomery, M. R., Stren, R., Cohen, B., and Reed, H. E. The National Academies Press, Washington, D.C.

O'Neill, B., D. L. Balk,M. Ezra, and M. Brickman (2001). A Guide to Global Population Projections. *Demographic Research*, Vol. 4, pp. 203-288.

O'Neill, B., and S. Scherbov (2006). *Interpreting UN Urbanization Projections Using a Multi-state Model*. Laxenburg, Austria: IIASA. IR-06-012.

Pumain, D. (2004). An evolutionary approach to settlement systems. In A. G. Champion and G. Hugo (Eds.), *New forms of urbanization - beyond the urban-rural dichotomy*. (pp. 231-248). Aldershot, Hants, England; Burlington, VT: Ashgate Publishing.

Preston, S. H. (1979). "Urban Growth in Developing Countries: A Demographic Reappraisal. Population and Development Review 5 (2): 195–215.

Raftery, A. E., Chunn, J. E., Gerland, P., & Ševčíková, H. (2013). "Bayesian Probabilistic Projections of Life Expectancy for All Countries". Demography, 50(3), 777-801. doi:10.1007/s13524-012-0193-x

Raftery, A.E., N. Li, H. Ševčíková, P. Gerland, and G.K. Heilig. (2012). "Bayesian probabilistic population projections for all countries." Proceedings of the National Academy of Sciences 109 (35):13915-13921. doi:10.1073/pnas.1211452109

Rogers, A. (1982). Sources of Urban Population Growth and Urbanization, 1950-2000: A Demographic Accounting. *Economic Development and Cultural Change*, Vol. 30 (3), pp. 483-506.

Salvatore, M., M. Pozzi,E. Ataman, B. Huddleston, and M. Bloise (2005). *Mapping global urban and rural population distributions*. Rome: FAO.

United Nations (1967). *Urban and Rural Population Growth 1920-1960 with Projections.* Department of International Economic and Social Affairs, Population Division (ESA/P/WP/15).

United Nations (1968). *World urbanization trends, 1920-1960.* Department of International Economic and Social Affairs, Population Division (United Nations publication, Sales No. E.68.IV.1).

United Nations (1969). *Growth of the World's Urban and Rural Population, 1920-2000.* Department of Economic and Social Affairs, Population Division (ST/SOA/Series A/44) (United Nations publication, Sales No. E.69.XIII.3).

United Nations (1970a). *Population estimates by regions and countries, 1950-1960: Total population, age/sex structure and urban/rural distribution.* Department of International Economic and Social Affairs, Population Division (ESA/P/WP/31).

United Nations (1970b). *Urban and Rural Populations: Individual Countries 1950-1985 and Regions and Major Areas 1950-2000.* Department of Economic and Social Affairs, Population Division (ESA/P/WP.33 Rev. 1).

United Nations (1971a). *Some simple methods for urban and rural population forecasts.* Department of Economic and Social Affairs, Population Division (ESA/P/WP41).

United Nations (1971b). *The world population situation in 1970.* Department of Economic and Social Affairs, Population Division (ST/SOA/Series A/49) (United Nations publication, Sales No. E.71.XIII.4).

United Nations (1972a). *Sex/age composition of the urban and rural population of the world, major areas, regions and individual countries, in 1960*. Department of Economic and Social Affairs, Population Division (ESA/P/WP/44).

United Nations (1972b). *The world's million-cities, 1950-1985*. Department of Economic and Social Affairs, Population Division (ESA/P/WP/45).

United Nations (1974). *Manual VIII: Methods for Projections of Urban and Rural Population*. Department of Economic and Social Affairs, Population Division (ST/ESA/Ser.A/55) (United Nations publication, Sales No. E.74.XIII.3).

United Nations (1975a). *Trends and Prospects in the Populations of Urban agglomerations, 1950-2000, as Assessed in 1973-1975*. Department of International Economic and Social Affairs, Population Division (ESA/P/WP.58).

United Nations (1975b). *Trends and Prospects in Urban and Rural Population, 1950-2000, as Assessed in 1973-1974*. Department of International Economic and Social Affairs, Population Division (ESA/P/WP.54).

United Nations (1979). *Age/sex distribution in rural and urban areas*. Department of International Economic and Social Affairs, Population Division (ESA/P/WP.64).

United Nations (1980a). *Urban, Rural and City Population, 1950-2000, as Assessed in 1978*. Department of International Economic and Social Affairs, Population Division (ESA/P/WP.66).

United Nations (1980b). *Patterns of Urban and Rural Population Growth*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.A/68) (United Nations publication, Sales No. E.79.XIII.9).

United Nations (1982a). *Estimates and Projections of Urban, Rural and City Populations, 1950-2025: The 1980 Assessment*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.R/45).

United Nations (1982b). *Age and Sex Structure of Urban and Rural populations, 1970-2000: The 1980 Assessment*. Department of International Economic and Social Affairs, Population Division (ESA/P/WP.81).

United Nations (1985). *Estimates and Projections of Urban, Rural, and City Populations, 1950-2025: The 1982 Assessment*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.R/58).

United Nations (1987a). *The Prospects of World Urbanization: Revised as of 1984-1985*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.A101) (United Nations publication, Sales No. E.87.XIII.3).

United Nations (1987b). Urbanization and internal migration. *Population Bulletin of the United Nations*, Vol. 18-20/1986, pp. 70-81.

United Nations (1989). *Prospects of World Urbanization, 1988*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.A/112) (United Nations publication, Sales No. E.89.XIII.8).

United Nations (1991). *World Urbanization Prospects 1990: Estimates and Projections of Urban and Rural Populations and of Urban Agglomerations*. Department of International Economic and Social Affairs, Population Division (ST/ESA/SER.A/121) (United Nations publication, Sales No. E.91.XII.11.).

United Nations (1993). *World Urbanization Prospects: The 1992 Revision. Estimates and Projections of Urban and Rural Populations and of Urban Agglomerations*. Department for Economic and Social Information and Policy Analysis, Population Division (ST/ESA/SER.A/136) (United Nations publication, Sales No. E.91.XIII.).

United Nations (1995). *World Urbanization Prospects: The 1994 Revision. Estimates and Projections of Urban and Rural Populations and of Urban Agglomerations*. Department for Economic and Social Information and Policy Analysis, Population Division (ST/ESA/SER.A/150) (United Nations publication, Sales No. E.95.XIII.12).

United Nations (1998a). *World Urbanization Prospects: The 1996 Revision. Estimates and Projections of Urban and Rural Populations and of Urban Agglomerations*. Department of Economic and Social Affairs, Population Division (ST/ESA/SER.A/170) (United Nations publication, Sales No. E.98.XIII.6).

United Nations (1998b). *Demographic Yearbook 1996*. New York: Department of Economic and Social Affairs. Statistics Division.

United Nations (2001a). *World Urbanization Prospects: the 1999 Revision*. Department of Economic and Social Affairs, Population Division (ST/ESA/SER.A/194) (United Nations publication, Sales No. E.01.XIII.11).

United Nations (2001b.) *The Components of Urban Growth in Developing Countries*. Department of Economic and Social Affairs, Population Division (ESA/P/WP.169).

United Nations (2002). *World Urbanization Prospects: the 2001 Revision*. Department of Economic and Social Affairs, Population Division (ST/ESA/SER.A/216) (United Nations publication, Sales No. E.02.XIII.16).

United Nations (2004). *World Urbanization Prospects: the 2003 Revision*. Department of Economic and Social Affairs, Population Division (ST/ESA/SER.A/237) (United Nations publication, Sales No. E.04.XIII.6).

United Nations (2006). *World Urbanization Prospects: the 2005 Revision: The 2005 Revision. Executive Summary, Fact Sheets, Data Tables*. Department of Economic and Social Affairs, Population Division (ESA/P/WP/200).

United Nations (2008). *World Urbanization Prospects: The 2007 Revision. Highlights*. Department of Economic and Social Affairs, Population Division (ESA/P/WP/205).

United Nations (2008c). *Principles and Recommendations for Population and Housing Censuses. Revision 2*. Department of Economic and Social Affairs, Statistics Division (ST/ESA/STAT/SER.M/67/Rev.2) (United Nations publication, Sales No. E.07.XVII.8).

United Nations (2010). *World Urbanization Prospects: The 2009 Revision. Highlights*. Department of Economic and Social Affairs, Population Division (ESA/P/WP/215). http://esa.un.org/unpd/wup/Documents/WUP2009_Highlights_Final.pdf

United Nations (2011). World Population Prospects: The 2010 Revision, Volume I: Comprehensive Tables. Department of Economic and Social Affairs, Population Division (ST/ESA/SER.A/313).. http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Volume-I_Comprehensive-Tables.pdf

United Nations (2012a). *World Urbanization Prospects: The 2011 Revision*. Department of Economic and Social Affairs, Population Division ST/ESA/SER.A/322. http://esa.un.org/unpd/wup/Documentation/final-report.htm

Source: United Nations (2012b). World Urbanization Prospects : The 2011 Revision. CD-ROM Edition - Data in digital form. Department of Economic and Social Affairs, Population Division (POP/DB/WUP/Rev.2011)

United Nations Population Fund (2007). *State of world population 2007: Unleashing the potential of urban growth*. New York: United Nations Population Fund.

World Bank (2009a). *World Development Report 2009. Shaping economic geography. Part One*. Washington, D.C.

World Bank (2009b). *World Development Report 2009. Shaping economic geography. Part Two*. Washington, D.C.

Zlotnik, H. (2002). *Assessing past trends and future urbanization prospects: the limitations of available data*. Paper prepared for the Meeting on Beyond the Urban-Rural Dichotomy: Towards a new Conceptualization of Human Settlement Systems, Bellagio, Italy, 4-9 March 2002.

Zlotnik, H. (2003). World Urbanization: Trends and Prospects. In Champion, A. G., and G. Hugo. (2003). *New forms of urbanization: beyond the urban-rural dichotomy*. Aldershot, Hants, England; Burlington, VT: Ashgate Publishing, pp. 43-64.