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SPATIAL ANALYSIS OF URBAN GROWTH AND AGGLOMERATION IN A FACTORIAL CONTEXT (1980-2020)

Ionel MUNTELE*
”Alexandru Ioan Cuza” University of Iași,
11 Bd. Carol I, Iași 700506, Romania;
Center of Geographical Research, Iași Branch of Romanian Academy,
8 Bd. Carol I, Iași 700506, Romania;
e-mail: ionel.muntele@uaic.ro

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Abstract: The complex relationship between demographic growth, urban expansion, and global change has become a central focus of contemporary interdisciplinary research. A simple Google Scholar search yields over one million entries, highlighting the field's significance. This study uses a multivariate analysis to examine factors driving the dynamics of global urban agglomerations from 1980 to 2020. Agglomerations are defined spatially, using a consistent methodology for all 2015 cases with a minimum population of 500,000. Our analysis reveals regional patterns of evolution strongly correlated with geographic location, demographic growth, economic development, and risk levels. The study underscores the increasing tension between urban expansion and natural or anthropogenic risks, demanding urgent solutions for sustainable development. While not explicitly focusing on the urban environment relationship, the study also highlights models for sustainable adaptation across diverse geographical contexts.

Key words: urban expansion; coupling urban agglomeration; growth drivers; cyclical evolution; world scale

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INTRODUCTION

The issue of the expansion of the urbanization process and the driving factors that determine it is hotly debated (Li, Sun, & Fang, 2018). The interdisciplinary perspective, in which geography has long made a significant contribution through the spatial variables it introduces into explanatory models, amplifies this interest (Moudon, 1997). Developments in recent decades have introduced new concepts adapted to the dual phenomenon of urban expansion: *demographic* and *spatial*. Terms such as "global city" or "global urban society" have become common, corresponding to new trends in the localization and development of urban settlements (Clark, 1996). Termed *late urbanization*, these trends certify the importance of intersecting historical and geographical views for understanding current urban processes (Fox & Goodfellow, 2021). The classic dispute between the

* Corresponding Author

universality and specificity of urbanization is becoming obsolete. Late urbanization manifests itself in the context of the combination of unique conditions specific to the end of the 20th century and the beginning of the current one, which it shapes: the *unprecedented intensity of population growth*; *hyperglobalization*; *centripetal politics of states* and *the specter of catastrophic environmental change* as a result of the evolution of human society in the Anthropocene. This phase corresponds to the vision proposed by Denise Pumain, who separates three major dynamic "regimes" in the process of urbanization: *emergent*, which manifested itself until the threshold of the modern era; *intensive*, generated by the industrial revolution and the demographic transition; *adaptive*, marked by increasingly scarce resources, against the backdrop of the halting of population growth in advanced countries and the need for an ecological transition capable of limiting the negative effects of climate change (Pumain, 2021).

This *evolutionary vision of* urban systems is imposed by its ability to reconcile classical explanatory models developed by Gibrat in 1931, Christaller in 1933 and Zipf in 1942 with the analytical possibilities provided by the information revolution. Provided that the sources used are harmonized, given the great variability in data collection methods and administrative-territorial organization at the national level. According to evolutionary models, the *inequalities between urban centres arise as an effect of their co-evolution*, the formation of new geographical structures, such as metropolitan agglomerations, urban systems or regions, etc (Pumain, 2021). This is because, more than ever before, all interactions between cities (from the transfer of goods and people to investment and information exchange) generate interdependence and, implicitly, unequal relationships that lead to a regular hierarchical distribution.

Urban settlement systems have thus become *adaptive systems* organized to accommodate the exchange of information, diffusion of innovations, reduction of uncertainties, and deriving benefits from complementary resources located far away (Shi, et al., 2021). Against this backdrop, a trend of simplifying hierarchies at the grassroots level has emerged in recent decades, leading to the decline of many urban centers, especially small and medium-sized ones (Pumain, et al., 2015). The dynamics of complex systems, such as the urban one, are unpredictable, but contextualizing them in terms of their demographic, income or access to resources components reduces forecasting errors (Raimbault, Denis, & Pumain, 2020). In this way, the expansion of urbanization in recent decades can be deciphered in a more complex key than through interdependence theory, which simplistically postulates that it is the result of the geographical expansion of capitalism, with the urbanization of Africa and Asia seen as a response to the global economic order (Clark, 1998). For a long time, urban population growth in developing countries has been slower by Western standards, resulting almost exclusively from natural population growth, with no association with industrialization or the expansion of the urban network (Spence, Annez, & Buckley, 2009). The massive migration from the villages (rural exodus) is of very recent date here and is manifested mainly as an effect of the insertion of modern infrastructure, generating disparities but also opportunities (Preston, 1979).

Numerous multivariate models have been developed on the factors (*driving forces*) that determine specific trends in the urbanization process. Recent studies indicate an inverse relationship between population growth and city size, the latter being considered a key variable for the study of urban dynamics. In recent decades, however, a heterogeneous growth has been observed, explained by the increasing importance of the ageing process or by the diversification of migration patterns in 1857 agglomerations of 155 countries for the period 1950-2030 (Egidi, Salvati, & Vinci, 2020). In classical studies, the availability of space for expansion, access to transportation networks, position about the hydrographic network and the presence of resources were privileged. In recent decades, however, factors such as the level of gross domestic product, foreign direct investment, and the share and occupational structure of the non-farm population have gained importance, especially in developing countries (Cheng, Jungxiang, & Jianguo, 2018). Also very important at the national level are government economic policies, institutional and administrative changes, etc. Contemporary urbanization is completely different from classical historical patterns of growth in terms of *scale, pace, place, form* and *functionality*.

Some studies point to the action of *two essential categories of forces*: those of *urban planning*, which shape the relationship between urbanization and the environment, desirable to be integrated with the principles of sustainable development through synergetic adaptation strategies; those of *agglomeration*, often out of control, which lead to the geographical concentration of economic activities at various scales (Seto, Sanchez-Rodriguez, & Fragkias, 2010). This vision is in the spirit of the new economic geography which distinguishes *the dispersive forces of* human activities (cost of land, availability of land, existence of natural resources) from the *concentrating forces* (production linkages, markets, diversification of activities, spatial competition, returns to scale, specialization, creativity and innovation, etc. In this way, natural advantages, with all their ambiguous role, internal market effects, consumption opportunities, all contribute to agglomeration through the formation of regional networks or *clusters* that generate a dominant global trend, stimulating urban growth with massive environmental implications (Schmutzler, 2002).

One should also not lose sight of the push (*restrictive*) factors of the urbanization process, seen as a change over time in the size, density and heterogeneity of human settlements. Thus, authors (Tonne, et al., 2021) consider that in addition to the positive factors of urbanization (demographic growth, economic development, good governance), factors such as poverty, territorial conflicts, social disruption, unemployment, extreme weather events or, especially, income disparities cannot be ignored urban attractiveness is currently enhanced primarily by economic opportunities (diversified jobs and high wages) and access to modern services or facilities

The dissociation between urban population growth and the spatial extension of urban agglomerations has become increasingly difficult, the latter being strongly correlated with the demographic explosion in developing countries and with the changing lifestyles in developed countries (motorization, suburbanization, gentrification). Urban sprawl, by which is meant the extension of built space beyond the administrative boundaries of the city, can be seen as a decentralization of residential space, services and related structure that has led to the coalescence of traditional forms of transition to the countryside (suburbs) through processes of diffusion of reticular or sprawling form (Weir, Wolman, & Swanstrom, 2005). Over time, these lead to the emergence of urban regions (areas), monocentric agglomerations, conurbations, etc. The decentralization of population and labor force implies the formation of *polycentric local systems* that tend to replace the old hierarchical organization. The main effect of this trend can be observed in the increasing social and spatial fragmentation of contemporary urban agglomerations (Dematteis & Governa, 2001). This situation, long specific to North America, has generalized globally, with the area of urbanized land increasing in proportion to, but faster than, population growth. Marshall formalized this process mathematically ($A=P^n$, where A is the area, P is the population and ^{n} *is* an exponent that usually depends on the level of socio-economic development) (Marshall, 2007). The correlation between urban *sprawl* and the human development index has been observed in large global studies, explaining the very rapid rate of increase in space consumption in Europe after 1990 (Behnisch, Krüger, & Jaeger, 2022). The need for a balance between quality of life and land use for sustainable development is urgent, especially in densely populated regions with high greenhouse gas emissions and low availability of ecosystem services. Urban concentration plans to limit land consumption are underway in the Netherlands for example, especially in peripheral areas of agglomerations where facilities are diversified while respecting natural and landscape values (Broitmann & Koomen, 2015). Concerns in this regard are also manifest in countries that have recently undergone alert urbanization, including authoritarian regimes that have overseen the process of urban agglomeration sprawl, such as China (Huang & Liu, 2021). But even in such situations, the dynamics of urban sprawl can spiral out of control, subjecting itself to the same dispersion tendencies that have long been manifest in Western states. One-off studies of very large urban agglomerations have demonstrated this trend, such as the Chinese metropolis Wuhan where a proximity effect has been observed that pushes the edges of the agglomeration further and further away from its center (Jiao, et al., 2018).

Although considered outdated (Billen, Garnier, & Barles, 2012), the concept of *hinterland* becomes important in this context. In the past, relations between large cities and their neighboring territories was much closer, the latter being structured to meet supply needs (food, energy, water or labor, etc.). With globalization, cities seem to have become mere nodes in a worldwide network of trade (Short, Breitbach, Buckman, & Essex, 2000). The urban dispersion of recent decades, however, expresses new aspirations to reconnect the city, whatever its size, with the surrounding area. It is in fact the product of a *transition from the compact, mono-centered and highly densely populated compact city to the semi-compact or dissociated city of intermediate density* (Salvati, Morelli, Rontos, & Sabii, 2013). This transition seems to be completed in the United States, where it is more likely to be a filling of available spaces within the agglomeration or a restructuring of those already occupied. In developing countries, however, the transition is at an early stage, with demographics and economic conditions still the key drivers (Kuang, Chi, Lu, & Dou, 2014).

The conversion of land area to urbanized space is a process with irreversible impacts on the biosphere, affecting local climate, fragmenting natural habitats, reducing biodiversity. All studies that have used satellite imagery to observe such transformations certify this impact (Seto, Fragkias, Güneralp, & Reilly, 2011). The cited authors, studying the period 1970-2000, observed a 58 000 km^2 increase in the area occupied by cities in India, China and Africa alone. The highest rate of expansion, however, was in North America, exceeding the rate of urban population growth. There is an increasingly strong correlation with growth in gross domestic product everywhere. Alongside this, international capital flows, the informal economy, land-use policies, and transportation costs have also become very important, factors that have been too little studied. Average forecasts by the same authors estimate that by 2030, the land area occupied by urban areas will exceed 5 000 000 km^2, of which one third will be due to the expansion between 2010 and 2030, mainly in developing countries. There is a lack of understanding of how urban population growth will affect the expansion of the territory occupied by cities in the future. The *population growth/economic growth* dilemma persists, even though some large studies with representative samples show a relative importance of both factors (Peterson, 2017). Level of development and good governance are essential criteria for balanced development and after 2000, the effect of gross domestic product growth on land consumption seems to dominate (Mahtta, et al., 2022). For example, in Africa, the urban population grew at a rate of 4.91% per year between 2001-2019 and the area occupied by cities by 5.92% per year, with a particular intensity in countries with large populations (Nigeria, D.R. Congo, Ethiopia), the environmental effects being far from known (Bloch, Monroy, Fox, & Ojo, 2015) (Jiang, et al., 2021). In Europe, after a massive expansion (78% increase between 1950−2010, with only 33% in population), the process has reached saturation. Comprehensive strategies to reconsider urban-rural relations are needed for a sustainable future: better coordination of transportation; use and planning of greenfield land; urban isolation and densification through the development of a green compact city; preservation of blue and green infrastructure; saving agricultural land and promoting local agricultural production; reducing urban-rural disparities, etc., coordinated by *strengthening governance at regional level* (Nillson, Nielsen, Aalbers, Bell, & Boitier, 2014).

As a result, the study of urban dynamics is becoming increasingly complex and the trends observed can often appear contradictory and unpredictable, limiting the ability to forecast. The global divergences manifested as an effect of asynchronous driving forces are also felt at the national level. Thus, Kroll and Kabisch show that the impact of the consequences induced by the changes manifested in Germany's urban dynamics is dependent on the differentiated way in which demographic developments are managed, especially in terms of labor migration (Kroll & Kabisch, 2012). Processes such as ageing or demographic decline affect both growing and shrinking regions, proving once again the existence of systemic particularities.

Beyond this complexity, the issue of urban dynamics can be addressed at a global level. At least at the level of large urban agglomerations, as argued by some authors (Novotný, Chakraborty, & Maity, 2022), similar global macro-models of urban growth can be identified, based on three consecutive processes: *suburbanization*; *expansion towards the edges*; *filling of the interstices*.

Using an urban scaling model they have identified two effects that can predict the expansion of urban space: the *agglomeration effect* (increase of built space based on available floor space) and the *hinterland effect* (land availability in the neighboring space). The agglomeration effect is essential for the process of filling in the interstices and the hinterland effect for the expansion of the edges and peripheral spaces. This is contrary to the view that the formation of urban agglomerations is a *diffusion-coalescence* process that develops simultaneously (Li, Li, & Wu, 2013). Urban sprawl has been resiliently adaptive, with large metropolises appearing in deserts (Dubai, Las Vegas) or in small coastal areas (Singapore, Hong Kong). Fears that urban sprawl in developing countries may reduce agricultural production possibilities are considered unfounded by many authors, given the contradiction between developed countries (where the area occupied by cities increased 1.8 times between 1990-2015 while population grew only 1.2 times) and developing countries (where the same indicators increased 3.5 and 3 times respectively, starting from a much lower level). The example of countries such as India and China is invoked, where alert urbanization has not led to a reduction in food availability; on the contrary, by using superior agro-techniques they have ended up with surpluses on some levels (Zhang, Wang, Xie, Rao, & He, 2020). The process of urbanization of the two demographic giants is considered by the authors as the key factor that will shape the new configuration of the world in the 21st century.

The objectives of the study, as foreshadowed by the literature review, propose a geographical perspective. The main aim is to test the extent to which *the geographical position expressed by morphological and climatic characteristics or by the manifestation of certain risks is a favorable or restrictive factor* for the evolution of the two essential elements that determine urban dynamics: demographic growth and economic dynamics expressed by the level of Gross Domestic Product.

The main hypothesis of the study postulates that, in line with the results of other studies, *demographic growth is determinant especially for developing countries and the level of Gross Domestic Product for developed* and, increasingly, emerging *countries*. At the same time, a secondary hypothesis was also tested: *rapid urban population growth is primarily concentrated in areas marked by natural or man-made hazards*.

MATERIALS AND METHODS

It has become evident that in the current context it is difficult to approach the issue of urban dynamics other than through the prism of *spatial forms of agglomeration* (metropolitan areas, agglomerations, etc.), especially in comparative studies. Some authors attest that these forms of agglomeration are faced with the prospect of continuous expansion of the surface and intensity of spatial use leading to the increasing manifestation of climatic excesses (Wernstedt & Carlet, 2014). Thus, with these points of support, which constitute only a tiny part of the vast specialized literature, the database set up to analyze population dynamics and a series of determining factors used *urban agglomeration* as a unitary spatial support. This was defined in terms of the *potential distance of interaction with the neighboring space*, closely dependent on population density. A number of *2015 agglomerations* have been identified, with a lower limit of 500 000 inhabitants, considered relevant to express the capacity of integration into the higher hierarchical levels of the global urban network. The calculation of this distance is based on the following mathematical model:

$P_{1 \ldots n} = (\pi r^2_{1 \ldots n}) * 100 + k$, where P is the population, *r is the* radius of the circumscribed circle and k is a correction coefficient, calculated as follows:

$k = (n-1) * (\pi/4 * 100)$, where *n is* the correction coefficient of the previous distance expressed in km. Its multiplication by the fourth of π expressed in percent is based on the evidence that with distance there is an increase in the polarized population.

This mathematical model takes into account both the decreasing attractiveness with distance from the center and the increasing attractiveness with the size of the center of attraction (*figure 1*). All potential agglomerations were thus identified according to the limit up to which the polarization capacity can be expressed. In the case of densely populated areas with a dense urban network, complex aggregates, centered on the most populated city, were thus formed. Agglomeration capacity increases as the population of the center becomes denser and more numerous, depending on the level of population density in the hinterland.

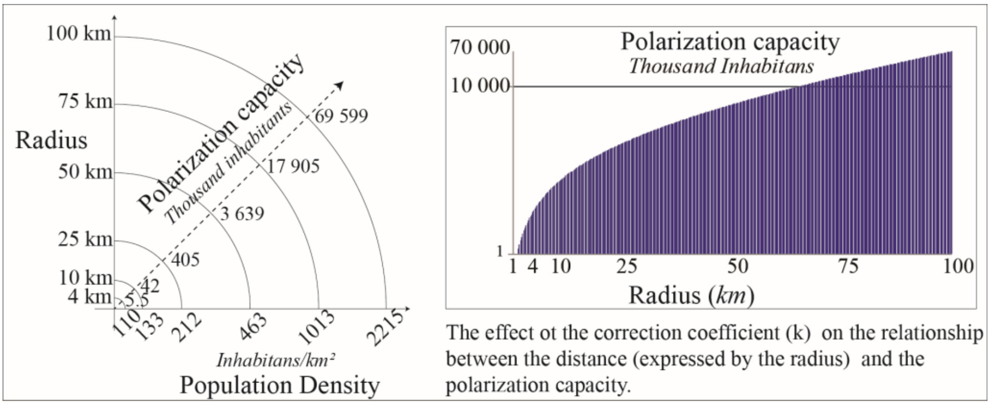

Figure 1. The model of the delimitation of the maximum polarization capacity of the urban agglomeration centers retained for analysis
(Source: own design)

For the *descriptive analysis*, information on the population of each agglomeration has been aggregated from 1980 onwards, every ten years until 2020. The study period selected, 1980-2020, corresponds to a period for which information from various databases was accessible. The population for the 5 points in time was aggregated using the following source of information: *Citypopulation (www.citypopulation.de)*, which collects detailed official data for all states and territories in chronological profile, in tabular or cartographic format. Data collection started in 2010, with the currently available form removing information older than three decades. *The websites of the national statistical institutes* were also consulted to fill in missing information, in particular information from censuses conducted after 1980. From the primary database, a derived database was obtained by interpolation, adjusted to the same time benchmarks (1980, 1990, 2000, 2010, 2020). These were used to calculate *the average annual* population *growth rate (APG)* for each decade, according to the relation: $APG= ((P_1-P_0)/10)/((P_0+P_1)/2)$. Values are expressed as percentages and were standardized with Z-scores to eliminate extreme variations. They were used to identify patterns of urban growth and the dynamics of the agglomeration process. The statistical procedure used was AHC (agglomerative hierarchical clustering), available in the program Xlstat (https://www.xlstat.com), 2014 edition. The typological analysis retained 6 distinct classes, with a clearly outlined profile and a strongly regionalized distribution.

For the *multivariate analysis*, information on geographical position, predominant climate type, hierarchical position in the proximity network, natural and anthropogenic hazards, population growth, gross domestic product were used. The decadal average rate of population growth served as the dependent variable in a PLS (partial least square regression) analysis using a number of explanatory variables (Table 1). The data processing used the same Xlstat.

Table 1. Variables used in the multivariate analysis

Variables	**Measurement unit/ Calculation method**	**Data source**	**Reference year/period**	**Standardization**
Average annual population	%	(Brinkhoff, 1998-2025)	1981−1990; 1991−2000; 2001−2010; 2011−2020	Z score

growth rate (APG)				
Population density of agglomeration (DNS)	inhabitants/km^2	Own calculation	1990, 2000, 2010, 2020	
Average distance to neighboring agglomerations (ATN)	Km	(Great World Atlas, 2002)	Invariable	
Primacy index (PRM)	*Pna/Pa*, where *Pna* is the sum of population fo neighboring agglomerations and Pa, population of the agglomeration concerned	Own calculation	1990, 2000, 2010, 2020	
Gross domestic product (GDP)	USDppa/inhabitant	(Countries by GDP Growth, 1980-2024) (Worldbank, 2023)	1990, 2000, 2010, 2020	
Rate of Natural Increase (RNI)	‰	(World Population Data Sheet, 1990-2024) (Demographic Yearbook, 1979-2022)	1981−1990; 1991−2000; 2001−2010; 2011−2020	
Share of crowded population outside the center (SCP)	%	Own calculation	1990, 2000, 2010, 2020	
Geographical position (GPS)	Factorial score: 1 = estuary, delta, strait; 0.9 = coast; 0.8 = major confluence in plain; 0.7 = plain; 0.6 = contact plain/uplands; 0.5 =major confluence in hill area; 0.4 = hill area; 0.3 =mountain valleys; 0.2 = mountains -	own estimation using Great World Atlas and Google Maps	Invariable	Factorial Score
Climate type (CLM)	Factorial score: 1 = equatorial; 0.9 = tropical humid; 0.8 = subtropical humid; 0.75 = tropical dry saison; 0.7 = temperate humid; 0.6 = temperate continental; 0.5 = subtropical arid; 0.4 = tropical arid; 0.3 = temperate arid; 0.2 = boreal humid = 0.1;= boreal continental	own estimation using Great World Atlas and Google Maps	Invariable	
Incidence of Natural Risks (INH)	Factorial score: 1= presence; 0 = absence. Six categories were considered: seismic risk; volcanism; geomorphological risk; flood risk; sea level rise; heat waves and wildfires;	(Shi & Kasperson, 2015)	Invariable	average of the factor score specific to each risk category

Incidence of Anthropogenic Risks (IAR)	Factorial score: 1= strong incidence; 0 = low incidence. Three categories were considered: political regime change; military conflicts; terrorism and endemic criminality.	(World Population Review, 1980-2024) (Quality of Life Index by Country, 1990-2024)	1981−1990; 1991−2000; 2001−2010; 2011−2020	

We point out that the area needed to compute the DNS variable was calculated according to the potential interaction distance mentioned above. This resulted in identical areas for agglomerations of the same size. In case of interference of agglomerations or peripheral position (coastal, border), corrections were necessary, using the facilities provided by Google Maps. Regarding the ATN variable, the average distance to the 6 nearest agglomerations was estimated, irrespective of the natural barriers present, according to the situation at the end of the study period. Regional average values were used as far as possible to calculate the RNI. In the case of seismic and volcanic hazards, specific events over the last 100 years were taken into account, and for the other natural hazard categories, the incidence during the study period. For anthropogenic hazards, the events in each decade, their frequency, were taken into account.

The dependent variable (APG) was calculated for each reference period (1981-1990; 1991-2000; 2001-2010; 2011-2020), and 4 multiple regressions were carried out in order to follow the dynamics of the influence of the descriptive variables over time. Separate analyses were processed, both for all the 2015 agglomerations under consideration and by categories expressing major socio-economic disparities: developed countries; developing countries; Sub-Saharan African countries. The multivariate analyses were primarily aimed at the correlation between variables, the validation of the results being guided by the coefficient R^2.

RESULTS

A synthetic picture of the dynamics of the process of urban agglomeration, as defined, as an expression of the combination of the actual process of urbanization and the process of human agglomeration generated by the increase in the potential for interaction as a result of the massive densification of immediately neighbouring areas, is provided by the evolution of the number of agglomerations at the continental level. A first conclusion is that their number is steadily increasing from 1164 to 1975 between 1980-2020 (*see Table 2*). The difference to the total number of agglomerations taken into account (2015) is due to the progressive fall below the 500 000 inhabitants limit in 40 cases, mainly located in Europe.

Table 2. Numerical evolution of major urban agglomerations at continental level
(Data source: see Table 1)

Continent	Year	Size category (millions inhabitants)									Total
		0.5-1	1−2	2−3	3−5	5−10	10−20	20−30	30−50	>50	
Europe	1980	106	52	13	11	6	4	0	0	0	192
	1990	124	51	17	11	7	4	0	0	0	214
	2000	125	56	18	10	6	5	0	0	0	220
	2010	115	64	21	9	7	5	0	0	0	221
	2020	118	66	17	12	9	5	0	0	0	227
America	1980	66	43	18	10	6	4	0	0	0	147
	1990	91	44	21	12	7	4	1	0	0	180
	2000	97	52	18	25	7	4	2	0	0	205
	2010	106	59	24	24	12	4	2	0	0	231
	2020	130	67	26	28	14	5	2	1	0	273

Asia-Oceania	1980	303	198	64	69	66	18	3	2	0	723
	1990	336	220	83	77	78	26	4	3	0	827
	2000	379	252	92	88	83	37	6	6	0	943
	2010	423	279	97	102	87	45	10	7	1	1051
	2020	471	298	127	95	95	51	14	5	6	1162
Africa	1980	57	25	12	4	3	1	0	0	0	102
	1990	65	38	12	11	5	0	1	0	0	132
	2000	84	46	17	15	8	1	1	0	0	172
	2010	113	54	21	20	12	2	0	1	0	223
	2020	167	74	20	25	17	9	0	1	0	313
WORLD	1980	532	318	107	94	81	27	3	2	0	1164
	1990	616	353	133	111	97	34	6	3	0	1353
	2000	685	406	145	138	104	47	9	6	0	1540
	2010	757	456	163	155	118	56	12	8	1	1726
	2020	886	505	190	160	135	70	16	7	6	1975

This growth was primarily due to Asia (in absolute terms) and Africa (in relative terms). Europe was relatively stable and the Americas were in between. There were significant changes in the size distribution, with a rapid increase in the number of giant agglomerations (over 20 million inhabitants). Absent in Europe, a densely populated continent compared to the world average, and rare in the Americas, these agglomerations are specific to Asia, in line with the human agglomerations in the deltaic and coastal areas of monsoon Asia. In Europe and Africa, most agglomerations are smaller (less than 1 000 000 inhabitants), which can be explained by the age and density of the urban network and, in contrast, by later urbanization. Initially, the world's largest agglomeration was the Japanese capital, Tokyo, which has gradually lost ground to other metropolitan areas favored by the demographic explosion: four in the Indian subcontinent (Delhi, Calcutta, Patna and Dhaka, the last of which is now the largest), one in the Indonesian archipelago (Jakarta) and another in southern China (Guangzhou), all with more than 50 million inhabitants. The excessive agglomeration of the human population on a relatively small area is evident, the share of the occupied area has increased steadily, but much slower than the agglomerated population (30% compared to 108%), also visible in the significant increase in density (see Table 3).

Tabel 3. Changes in the surface area and population of urban agglomerations (1980-2020)
(Source: see Table 1)

Year	**Corresponding surface area (km^2)**		**Population of agglomerations**		**Density**
	thousands km^2	**% of total**	**Millions inhabitants**	**% of total**	**Inhab./km^2**
1980	6753.8	5.0	2509	56.4	372
1990	7339.6	5.5	3088	58.6	421
2000	7847.8	5.8	3761	61.8	479
2010	8297.2	6.2	4445	64.4	536
2020	8812.1	6.5	5206	67.4	591

Basically, more than two-thirds of the world's current population is crammed into just 6.5% of the Earth's land surface (excluding Antarctica). On the face of it, the spatial footprint of large human agglomerations is not necessarily excessive. But their impact in terms of the demand for resources that ensure a high level of development is enormous, reflected in increasing amounts of greenhouse gas emissions, multiple pollution, reduced biodiversity through shrinking natural ecosystems, etc. The trends of continued concentration of the global population in a few thousand significant agglomerations, extending the rates of evolution of the last decades, will lead to the occupation, by 2050, of probably around 7.5% of the terrestrial land surface and more than 3/4 of the human population, which will increase by about 20% anyway. The likelihood that many smaller agglomerations, at least in Africa but also in Asia and Latin America, will exceed the 500 000 population threshold must also be taken into account. These may add at least 10% to the above weights. The human pressure of the 7-8 billion people who will live in large agglomerations will increase further as access to the benefits of a modern lifestyle becomes more democratic, even if socio-economic disparities will persist. The world of the future belongs to these human agglomerations, clustered in more or less dense networks, interconnected in what some have long called the 'ecumenopolis' or 'global city' and is considered 'humanity's greatest invention' (Wilson, 2021).

Typology of population dynamics of urban agglomerations

The profile of the types retained from the AHC analysis is very clearly personalized, with a specific growth rate. It generally follows a progressive decreasing trend, with the exception of types 4 and 5, which have diverged (Figure 2).

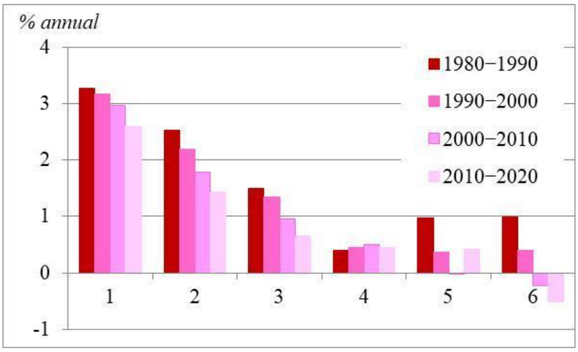

Figure 2. Typology of the evolution of the average annual population growth rate of large agglomerations (*Data source: see Table 1*)

The first three types have recorded high APG values, with type 1 permanently above 2.5%. The steady growth rate follows a similar pattern. Accounting for 3/4 of the total number of agglomerations considered, they are dominant worldwide.

Types 4,5 and 6 are less common and have an equal share. Each one expresses specific ways of adapting to the context of the completion of the demographic transition, the expansion of peri-urban areas and the knowledge and innovation-based economy. Type 4 is an active adaptation, maintaining attractiveness at a modest but constant level. It expresses a high potential for innovation characteristic of the smart city concept and is more common in North America and Western Europe. Type 5 is a particular case, deeply marked by the crisis of the first decade of this century but which has subsequently managed to adapt, approaching the growth pattern of type 4. It is common in Southern and Eastern Europe. The last one, type 6, is the vulnerable variant of the previous type, deeply marked by the crisis, with no chance of improvement for the time being.

The spatial distribution of these types thus indicates a strong regionalization, which attests to the importance of changes in the political and economic-social system. In Europe, the last three types clearly predominate, reflecting the early completion of the demographic transition, with natural growth no longer able to sustain urban expansion. Based on exogenous flows, urban population growth continues at a moderate level in most agglomerations in the west of the continent, while the east, beyond the former "iron curtain", with the change of political regime in 1989, enters a phase of deterioration of economic structures, generating a real dynamic gradient (Kröhnert, Hossmann, & Klingholz, 2008). The negative effects of the transition to a market economy have been stronger in highly industrialized agglomerations (e.g. Donbas, Silesia) than in capital cities or regional centers with diversified economies that were able to gradually recover, after 2010 in particular, from the shock of the fall of communism (Sandu, Bănică , & Muntele, 2021). Isolated, some capitals (Moscow, Minsk, Madrid) or some coastal agglomerations have experienced sustained growth, in line with type 3 (Figure 3). The local geographical context is very important in the south of the continent, explaining the differences between agglomerations that apparently have the same socio-economic data, such as Barcelona, Rome or Athens (Ciommi, Chelli, Carlucci, & Salvati, 2018). The contrast observed between Europe and neighboring regions (Near East, Maghreb) is very strong.

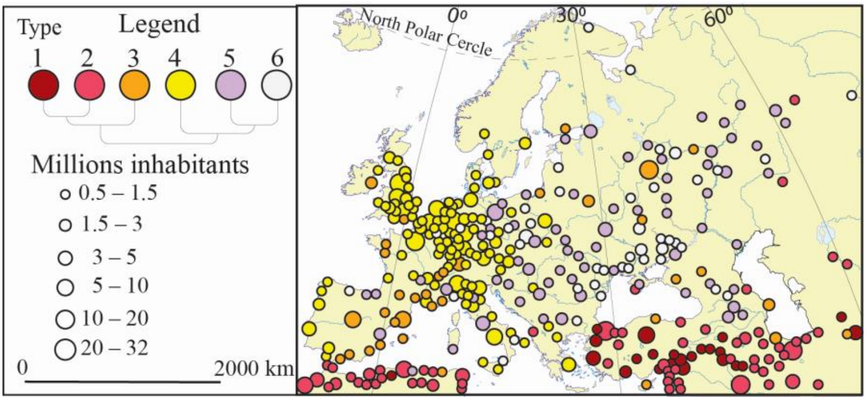

Figure 3. Typology of population evolution of urban agglomerations in Europe
(*Data source: see Table 1*)

In Asia, the typology shows a much more complex evolution, depending on demographic growth, the precocity of industrialization in some regions or the favorable geographical position in relation to the major maritime transport axes (see Figure 4). The strongest growth is observed in areas that preserve an exceptional demographic potential (the north of the Indian subcontinent, the Philippines, some areas of Indonesia, Central Asia, etc.) or express the unprecedented development of industrial-port infrastructure (the Pearl River and Yangtze deltas in China). Intermediate values, corresponding to types 2-3, have a high frequency, especially in the Indian subcontinent, where a gradual north-south disposition is observed, closely linked to the advance of the demographic transition in the south. In East Asia there is a predominance of types 3, 5 and 6, correlated with the size hierarchy. Large agglomerations usually manage to maintain higher growth than smaller ones (Beijing in North China, Seoul in Korea or Tokyo in Japan). China's marginal areas have seen a significant expansion of agglomerations (Inner Mongolia, Xinjiang, Yunnan), reflecting the preservation of a more sustained population growth, but also massive colonization by Han people. The south-east coast of China as a whole is much more dynamic than the inland areas, which are more reminiscent of Eastern Europe, with the predominance of types 5 and 6.

This crisis of more modest agglomerations in inland China is also linked to the demographic policy of the Chinese state but also to the strong migration to increasingly economically advanced coastal areas (Chen, 2013). The Yangtze basin (including the southwestern province of Sichuan) seems to be a marked axis of recovery in the last decade, as in similar areas in Eastern Europe. This situation can also be explained by the diffusion of industrial and service development from the more expansive metropolitan areas (Chengdu and Chongqing in Sichuan, Wuhan on the middle Yangtze or Shanghai and Hangzhou in the delta area). Turning the wide river valley into a development axis may be a counterweight to the overdevelopment of the south-eastern coastal zone. Recent studies confirm this hypothesis of the formation of a so-called *Yangtze Economic Belt* (Ren, Tian, & Xiao, 2022). Important disparities are also evident in other Asian regions. For example, in Indonesia, the central-eastern part of Jawa Island is clearly distinguished by belonging to moderate-dynamic types that express the overpopulation of the island and the tendency of population migration to the more sparsely populated islands in the north and east of the archipelago or to the huge agglomeration of Jakarta (Pravitasari, el al., 2015). Such differences are also observed in Indochina between the more dynamic coastal zone and the interior. Japan and South Korea resemble in the arrangement of types more closely to Western Europe or North America.

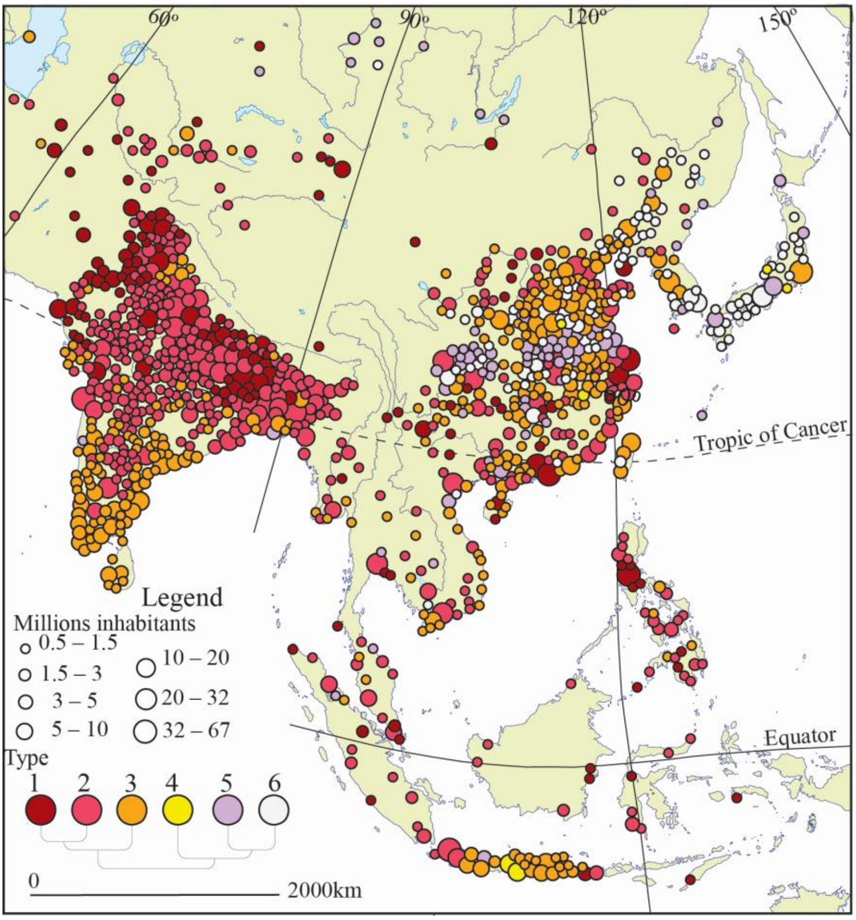

Figure 4. Typology of population evolution of urban agglomerations in South and East Asia
(*Data source: see Table 1*)

For America and Oceania, the situation is somewhat similar to that in Asia. The earlier urbanized and industrialized areas (north-eastern United States, the Great Lakes area, etc.) have developed in a similar way to Western Europe, in contrast to Central America where the more dynamic types predominate (see Figure 5).

In contrast to Asia, the large urban agglomerations in Latin America (Mexico City, Sao Paolo, Buenos Aires, Caracas) have slowed their rate of demographic expansion, expressing a state of saturation. In Brazil, the inland agglomerations are the most dynamic (Manaus in the heart of the Amazon, Brasilia enjoying the status of capital city, etc.), as are many smaller agglomerations in the Andean or Central American countries. It may be the expression of a lower demographic pressure, in the context of a sparse population massively concentrated in coastal areas.

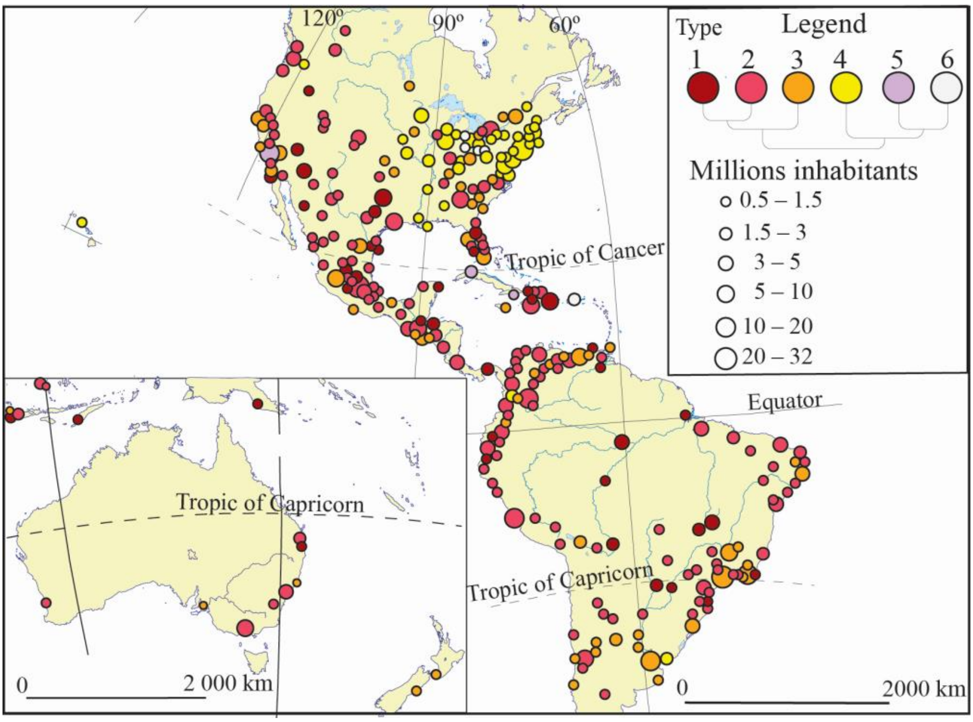

Figure 5. Typology of population evolution of urban agglomerations in America and Oceania
(*Data source: see Table 1*)

In contrast to Asia, the large urban agglomerations in Latin America (Mexico City, Sao Paolo, Buenos Aires, Caracas) have slowed their rate of demographic expansion, expressing a state of saturation. In Brazil, the inland agglomerations are the most dynamic (Manaus in the heart of the Amazon, Brasilia enjoying the status of capital city, etc.), as are many smaller agglomerations in the Andean or Central American countries. It may be the expression of a lower demographic pressure, in the context of a sparse population massively concentrated in coastal areas.

In North America, the contrast between the north-east and the south-west continues, with the newer agglomerations on the Pacific coast or in Texas and Florida being much more dynamic. However, the giant agglomerations (like Los Angeles) have reached the limits of population expansion. In Canada, the same contrast is less visible, with Vancouver in the extreme west forming, along with Seattle and Portland in the north-west of the USA, a veritable highly dynamic urban axis. In Oceania, the situation appears much more balanced, with moderate or moderately-dynamic growth, without strong regional or hierarchical differentiations.

Africa presents the most interesting case, along with the Middle East, with the predominance of explosive growth, in line with a delayed demographic transition, against a background of incipient urbanization (see Figure 6).

In sub-Saharan Africa, types 1 and 2 predominate (the latter especially in the economically more advanced extreme south), while type 3 is rarely present. Two broad groupings are distinguished in the first place: that centered in Nigeria, extending along the Gulf of Guinea coast westward; that around the Great Lakes, especially Lake Victoria in eastern Africa. Add the Nile Valley in Egypt or the Maghreb coast. These are similar to those of Monsoon Asia, with densely populated rural areas, and are of interest because of their potential for development, mainly due to their abundant labor force. Other significant urban networks are also taking shape, such as the Abyssinian Plateau or the Congo river basin (controlled by the large conurbations of Kinshasa and Luanda) and others.

In the Arabian peninsula, adjacent to Africa, despite the restrictions imposed by the physical-geographical context, several concentrations have developed. The most well-defined is the one on the southern coast of the Persian Gulf, somewhat linked to the ancient urban systems of Mesopotamia and Iran. Dubai is emerging as one of the most dynamic conurbations in the world, with all the prerequisites to prevail over other large conurbations on the peninsula, such as Riyadh. The dynamics of urban agglomerations in the periphery of the Middle East (Levant, Iran) are more moderate, reflecting the decline in population growth but also the presence of a denser urban network with many small and medium-sized towns.

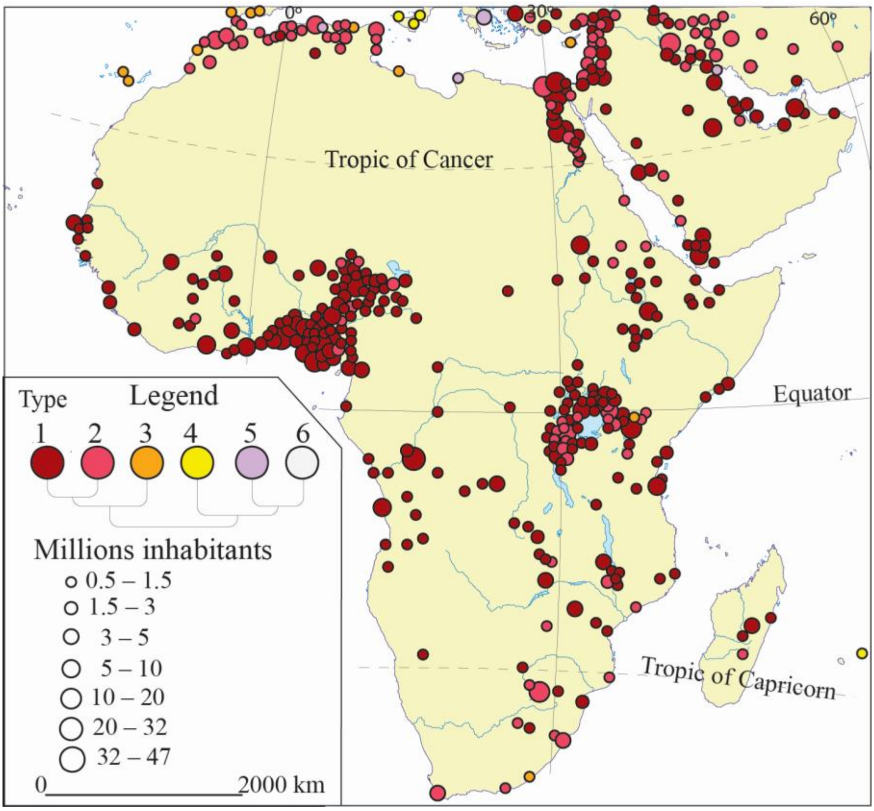

Figure 6. Population typology of urban agglomerations in Africa and South-West Asia
(*Data source: see Table 1*)

Africa's urban expansion is inevitable, growth rates may record exceptional values since so far growth has been based more on natural dynamics, with rural exodus on the rise. Some studies point to a trend towards smaller, compact cities that are more manageable in the absence of efficient infrastructure. This development is desirable in Africa in order to avoid the chaotic development that has so far characterized the expansion of capital cities (Linard, Tatem, & Gilbert, 2013).

Multivariate analysis

The variables used to test how the driving factors of urban dynamics manifest themselves were synthesized on the basis of information collected from various sources as presented in the methodological chapter

Analyzed individually, these variables exert a clear influence on urban dynamics, expressed in terms of the average annual growth rate (see Table 4).

Table 4. Evolution of average annual population growth rate by explanatory variables (*Data source: see Table 1*).

Average annual population growth rate in %					**Average annual population growth rate in %(APG)**				
Category	1981-1990	1991-2000	2001-2010	2011-2020	Category	1981-1990	1991-2000	2001-2010	2011-2020
Average distance to neighboring agglomerations in km					0.8	1.82	1.76	1.40	1.43
46–100	0.7	1.50	1.10	1.08	0.7	1.61	1.58	1.43	1.08
101–200	0.6	1.75	1.41	1.26	0.6	1.47	1.47	0.99	0.93
201–300	0.5	1.65	1.63	1.35	0.5	1.60	1.49	1.24	1.51
301–500	0.4	1.87	1.74	1.63	0.4	2.10	1.84	1.68	1.52
501–1000	0.3	2.07	2.04	1.96	0.3	2.20	1.93	1.59	1,47
1000-4114	0.2	1.90	2.10	1.91	0.2	2.31	2.17	1.63	1.58
Primacy index					Climate type (factorial score)				
0.02 − 0.25	1.76	1.62	1.20	0.97	1	2.26	2.08	1.86	1.61
0.26 − 0.50	1.68	1.50	1.23	1.10	0.9	2.19	2.03	1.64	1.42
0.51 – 1	1.78	1.64	1.31	1.19	0.8	2.45	2.21	1.96	1.69
1.01 – 2	1.71	1.64	1.38	1.27	0.75	3.03	2.75	2.56	2.32
2.01 − 5	1.74	1.84	1.59	1.37	0.7	1.39	1.55	1.06	1.12
Over 5	1.94	1.85	1.63	1.55	0.6	2.33	2.03	1.02	1.58
GDP, ppa in 2020 (thousand USD/inhabitant)					0.5	0.68	0.64	0.45	0.55
0.57 – 2	3.02	2.96	2.81	2.76	0.4	0,98	1.01	0.75	0.48
2.01 – 5	2.59	2.37	2.12	1.84	0.3	1.85	1.69	1.52	1.41
5.01 – 10	1.76	1.70	1.27	1.21	0.2	0,86	0.35	0,75	1
10.01 – 25	1.87	1.87	1.51	1.34	0.1	1.35	0,05	0,47	0,81
25.01 – 50	1.47	1.09	1.15	0.95	Incidence of Natural Risks (factorial score)				
Over 50	0.91	1.02	0.93	0.88	0	2.03	1.68	1.47	1.25
Average rate of natural increase (in‰)					0 – 0.25	2.01	1.69	1.35	1.14
Negative rate	0.63	0.1	0.13	0.11	0.26 – 0,5	2.09	1.87	1.54	1.29
0 – 5	0.93	1.12	0.92	0.66	0.51 – 0.75	2.16	1.95	1.56	1.28
5 – 10	1.57	1.70	1.08	1.19	0.76 – 1	2.03	1.83	1.51	1.16
10 - 20	2.38	2.06	1.74	1.43	Incidence of Anthropogenic Risks (factorial score)				
Over 20	2.97	2.82	2.77	2.66	0	1.96	1.79	1.37	1.08
Geographical position (factorial score)					0 – 0.33	2.10	1.59	1.48	1.33
1	1.76	1.89	1.69	1.44.	0.34 –0.66	2.83	2.42	2.14	1.98
0.9	1.62	1.55	1.39	1.17	0.67 – 1	2.76	2.71	2.45	2.16

The distance from neighboring agglomerations creates a visible gradient, with the values of the pace increasing with increasing distance. This translates the modernity gap between intensely anthropized regions with a dense urban network and those where the urbanization process is at an early stage.

On the other hand, *the primationality index*, which expresses the potential dominance of the neighboring urban network, has a less constant influence. In the first period, there were practically no differences, the values of population growth being rather uniform, the urbanization process not being completed even in the most developed countries. Subsequently, however, there was a gradual differentiation in favor of the dominant agglomerations, with the size gradient being highly visible. This trend towards concentration of population in large metropolitan areas (mega-cities) has been manifesting itself in recent decades, thus contradicting Gibrat's law and, to some extent, the rank-size theory. This phenomenon is confirmed in studies conducted on large urban systems such as the Chinese one, where the exponential growth of the first 32 large agglomerations has been shown to be exponentially increasing, far above planned projections and inversely correlated with city size (Shuqing, Decheng, Chao, & Yan, 2015).

Gross domestic product, often invoked as a driving force of urban dynamics, is strongly correlated with the rate of growth but inversely proportional, with the highest growth rates characterizing agglomerations with a low level of development. Beyond this, however, at the peak, the agglomerations with the highest levels of GDP are distinguished by the constancy of their growth, which in fact expresses their strong attractiveness. *Demographic growth*, another factor often cited as having a determining role, is clearly important, with the highest values being recorded in geographical areas strongly marked by demographic explosion. However, agglomerations with a low or even negative natural balance (as is increasingly the case in developed countries) are able to maintain moderate growth because of their attractiveness. We can speak of a genuine phenomenon of *compensation* on a global scale, through the generalized migration we have witnessed in recent decades with the democratization of the cost of travel. We may thus witness a convergence that will reduce the importance of demographic growth.

The invariant factors introduced in the model have rather a contradictory influence. It is certain that the favorable *location* (major confluences, coastal areas providing rapid access to the hinterland) is reflected in high growth rates, with most large agglomerations being located in such positions. They may, however, contradict the very high values in mountain or foothill areas, at least in the first decades. Later urbanization or the preservation of a traditional demographic behavior can be invoked in this respect. The evidence of a rapid decline in the rate of growth over time indicates a trend that is still in favor of areas with high interaction potential (plains, coastal regions). There is a latitudinal gradient in *climate* , with the rate of growth being much faster in the warm zone, at least in the first two decades, closely linked to global north-south development disparities. There is a certain fragility in cold climates, but also an apparent contradiction in the strong growth rate in arid (temperate or tropical) areas. The moderate and relatively constant values in humid temperate or transitional zones are explained by the low population growth in these areas, which cover the most developed societies. As in the case of geographical position, a trend towards homogenization seems to have been noticeable in the last decade when the only excessive growth values still characterized the arid zones. This seemingly irresistible attraction to warm arid climates is to a large extent due to the growing share of large human agglomerations in South-West Asia, North Africa and North America (Phoenix for example, one of the most dynamic agglomerations in the United States). Natural and anthropogenic *risks* also manifest themselves contradictorily in relation to the rate of population growth in urban agglomerations. In the case of natural hazards, the influence is minimal, with growth being relatively evenly distributed, irrespective of vulnerability to the various risks. In the case of anthropogenic ones, the maximum increase is concentrated precisely where the incidence is highest over the whole period. This apparent contradiction can be explained by the concentration of vulnerabilities in areas of high population growth, poor economic development, and high levels of inequality, which can be manifested in an upsurge in criminal activity or political instability.

The results of the multivariate analysis indicate a strong correlation between the variables considered in many other studies as determinants of urban dynamics: the level of population growth (expressed by the natural balance) and gross domestic product. The average distance between agglomerations, climate or anthropogenic hazards also shows a satisfactory level of correlation. The R^2 index shows a significant validity of the analysis at the global level (Table 5).

It can be concluded that the population expansion of urban agglomerations over the last four decades has generally been dependent on the factor that objectively drives growth, the natural balance. None of the other factors have recorded such high correlation values. Gross domestic product exerts an inversely proportional correlation, the higher it is, the more it tends to limit the demographic expansion of large agglomerations. The positive correlation of the average distance between agglomerations, even if not at a high level, indicates the presence of a certain tendency for "congestion" in densely populated areas, with expansion tending to occur in agglomerations with more space in their immediate vicinity. Climate had some influence before 2000, linked to the population preference for more favorable climate types (humid, transitional) which were higher bonality in the model. In the last two decades, however, this dependence has shifted, with urban sprawl occurring despite climate limitations or associated natural hazards. This can only be a worrying development, with an *unprecedented increase in anthropogenic pressure on fragile environments* (coastal, flood-prone, rugged, subject to seismic and volcanic movements, etc.). This correlates with the growing influence of anthropogenic risks, concentrated precisely where the strongest urban sprawl is taking place. Indifference to variables such as population density, primacy index, share of agglomerated population in the area of influence or geographical location may be an effect of the ubiquity of the phenomenon of urban agglomeration at the global level, regardless of factors that previously restricted or favored human presence.

Table 5. Correlations between the evolution of the population growth rate of urban agglomerations and explanatory variables at the global level.

APG	*DNS*	*ATN*	*PRM*	*GDP*	*RNI*	*SCP*	*GPS*	*CLM*	*INH*	*IAR*	*R^2*
1980 – 1990	−0.14	**0.26**	0.01	**−0.29**	**0.65**	**−0.24**	−0.14	**0.23**	0.03	0.18	**0.43**
1990 − 2000	−0.04	0.15	0.03	**−0.32**	**0.67**	−0.05	−0.13	**0.23**	0.08	0.13	**0.39**
2000 − 2010	−0.04	**0.23**	0.04	**−0.21**	**0.65**	−0.09	−0.07	0.02	0.04	**0.20**	**0.39**
2010 − 2020	0.03	**0.25**	0.07	**−0.23**	**0.71**	−0.07	−0.10	−0.01	0.02	**0.26**	**0.45**

Analyzed by categories of countries, the correlation between the dependent and explanatory variables takes on new dimensions. Thus, in the case of *developed countries*, the validity of the model is higher, especially in the first decades, with a higher incidence than the global average in the case of gross domestic product or population growth in suburbs (Table 11).

Table 6. Correlations between the evolution of population growth rates of urban agglomerations and explanatory variables in developed countries.

APG	*DNS*	*ATN*	*PRM*	*GDP*	*RNI*	*SCP*	*GPS*	*CLM*	*INH*	*IAR*	*R^2*
1980 – 1990	0.19	−0.11	0.06	**0.57**	**0.48**	**0.34**	0.05	**0.31**	**0.27**	**−0.55**	**0.54**
1990 − 2000	**0.23**	−0.11	0.06	**0.57**	**0.61**	**0.33**	0.05	**0.31**	**0.27**	**−0.55**	**0.51**
2000 − 2010	0.14	**−0.30**	0.06	**0.42**	**0.62**	**0.20**	0.02	0.09	0.05	**−0.29**	**0.37**
2010 − 2020	0.10	**−0.35**	0.09	**0.40**	**0.64**	0.10	0.01	0.00	−0.01	−0.14	**0.43**

Most of the factors recorded, at least episodically, significant values, which shows that the proposed model is more adapted to the specific evolutions of developed countries. The population density or the share of population in peri-urban/metropolitan areas had a clear influence in the context of counter-urbanization, a term which is increasingly contested today, when we observe a revalorization of agglomeration centres. *The level of economic development is very important in advanced countries, with a share close to that of population growth*. The reasons for population agglomeration in large territorial structures are linked to income levels, access to basic services, etc. The average distance between agglomerations in developed countries is becoming increasingly important, disfavouring sparsely populated, isolated areas and favouring densely populated major urbanization axes such as the famous 'Blue Banana' or the megalopolises of North America and Japan. The influence of climate and natural hazards appears to be decreasing in developed countries, possibly as a result of global climate change awareness and the development of a more environmentally friendly attitude.

By contrast, in *developing countries*, the model used has less explanatory power, but there is an increasingly significant conformity with the global trends already presented (Table 7). Urban sprawl, initially less dependent on population growth, is now more closely linked to it. The influence of the average distance between agglomerations is similar to the situation in developed countries, with densely populated areas (especially in Asia) certainly playing a determining role. The significant differences with the developed countries are certainly due to the economic and social disparities between them, which are in line with the early stages of urban transition.

Table 7. Correlations between trends in population growth rates of urban agglomerations and explanatory variables in developing countries

APG	*DNS*	*ATN*	*PRM*	*GDP*	*RNI*	*SCP*	*GPS*	*CLM*	*INH*	*IAR*	R^2
1980 – 1990	0.00	**−0.24**	0.01	−0.02	**−0.31**	−0.15	0.07	0.10	0.05	−0.08	**0.25**
1990 − 2000	−0.05	**−0.24**	0.01	−0.02	**−0.38**	**−0.21**	0.06	0.10	0.04	−0.08	**0.26**
2000 − 2010	−0.17	**−0.25**	0.09	0.12	**0.54**	−0.19	0.04	−0.16	0.09	**0.26**	**0.31**
2010 − 2020	−0.01	**−0.29**	0.12	0.16	**0.52**	−0.13	0.01	−0.17	0.08	**0.25**	**0.28**

Sub-Saharan Africa stands out in this category as a whole by showing a visible delay in the *relatively high correlation of the primaciality index*, corresponding to the excessive development of capitals to the detriment of regional centers, which is typical of the beginning of the urban transition (Table 8). The negative correlation with the geographical position in the first decade is explained by the incipient nature of the urbanization process as well as the share of the population in metropolitan areas, which are disadvantaged in this phase by strong disparities with respect to agglomeration centres. It is interesting to note the evolution of natural risks, which were initially positively correlated, indicating a certain indifference. Gradually, they have moved to significant negative values, possibly related to the emergence of major agglomerations in less exposed areas, including through the construction of new capitals (Abuja in Nigeria). Some studies emphasize food security risks with public health impacts, correlated with significant connectivity gaps between cities and their peripheral areas (Abu, Maria, Cavinato, Lindemer, & Lagerkvist, 2019). The solution of sustainable peri-urbanization in Africa's large agglomerations by integrating communities into the food production and distribution chains to counter the massive dependence on imports has become imperative.

Table 8. Correlations between trends in urban agglomeration population growth rates and explanatory variables in Sub-Saharan African countries

APG	*DNS*	*ATN*	*PRM*	*GDP*	*RNI*	*SCP*	*GPS*	*CLM*	*INH*	*IAR*	R^2
1980 – 1990	0.08	−0.01	0.00	0.02	−0.05	0.07	**−0.42**	0.17	**0.31**	−0.06	**0.21**
1990 − 2000	0.03	0.02	0.01	−0.05	−0.13	0.08	**−0.47**	0.18	**0.39**	−0.05	**0.27**
2000 − 2010	−0.09	−0.06	0.11	−0.19	**0.34**	−0.08	0.12	−0.07	−0.10	0.02	0.16
2010 − 2020	−0.16	−0.19	**0.21**	**−0.25**	**0.42**	**−0.28**	0.15	**−0.22**	**−0.20**	0.15	**0.31**

Other particularities could be observed if the analysis would go down to the regional level. Given the share of large population countries in the developing countries (China and India in the first place), some correlations can be nuanced. Broadly speaking, however, the analysis presented confirms *the clear role of population growth* in the dynamics of contemporary urban agglomerations and *the ambiguous role of the level of development* expressed in terms of gross domestic product. The latter becomes important where it is associated with maximum diversification of activities, especially those based on creativity and innovation, as is the case in Western countries where the 'smart city' concept is becoming increasingly concrete. The other factors may be of episodic importance at regional level, depending on how long the process of urban agglomeration has been taking place and its consistency. In addition, an increase in the incidence of natural hazards associated with climate change should also be taken into account.

DISCUSSIONS AND CONCLUSIONS

This study demonstrates how complex the analysis of urban dynamics is and how relative the connections with some factors considered *a priori* as determinants can be, both from *a* classical, descriptive perspective and from a systemic-integrative perspective. The dynamic trends highlighted are generally subject to the overall evolution of the demographic system, which is still characterized by exponential growth in the less developed countries, but is forced to adapt in countries experiencing stagnation or decline. The contradictions between expectations that the dynamics of urban systems should conform to the geosystemic components and the reality of opportunism generated by key factors of economic development, such as the presence of resources or strategic location, may be a cause for reflection in terms of the long-term effects of population concentration in 'unsuitable' areas, which are subject to major risks. *Adaptation strategies based on rigorous planning*, taking existing vulnerabilities into account, are needed everywhere. Whether we are talking about dynamic agglomerations in the middle of a desert or formed by the accumulation of huge population masses in densely populated areas, or about agglomerations that have been in decline for decades (e.g. Central and Eastern Europe; Muntele, 2021). For the latter case, trends of socio-spatial change (industrial restructuring, gentrification/degradation of old neighborhoods, socio-economic polarization) have been observed, which are still insufficiently controlled by strategic planning, essential in managing urban decline (Scott & Kühn, 2012).

It is difficult to answer the *dilemma of spatial expansion/compact concentration.* However, the space occupied by the urban agglomerations under consideration is tiny on a global scale. There are studies which indicate a significant reduction in traffic and hence in greenhouse gas emissions in the compact development model. Some studies indicate a reduction of up to 20-40% in road traffic and 7-10% in emissions using a plausible set of assumptions (Ewing, et al., 2008). Adapting to metropolitan sprawl is a major challenge of the contemporary world especially in the context of globalization and deepening institutional decentralization (Woltjer, 2014). Controlling the suburbanization process becomes imperative, with the focus of strategic planning shifting from the center (usually with symbolic relevance for brand image) to the increasingly fragmented and differentiated periphery. Understanding the regulatory mechanisms of the center-periphery dynamics becomes absolutely necessary to provide adequate institutional responses. The huge share of the population living in interaction with a large urban agglomeration (44% globally) calls for a primary attention to urban-rural relations. The option for polycentric development within national urban systems is in line with the orientation of economic systems towards higher-level functions based on creativity and innovation in a multicultural context. It has already become a reality in Northwest Europe or North America. The chaotic expansion of compact and monocentric cities in Southern Europe is considered a failure of polycentric development strategies (Salvati, Carlucci, & Grigoriadis, 2018)and should give food for thought to planners and decision-makers in the transition states in the Eastern part of the continent. The organization of urban networks into nodes of production with discontinuous and dispersed morphology, based on local competitiveness, urban hierarchies and neoliberal globalization is preferable to autarkic or chaotic developments (Herrschel, 2018). The coming decades will gradually reveal which of the urban systems in transition or emerging states will have adapted to what seems to be the most advanced option. The patterns of evolution and the causes of change can be highly personalized, requiring the diagnosis of carefully selected case studies and locally appropriate public policies (Grigorescu, et al., 2012).

The *rapid growth of urban agglomerations in developing countries* remains problematic and challenging (90% of urban population growth in the immediate perspective will occur here). Providing with jobs, housing or urban infrastructure will induce massive pressure on land management, causing spatial inequities, often against the principles of sustainable development (Wei & Ewing, 2018). The prospect of expanding the occupied area and intensity of spatial use will lead to increasingly intense challenges from extreme climate events (Wernstedt & Carlet, 2014). Land may become a scarce vital resource in overpopulated areas of Asia or Africa, with effects on ensuring sustainable social development rarely addressed and little known. The causal relationships between urban sprawl and spatial inequalities are rarely addressed, motivated by the scarce availability of information. More emphasis is placed on environmental implications but social sustainability is lost sight of, whose processes, mechanisms are vaguely deciphered, requiring the development of appropriate theoretical models to understand what are the risks of an out of control urban dynamics.

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