Linking the Global Municipal Database with the Atlas of Urban Expansion

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Abstract

This paper provides an overview of two databases: the Global Municipal Database (GMD) and the Atlas of Urban Expansion (AUE), and discusses they ways they are linked and can be analyzed together. The GMD contains standardized budget indicators for nearly 100 cities around the world. The AUE provides spatial data on the urban expansion and urban layouts of 200 cities around the world. All of the cities currently in the GMD are also in the AUE, providing a unique opportunity for researchers and policymakers to empirically examine the relationship between municipal finance and the urban spatial characteristics of cities. However, some key differences should be noted in the GMD and AUE's samples, the timing of their observations and the geographic extent of their city units. The linkages and differences between the databases are described here, with recommendations for future research.

Overview of the two databases

The Global Municipal Database (GMD)[1] is a collection of shared indicators for a sample of local city governments around the world, focusing on budget data, led by UN-Habitat and partners. The data was compiled by UN-Habitat with cooperation from city-based researchers and the technical staff of municipalities from developed and developing countries around the world, and with support from New York University and Lincoln Institute of Land Policy. As of June 2018, the GMD contains data on 94 cities, all of which are also included in the Atlas of Urban Expansion.

The GMD contains budget data for local governments. It does not include full budget details, but instead has a common set of indicators representing major budget categories, to facilitate comparison between cities and global regions. The database includes figures on total budget, capital expenditures, own-source revenues and debt service payments. The database also includes a sub-set of major expenditure categories to account for differing local government mandates and their budget associated. All data is available both in total and in per capita figures and has been converted into US$[2] to support comparability.

Where multiple municipal governments exist within an urban region, the GMD provides data on the largest municipality by population.[3]

The Atlas of Urban Expansion (AUE)[4] is a database of indicators for a representative sample of 200 cities worldwide, measured using satellite and aerial imagery. It contains data on the spatial extent of the built-up areas in and around cities and how they have changed over time, including measures of density,

[1] GMD database located at globalmunicipaldata.org
[2] Using IMF official exchange rates from the data year
[3] See Gauntner et al. (2018) for more detailed metadata
[4] The Atlas of Urban Expansion can be found at atlasofurbanexpansion.org

connectivity and sprawl. The AUE also contains indicators on road access and connectivity, and how they have changed over time.

For each city listed in the AUE, data pertains to the urbanized geographic area of a continuous built-up landscape. The area of each city, as defined by the AUE, may contain multiple municipalities within it. The difference in geographies used by the GMD and AUE is described further below.

City selection comparison

The Atlas of Urban Expansion bases city selection[5] on a representative sample of all global cities with populations of 100,000 or more in 2010. Cities were defined by their geographic extent (i.e. continuous built-up area) rather than municipal boundaries. Based on this definition, a universe of 4,231 global cities was identified, drawing upon population data from the UN Population Division, the website citypopulation.de,[6] and the Chinese Academy of Social Sciences.

From the total universe of cities, 200 were selected in a stratified sampling technique designed so that results would be generalizable to the entire universe of cities. The sample drew a random selection of cities from eight world regions in proportion to the urban population in each region. Those regions were as follows:

- East Asia and the Pacific
- Europe and Japan
- Land-Rich Developed Countries
- Latin America and the Caribbean
- South and Central Asia
- Southeast Asia
- Sub-Saharan Africa
- Western Asia and North Africa

The sample also drew at random an approximately equal number of cities from four size categories, where each size category contains approximately 25% of the global urban population:

- 100,000 - 427,000
- 427,001 - 1,570,000
- 1,570,001 - 5,715,000
- 5,715,001 and above

Lastly, cities were randomly selected from three country groups in proportion to the urban population in each group:

- Countries with 1 - 9 cities
- Countries with 10 - 19 cities
- Countries with 20 or more cities

[5] The sampling methodology is fully described in Chapter 2 of Angel et al., (2016).
[6] Brinkhoff, 2016

The Global Municipal Database contains data on 94 cities from around the world. The initial set of GMD cities was taken from cities selected in the Atlas of Urban Expansion.[7] Researchers associated with the Atlas of Urban Expansion who were familiar with each of the 200 cities were contacted to participate in gathering data for the Global Municipal Database. Of those, 28% did not respond or had outdated contact information, 12% declined to participate, 13% attempted but were unable to obtain adequate data, and 47% provided data, resulting in the 94 cities in the GMD.

The GMD sample differs slightly from the AUE sample in its representation of cities within regional, size and country categories. The GMD has a lower percentage of cities from East Asia and the Pacific, South and Central Asia and Western Asia and North Africa. The GMD has a higher percentage of cities from Land-Rich Developed Countries, Southeast Asia and Sub-Saharan Africa (see Table 1).

The GMD also has less representation from the smallest city population size group and more from the highest size group (see Table 2). The GMD has slightly higher representation of cities from countries with fewer cities, and lower representation of cities from countries with the most cities (see Table 3).

Differences between the AUE and GMD sample of cities are largely due to the ease of obtaining budget data in various types of cities. These differences should be considered when making generalizations about the global universe of cities using the GMD.

Table 1: Regional representation in the AUE vs. GMD

Region	Percent within AUE	Percent within GMD
East Asia and the Pacific	21%	14%
Europe and Japan	17%	17%
Land-Rich Developed Countries	9%	12%
Latin America and the Caribbean	13%	13%
South and Central Asia	16%	10%
Southeast Asia	8%	13%
Sub-Saharan Africa	9%	16%
Western Asia and North Africa	8%	6%
TOTAL	100%	100%

Table 2: Representation of cities by size category in the AUE vs. GMD

City Population Size[8]	Percent within AUE	Percent within GMD
100,000-427,000	26%	19%
427,001-570,000	26%	26%
570,001-5,715,000	27%	28%
over 5,715,000	21%	28%
TOTAL	100%	100%

[7] Angel, et al. (2016).

[8] These groups are based on urbanized area population estimated in the AUE during third measurement period (T3).

Table 3: Representation of countries grouped by number of cities in the country: AUE vs. GMD

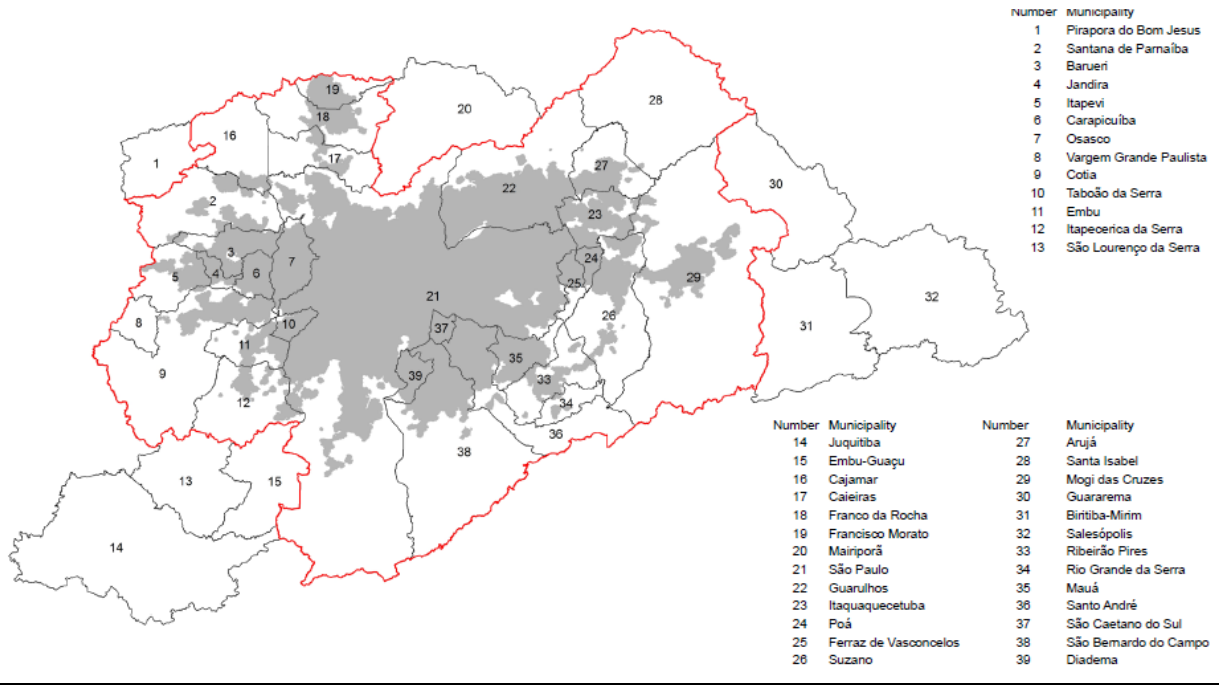
Country Groups	Percent within AUE	Percent within GMD
Cities from countries with 1-9 cities	12%	14%
Cities from countries with 10-19 cities	9%	9%
Cities from countries with 20 or more cities	80%	78%
TOTAL	100%	100%

Geographic and time correspondence

The Global Municipal Database takes as its boundaries the official government boundaries of the municipality. In cases where cities exist in urban regions comprised of many municipal governments, the GMD provides data for the municipality with the highest population.

The Atlas of Urban Expansion defines the city as the contiguous urbanized area encompassing the entire urban region, even in cases where it overlaps with multiple municipal jurisdictions (see Figure 1); this makes possible capture of the footprint of urban agglomerations rather than just the political boundaries.

Figure 1: The urban extent of São Paulo, Brazil (grey), showing the administrative boundaries of the 39 municipalities that constituted its metropolitan region. The urban extent of São Paulo measured by the AUE is contained in 31 municipalities (bounded in a red line). The GMD provides data on São Paulo municipality (#21 below).[9]



[9] Figure from Angel, et al. (2016), p. 10.

The two differing spatial definitions in the GMD and AUE each serve a purpose aligned with their data. The GMD contains budgetary data that is specifically associated with public infrastructure and services contained by a municipal boundary and provided to the population within that boundary. The AUE, on the other hand, contains spatial data about the ways cities expand, which cannot be fully illustrative without examining the full urbanized area, and especially its edges which may not fall within the largest, and often central, municipality.

Because the two databases define cities differently, their data should not be compared without accounting for geographic and population differences. Population data is provided within each database for each city as defined by that database.

The Atlas of Urban Expansion provides spatial data for three time periods: circa 1990, circa 2000 and circa 2014. The Global Municipal Database provides budget data for circa the year of the third AUE measurement. Within the GMD, 38% of cities report data after the year of the AUE's third measurement year, 55% report data for the same year, and 7% report data before the year of the AUE's third measurement. Of those cities reporting data in a different year than the AUE's third measurement, the majority are 1-2 years different, with 12% of the total sample being 3 or more years different.

Conceptual linkages: municipal finance and urban expansion

The spatial characteristics of cities have economic, environmental and social implications. There has been much written on the impacts of whether cities are compact or sprawling and connected or fragmented.[10] In developing countries, an additional concern is to what extent they are characterized by informality.

Municipal finances and a city's spatial form may be related in a number of ways. Both extension and densification of infrastructure typically require public expenditures. Without adequate spending, the city can still expand and densify, but may do so informally. As Angel et al. (2016) note, "it would be very difficult, if not futile, to resist urban expansion in the face of rapid population growth… ignoring it or denying it in the hope that it will not occur will simply allow expansion to take place unhindered and in a more costly and destructive way" (p. 5). This may be especially true in low and lower-middle income countries, where the private sector is not strong enough to make up for deficits in public sector infrastructure spending, and un-serviced informality is the default.

While municipal finances almost certainly impact spatial form, the reverse may be true too. Some have argued that more compact urban form with higher economic density can increase public revenues. For example, Carruthers and Ulfarsson (2003) note that high density urban areas have higher land values and therefore generate higher property taxes. They find a positive empirical relationship between property values and spending on most public services in a sample of U.S. cities, suggesting that density can help "pay for itself" (p. 508). One study suggests that in the U.S., compact development produces on average about 10 times more tax revenue per acre.[11]

Urban density gives rise to agglomeration economies, allowing for higher productivity, especially if congestion is well managed and skilled labour is present.[12] Transactions costs depend upon other

[10] See Slack (2002) for a summary of how sprawl has been defined and arguments for and against low density development.
[11] Smart Growth America (2013).
[12] Ferreyra & Roberts, 2018

components of urban form as well, and accessibility can be maintained even as densities decline under the right planning, mobility and coordination frameworks.[13] Therefore, density and the components of urban form related to accessibility may be linked to revenues via productivity.

There are also a number of studies showing that more compact and connected urban development can be cost-saving for municipal governments.[14] This is in many ways intuitive, as the length of trunk lines and cost of service delivery over a larger, less dense area presents higher costs per person. These costs have been incorporated by model developers attempting to forecast the differing costs of various development patterns in Canada[15] and the U.S., with one study finding that compact development costs, on average, 38% less in up-front infrastructure and 10% less in ongoing service delivery than lower density suburban development.[16]

Empirical studies using budget expenditure data have also shown the link between density and the cost of public services. A seminal report on this topic estimated that in the U.S., less dense, more sprawling growth would cost nearly US$ 30 more per capita or US$ 80 more per household than controlled growth.[17] Some studies have indicated that the relationship between density and municipal expenditures follows a U-shaped curve, with expenditures decreasing as density rises only to a certain point,[18] and the relationship not holding for the largest cities.[19] Caruthers and Ulfarsson (2003) point out the importance of controlling for property values in such studies, and find that the relationship between total public spending on capital facilities and services holds even at very high densities. It should be noted that few studies examine the link between urban spatial layout and municipal expenditures use data from countries in the developing world.

The AUE contains several indicators on the extent and quality of expansion and densification, including annual change in urban extent, annual change in density, area added as infill, extension and leapfrog, development, share of built up area that is gridded, density of arterial roads and share of residential areas laid out before development. The GMD and AUE can be used together to examine the nature of the relationship between municipal spending, including capital expenditures, and these spatial characteristics of cities.

Recommendations for future research

Research drawing upon the combined resource of the GMD and AUE can ask questions about the relationship between local budgets and urban form in a global and quantitative way not previously possible. This research can examine how municipal budgets impact urban form, including density, expansion, connectivity and informality, segmenting by region or income level. This research can also examine how urban form impacts municipal budgets in various countries. Such research can be applied to policy recommendations with the goal of using municipal budgets to foster sustainable urban form and using urban form to improve local budget performance.

[13] Vargas et al., 2017.
[14] Burchell et al., 2000, Caruthers & Ulfarsson, 2003
[15] Thompson, (2013).
[16] Smart Growth America, (2013).
[17] Burchell et al., 2000
[18] Ladd, (1992); Libertun de Duren & Compeán (2015)
[19] Holcombe & Williams, (2008).

In addition, future research can improve the two databases in a number of ways which will expand their analysis potential:

- Tracking municipal budgets over time and adding a second or third time observation to the GMD data would allow for research using time lags and improve the ability to assess the direction of causality between financial and spatial elements.
- Improving the geographic correspondence of the two databases could involve the addition of all regional jurisdictions to the GMD for cities comprising multiple local governments. Perhaps more simply, the AUE could provide spatial data disaggregated to the geography of the largest municipality.
- Collecting data on additional variables, such as municipal GDP and land values, would allow researchers to examine and control for these factors.
- Lastly, adding cities to the GMD so that the sample of cities matches the full 200 cities in the AUE would improve statistical power.

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