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A multilevel portrait of shrinking urban Russia

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Clémentine Cottineau

A multilevel portrait of shrinking urban Russia

- The social sciences have had to describe all types of population growth in the XXth century. This led for example to the development of the models of demographic transition [Notestein, 1945] and of urban transition [Zelinsky, 1971]. In the XXIst century, there seems to be a large share of processes which are affected by demographic shrinkage in the world, and they occur at every geographical scale. However, spatial forms of shrinkage differ from growth processes [Brunet, 1980], and new questions emerge from situations which used to be characterized by growth.
- Discussions about the specificity of the contemporary regional and urban shrinkage, seen as a long term perspective (instead of the cyclical ups and downs of the XXth century), gave rise to a new research field in the 1970s in Germany, popularised in the 1990s and 2000s under the labels of *Schrumpfung* and *shrinkage* [Florentin *et al.*, 2009; Baron *et al.*, 2010]. The development of this research field in Europe, and especially in Germany, is linked to the combination of the magnitude of shrinkage in East Germany after the reunification, and the presence of a school of thought proposing to view shrinkage as an opportunity to create new spaces and new uses of urban space [Florentin *et al.*, 2009, §7; Müller; Siedentop, 2004]. Finally, this theme benefited from the publicity given to the work of P. Oswalt and his team. This research group produced the first contributions on the phenomena at the world scale: an atlas of shrinking cities [Oswalt, Rieniets, 2006] and a comparison of four case studies throughout the world, embedded in a theoretical framework giving way to public policy recommendations [Oswalt, 2006]. Eventually, reports for the European Commission contributed to institutionalise this research field into the academic landscape in the 2000s and 2010s.
- The terminology of shrinkage tended to converge in English and German, but still fluctuates in French, where the terms déclin (decline), rétrécissement (shrinkage), and décroissance (decrease) persist [Baron et al., 2010]. In Russian, several adjectives are also used to describe shrinkage: сокращающийся (which evokes contraction), убывающий аnd сжимающийся, insisting respectively on the population decrease or on a demographic decrease together with a process of spatial shrinkage [Averkieva, 2014]. Despite the conceptual identification of shrinkage, its application in empirical studies varies greatly with respect to the spatial and temporal scales of urban delineation [Cunningham-Sabot et al., 2010; Châtel, 2011].
- Indeed, the choice of an urban definition impacts the extent to which the four processes of urban shrinkage can be observed and measured: deindustrialisation, ageing (the second demographic transition), the post-socialist transition and suburbanisation [Prigge, 2005, p.43] are unevenly distributed in space. Suburbanization can even be considered irrelevant when choosing a functional urban definition (that includes commuters living outside of the dense areas of the city), in which suburbanisation is a simple redistribution of population within the city, from the central area to the periphery.
- The temporal definition of shrinkage is also decisive to characterise this process as a trend and not a regular fluctuation of urban population. E. Cunningham-Sabot *et al.* consider a region to be shrinking if « *it looses a significant share of its population during a time period of a generation or more.* A minimal duration of 20 to 30 years is in fact necessary to appreciate demographic trends that often come in cycles » [2010, p.84].
- We use this theoretical framework to study and compare the evolution of cities in the Russian Federation since the 1990s. In fact, despite the inclusion of Ivanovo in the case studies of P. Oswalt's seminal work [2006], studies of Russian urban shrinkage have been scarce. However, the magnitude of the current phenomenon in Russia and the combination of demographic and economic factors of shrinkage make it a particularly interesting case to study shrinkage, as well as to link the regional and urban scales of the process. Moreover, the immensity of this territory

(17 million km²) accentuates the differentiation of dynamics between East and West, North and South. The spatial heterogeneity of demographic trends can therefore be evaluated at a quasicontinental scale that corresponds to the relational space of systems of cities [Pumain, 1997]. In this paper, we propose to explore the question of what makes urban Russia shrink since 1991. We start by measuring the phenomenon at three territorial scales (section 1): the State, the regions and the cities. These measures of demographic shrinkage are then confronted to urban attributes through a multilevel analysis in an attempt to identify potential factors of differentiation of demographic dynamics, according to the geographical situations of Russian cities since 1991 (section 2).

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- Demographic indicators are favoured, because of their availability for a large range of cities and regions. Moreover, the number of residents is not only one of the main criteria for subsidy allocation in the city and region levels, it also summarises a lot of other characteristics (jobs, economic specialisation, housing, density, etc.) usually correlated with the total population of the territory under scrutiny [Pumain, 1997]. Finally, demography seems to have become the major dimension of urban shrinkage in the former socialist block. The transition to the market economy is no longer sufficient to explain the new changes in urban space, and Eastern cities share with the Western ones many demographic challenges [Steinführer, Haase, 2007].
- We focus our analysis at the scale of the country and its system of cities, which has not been extensively explored in the literature on shrinking cities. This literature mainly focuses on the local scale by means of case studies [Killisch, Siedhoff, 2005]. However, some recent research has tackled demographic shrinkage at the system level using urban data for the European [Turok, Mykhnenko, 2007; Baron *et al.*, 2010; Avila de Sousa *et al.*, 2012; Wolff, Wiechmann, 2013], German [Châtel, 2011], French [Wolff *et al.*, 2013] and Russian [Slepukhina, 2014] systems. Those references will help comparing the magnitude and nature of urban shrinkage processes in different contexts, as well as identifying the impact of definition choices (spatial and temporal delineation of the city) on the description of shrinkage in the urban world. Eventually, our approach is complementary to the previous studies by its simultaneous focus on demographic dynamics at several scales and the harmonised definition of cities in Russia over the last twenty years in Russia (cf. box 1).

1. Measures of demographic shrinkage in Russia

Research on shrinking cities and shrinking regions started around case studies and their generalization on the basis of common processes. The most striking examples of these processes are the deindustrialisation experienced in Europe in recent years and the second demographic transition [Van de Kaa, 1987] leading to population ageing and a positive feedback loop reinforcing demographic shrinkage [Grasland, 2010]. In addition to this more or less local and qualitative knowledge, we think that it is interesting to test hypotheses more systematically at a lower scale (section 2). Before testing models of growth and shrinkage factors, we provide a multi-scale spatial description of the Russian population loss in the national (1.1), regional (1.2) and urban (1.3) contexts.

1.1. Less and less Russian citizens

The national population loss is the most striking and commented aspect of Russian demographic shrinkage. Since 1991, Russia has lost 4.6 million citizens, who represent 3.1% of its 1991 population (fig. 1). The minimal population was reached in 2009 (142.7 million) and its number has been growing since (143.7 million in 2014).

Population in millions 160 Russian **Federation** 140 120 **High Projection Average Projection Low Projection** 100 RSFSR 80 60 1880 1900 1920 1940 1960 1980 2000 2020 2040

Figure 1. Demographic shrinkage since 1991 in Russia

Source: GosKomStat, 2014, www.gks.ru

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Two out of the three demographic scenarios produced by the Russian statistical agency (GosKomStat) predict that shrinkage will persist up to at least 2030. According to demographers, the causes of this population loss are not new, even if it coincided with the economic and political transition following the Soviet Union crash. Those causes are structural. From the natural side of the demographic evolution, we can pinpoint the failure of the health care system and the decreasing life expectancy since the 1960s [Blum, Lefèvre, 2006], while the number of Russian births converges towards the European low standard of less than two children per woman since the end of the 1980s. Consequently, the low birth rate and rather high mortality cannot not be attributed to the systemic crisis experienced by the Russian society during the transition [Vichnevski, 2009]. This natural demographic pattern is thus not uncommon in developed countries (although mortality is unusually high).

In 1992, the natural balance became negative. It was compensated for a time by the migratory balance. Yet, this balance decreased during the 1990s, when the "repatriation" of Russians from the other Republics of the Former Soviet Union started to diminish (it accounted for 80% of migration flows between 1989 and 2007 [Vichnevski, 2009]). In recent years, the net migration recorded in Russia was stable and low (+200 000 every year on average between 2000 and 2008, while the natural balance has continuously been inferior to -400 000). Therefore, A. Vichnevski [2009] sees only two alternatives for demographic prospects in Russia: either accepting depopulation, or attracting international migrants. This second option looks problematic to this author in a society unprepared for such a social and ethno-cultural upheaval.

Finally, the continuous fall of fecundity and the dramatic episodes affecting the Russian population have produced a general context of lasting shrinkage, characterized by the ageing of society as well as a paradoxically short life expectancy. However, this context varies greatly across regions in the Russian Federation.

1.2. Regional differentiation of demographic shrinkage

As pointed out by A. Gaye [2006] for the time period 1989-2002, there seems to be two gradients structuring the regional disparities of demographic shrinkage (fig. 2). On the latitude axis, one roughly distinguishes the East, composed of regions less populated in 2010 than in 1989 (East of the Tomsk and Tyumen oblasts), and the West where one can still find some growing regions. On the longitude axis, we observe the opposition between the shrinking

North and the demographically dynamic South (particularly Caucasus). Some exceptions to this global scheme remain: Moscow (the city and the oblast are aggregated for this regional study) is growing much faster than its neighbours; the regions located near oil and gas basins appear very attractive (Tyumen, Bashkortorstan, Tatarstan); and Chechnya on the contrary obviously differs from the regional growing trend of Caucasus because of the wars that affected this territory in the 1990s and 2000s.

The North-South gradient reflects different natural demographic regimes in Russia. They are mainly inherited from past cultural behaviour regarding fecundity, which Soviet integration has not altered in 70 years of existence [Blum, 2004]. Birth rates in the North are comparable to those in most European countries, while we observe significantly more children per woman in the Caucasus.

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From West to East, we can see a differentiation of the net migration balance. This balance is negative in the East, due to the departure (or the absence of arrivals) of young educated adults, in opposition to what happened during the Soviet period. According to V. Kontorovich [2000], this new trend can be explained by: the harsh continental climate and its consequences on health, the decrease of monetary and non-monetary subsidy to workers in the Far East after the transition to liberal economy, the cost of living in this isolated area, as well as the lack of public equipment (security, housing, education, communication, etc.), Finally, regional inequalities, already high in 1991, showed a clear trend towards economic divergence, even if fiscal redistribution has proven useful to restrain this divergence [Bradshaw, Vartapetov, 2003]. Public policies tend to favour migrations to tackle the problem of territorial disparities. However, the result of such policies is very uncertain [Kontorovich, 2000; Vichnevski, 2009]. Bradshaw and Vartapetov [2003] note that the existence of a large agglomeration in a region is frequently associated with economic success. This is why we consider the observation at those two levels (the city and the region) as an interesting approach to the study of shrinkage, allowing for the building of alternative strategies of shrinkage governance and territory rebalancing [Slepukhina, 2014]. This author suggests that the coordination of policies at all administrative levels should be achieved in order to create regional polycentric networks articulated around engine-cities. Those cities could then stimulate the growth of less dynamic cities and make it possible for less competitive cities to shrink « smartly ». This policy would also avoid the polarisation of the whole country around Moscow.

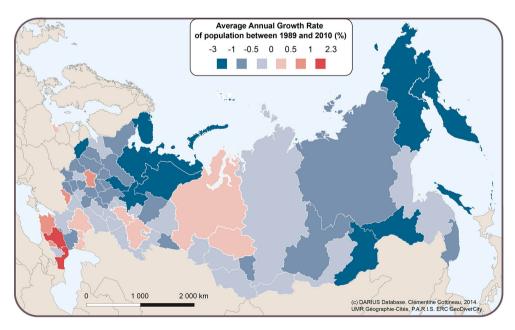


Figure 2. The uneven distribution of regional population growth

Source: Russian and Soviet Censuses (1989, 2002, 2010). DARIUS, 2014.

Finally, even if « thinking the link between processes at the regional and city level is hard and supposes to tackle definition problems and data availability » [Cunningham-Sabot et al., 2010,

p.89, translation], those two geographical levels appear crucial to the understanding of recent shrinkage. For a discussion of problems associated with data collections and harmonisation, see box. 1. The next section is dedicated to the presentation of measures of shrinkage in Russian cities.

1.3. Shrinking cities are dominant in contemporary Russia

In order to describe the shrinking processes affecting urban Russia, we proceed in two steps: first, we compare the magnitude of the contemporary Russian shrinkage to its historical levels and other systems in the world; then we differentiate three types of urban demographic dynamics by combining natural and migration balances over the last twenty years.

An unprecedented scale of shrinkage

Russia has experienced a lot of « *demographic catastrophes* » in the past [Polyan *et al.*, 2001; Nefedova, Treivish, 2003]. Yet, the magnitude of the current urban shrinkage is unprecedented. The share of shrinking cities had never reached more than 14% (between 1897 and 1989) and is comprised between 2/3 and 3/4 since 1989 (tab. 1).

Table 1. The unprecedented scale of urban shrinkage in Russia

Time periods	1897-1939	1926-1939	1939-1959	1959-1970	1970-1979	1979-1989	1989-2002	2002-2010
Number of shrinking cities	20	14	32	86	101	84	514	589
Total number of cities	156	257	402	644	725	761	793	793
Share of shrinking cities (%)	12.8	5.4	8.0	13.4	13.9	11.0	64.8	74.3

Source: DARIUS, 2014.

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Russia appears to be the most shrinking urban system in the world, even though Germany and Japan are usually cited to illustrate studies on urban shrinkage at a national scale. Their share of shrinking cities is indeed high (respectively 46 and 58%, cf. tab. 2) but significantly lower than that of Russia (> 70%). This non-exhaustive table allows for a first evaluation of the impact of city definition on the level of measured shrinkage, in Europe for example. The most interesting comparison here seems to be between Russia and Germany. The latter is where the shrinking paradigm emerged in the 1970s and developed the more rapidly. Shrinkage is presented as an important issue which needs to be triggered in terms of public policy (planning and social welfare), even if the majority of cities are still growing. In Russia, although the public debate is not as important, the impact of twenty years of shrinkage in 70% of cities should be important and lasting on society and its territory.

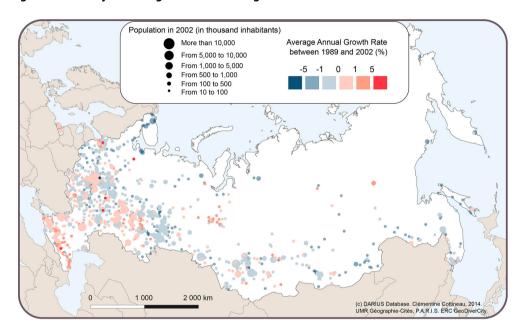
Table 2. The most shrinking urban system

Area	Urban delineation	Time period	N	Share of shrinking cities, %	Reference
Russia	Agglomerations > 10.000 inhab	1989-2010	793	70.5	DARIUS, 2014
	Local Units	2002-2010	1041	72	[Slepukhina, 2014]
Japan	Local Units > 20.000 inhab	1990-2005	989	57.5	www.citypopulation
Germany	Agglomerations > 10.000 inhab	2000-2010	971	46	[Chatel, 2011]
France	Agglomerations > 5.000 inhab	1990-2008	506	20	[Avila de Sousa et al., 2012]
	Urban areas	1975-2007	354	19.5	[Wolff et al., 2013]

Europe	Agglomerations	2000-2005	310	25	[Turok, Mykhnenko, 2007]
	Local Units ¹ > 5.000 inhab.	1990-2009	7035	20	[Wolff, Wiechmann, 2013]

The location of shrinking cities reproduces the geographical pattern of the regional demographic differentiation. Cities tend to shrink in shrinking regions and to grow in growing regions on average, as it can be observed in Europe [Baron *et al.*, 2010]. However, some diversity of situations exists in the different regions, which is reflected by the correlation coefficient of +0.42 between urban growth and regional growth.

Figure 3. Globally matching trends at the regional and urban levels



Source: Russian and Soviet Censuses (1989, 2002, 2010), DARIUS, 2014.

- Urban shrinkage is dominant nowadays in Russia, but has different meanings as to why a city looses population. We distinguish three types of shrinkage. Based on a crossing of the natural balance and net migration, we identify (fig. 4):
 - **Shrinking cities** *per se* are those in which natural balance and net migration are simultaneously negative. Their number has grown continuously since 1991, from 15% of all cities to nearly 50% in 2010. They are over-represented in the North and east of Russia, and most of the smallest cities belong to this category (fig. 5).
 - **Drifting cities** are cities losing population because of net out-migrations. Their natural balances are positive, but non compensated by the drift of people migrating out of the city. They represent less than 10% of total cities during the two decades under study. This small share of drifting cities shows that the main cause of shrinkage during the 1990s and 2000s was not migration, but a simultaneous lack of births and high mortality.
 - Finally, **Depopulating cities** are losing population because their positive net migration is not sufficient to compensate a negative natural balance. The relative evolution of this category of cities is opposed to that of drifting cities. They were a minority of 10% in 1991 but multiplied their proportion by four in ten years, after representing 15% in 2010.

Number of cities...

... growing
... shrinking
... drifting
... depopulating

200

1990
1994
1998
2002
2006
2010

Figure 4. Three types of population loss in Russian cities

Source: MultiStat.

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At the same time, the percentage of growing cities have evolved symmetrically from shrinking cities up to 2004. After representing the majority of the urban landscape in 1991 (63.8% of all cities), their proportion fluctuated around 20% between 1999 and 2005. The 2000s were a period of recovery for this category of cities, followed by a new fall in 2010. This means that only one out of four cities in Russia has had a growing number of inhabitants at this date.

We observe that the natural component of shrinkage is the major structural factor of the decline in population, and the most difficult to trigger. Therefore, the migration component of demographic evolution is the one that differentiates cities, since the end of urban transition and the low level of rural migrations to the cities [Becker *et al.*, 2012]. Indeed, the cities as a whole have experienced a global negative natural balance since 1992, but their net migration balance has remained positive throughout the 1990s and 2000s. The distribution of migrations is unequal and favours Southern and Western cities (as well as cities according to their size range [Polyan *et al.*, 2001]).

To summarize, two different trends have been observed recently in urban Russia: a cyclical effect in the repartition between depopulating and drifting cities; and a medium term trend towards the importance taken by shrinking cities at the expense of the growing cities in proportion.

Population in 2002 (in thousand inhabitants)

More than 10,000
From 5,000 to 10,000
From 500 to 1,000
From 500 to 1,000
From 100 to 500
From 10 to 100
From

Figure 5. Location of cities in 2002 according to their demographic evolution

Source: MultiStat. DARIUS, 2014.

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2. Multi-scalar factors of urban shrinkage

After describing the magnitude of shrinkage in Russia, we aim at identifying the typical profiles of cities losing population, in order to validate some theoretical hypotheses and thus help designing public policies at the national or regional scales. Such policies have proven effective in the reduction of economic inequalities between regions in the last decades [Bradshaw, Vartapetov, 2003]. At the city level, we try to specify the profiles over-represented among shrinking cities in order to identify the key elements of demographic dynamism and depression in the system of Russian cities over the last two decades.

2.1. Attributes of shrinking cities

Studies dedicated to the dynamics of systems of cities have shown that one of the main differences between cities relates to the functions they perform [Pumain, 1997]. The most generic urban functions range from territorial functions (control over a political territory) to central functions (provision of goods and services to nearby populations) and specialised functions (resource extraction, industry, transport, etc.). We collected information characterising cities functionally: the status of the capital city, the specialisation into a single industry², access to railways and airports³, the presence of accessible resources (coal, oil and gas [Flanagan, Schear, 2008, p.178]). We aim at testing quantitatively the observations made by Lappo and Polyan about the kind of cities experiencing demographic difficulties. They say that the common characteristics of shrinking cities are to be small district centres and industrial centres far away from communication routes [Lappo, Polyan, 1999, p.42].

In order to test these properties, we built five models of multivariate regression applied to two inter-census periods (1989-2002 and 2002-2010). The variable « to be explained » is the average annual growth rate of cities, while the « explaining variables » can be categorized into four groups: territorial and specialized functions (models 1), transportation accessibility (models 2), access to sub-surface resources (models 3) and regional evolution variables (models 4). Models 5 gather significant variables from the previous models. The hypothesis driving this selection is that some urban attributes play a positive role in city growth (to be a capital city, to have access to transportation and resources demanded on global markets, to be in a growing region still not fully urbanised) while other attributes are linked to obsolete innovation cycles and are associated with more systematic shrinkage (coal extraction, railway accessibility, shrinking region without rural possibility for migration). Results of all five models were produced on a set of 793 agglomerations and are presented in table 3.

Model 1 : $AAGR_{m-n,i,j} = a_0 + b_1 CAP_i + b_2 MONO_i + \varepsilon_i$

Model 2 : $AAGR_{m-n,i,j} = a_0 + b_1 RAIL_i + b_2 AIRPORT_i + \varepsilon_i$

Model 3 : $AAGR_{m-n,i,j} = a_0 + b_1 COAL_i + b_2 GAS_i + \varepsilon_i$

Model 4 : $AAGR_{m-n,i,j} = a_0 + b_1 AAGR_{m-n,j} + b_2 URBR_{m,j} + \varepsilon_i$

 $Model \ 5: AAGR_{m\cdot n,i,j} = a_0 + b_1 \ CAP_i + b_2 \ MONO_i + b_3 \ AIRPORT_i + b_4 \ GAS_i + b_5 \ AAGR_{m\cdot n,i,j} + \epsilon_i$

with: $AAGR_{\text{m-n,i,j}}$ the average annual growth rate of city i, located in region j, between years m and n, in %.

CAP_i being 1 if city i is a capital city, 0 otherwise.

MONO_i being 1 if city i is specialized in a unique industry, 0 otherwise.

RAIL, being 1 if city i is located less than 10 km away from a rail track, 0 otherwise.

AIRPORT; being 1 if city i has an airport, 0 otherwise.

COAL, being 1 if city i is located on a coal basin, 0 otherwise.

GAS_i being 1 if city i is located on an oil and gas basin, 0 otherwise.

AAGR_{m-n,i}the AAGR of region j,between years m and n, in %.

URBR_{mi}the urbanization ratio of region j, at the date m, in %.

 ε_i the individual error term summarising informations kept out of the model.

Table 3. Multiple regressions on urban average growth rates

Estimation of coefficients 1989-2002	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept a ₀	-0.29 ***	-0.39 ***	-0.17	0.05	-0.48 ***
CAP = 1	0.43 **				0.88 ***
MONO = 1	-0.04				-0.04
COAL = 1		0.03			
GAS=1		0.65 ***			0.77 ***
RAIL = 1			-0.01		
AIRPORT = 1			-0.08		-0.49 **
URBR _j				-0.00	
AAGR _j				-0.02	0.02
R ² , %	1.01	4.97	0.00	0.00	9.50
p-value	0.01398	6.87E-11	0.8144	0.7589	1.58E-15

Estimation of coefficients 2002-2010	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept a ₀	-0.51 ***	-0.57 ***	-0.53 ***	0.70 ***	-0.66 ***
CAP = 1	0.68 ***				0.39 *
MONO = 1	-0.23 **				-0.27 **
COAL = 1		0.03			
GAS=1		0.35 ***			0.39 ***
RAIL = 1			-0.01		
AIRPORT = 1			-0.49 ***		-0.32 *
URBR _j				-0.00	
AAGR _j				-0.08 *	0.08 *
R ² , %	5.21	2.32	2.60	0.55	10.0
p-value	6.59E-10	1.99E-05	3.42E-06	0.07301	2.74E-16

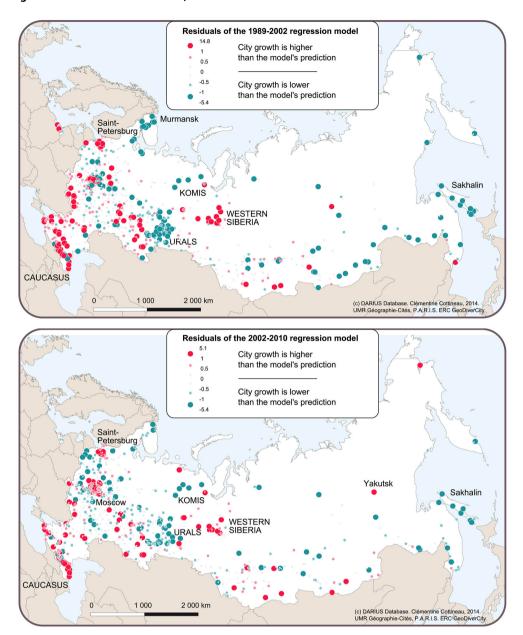
Italics: non-significant coefficients. "***" = significant coefficient with an error rate < 0.1%. "**" = error rate < 1%. "*" = error rate < 5%

Source: DARIUS, 2014.

We first note that urban attributes and regional dynamics are not able to statistically explain a large share of the variation of average annual growth rates ($R^2 \le 10\%$). However, all models (except the one with only regional dynamics) are significant for at least one time period. This

- leads to consider other effects, but still confirms the link hypothesised between urban functions and demographic dynamics.
- Economic functions appear to be the most significantly associated with growth (and shrinkage): for example, a capital city grows at a rate from 0.4 to 0.7 points higher than a non-capital city between 1989 and 2010 (all other characteristics being equal).
- Similarly, to be located on an oil and gas basin is associated with the faster demographic growth for cities. This result is not surprising if one looks at the importance of this resource in Russian exportations over the last two decades (up to 60% for their value [Garanina, 2009]). What we learn from models 2 and 5 is that the statistical impact of oil and gas in cities have been greater between 1989 and 2002 (+0.65 points) than afterwards (+0.35).
- Urban demographic dynamics appeared independent from transportation infrastructures in the 1990s (model 4). However, in contradiction with our hypothesis, to host an airport is associated with a lower average growth rate for a Russian city in the 2000s. We think that this counterintuitive result comes from a data bias: we considered all airports as equivalent, regardless of their importance (number of routes, of passengers, type, etc.). Therefore, the numerous shrinking cities in the eastern part of Russia, which are not connected to the railways or roads, but to a small airport, are put in the same category as hubs and large transportation centres. We would have better triggered accessibility measure by using an index of centrality in the airline network, but such data were unavailable for this study.
- Finally, regional data appear contradictory in their statistical associations: the coefficient of the regional growth rate is significantly negative in the non-significant model 4, and significantly positive in the significant model 5 when the effects of other variables are isolated.
- Given the low explaining power of these regression models, we focus on residuals because they still account for 90% of the total variance of urban average annual growth rates⁴. We observe strong concentrations of negative residuals in the Northern part of Russia (Murmansk oblast and Komis Republic for example), in the Urals and Far East (fig. 6). Positive residuals are concentrated in the Caucasus and around metropolises. We interpret those locations by the natural demographic dynamism of the former and the economic dynamism of the latter.

Figure 6. Residuals of models 5, 1989-2010



Source: DARIUS, 2014.

In any ways, functional urban attributes alone are not sufficient to represent the magnitude of 37 shrinkage in Russia, or they are prone to play a different role in different parts of the country. If this is the case, multilevel regression models can help reveal such relations.

2.2. Regional variations of urban attributes effects

38 Over the last two decades, regional fixed effects have been significant⁵. When adding urban attribute variables (models 2 and 3), we reduce the remaining variance (pseudo-R², cf. [Szmaragd, Leckie, 2011]) up to 34.3% between 1989 and 2002 (tab. 4). Interestingly, for example, being a capital city can be associated with a positive or a negative statistical effect across the different regions. Moreover, this attribute tends to be the most varying, especially between 1989 and 2002 (measured by the standard deviation of regional residuals).

Model 1 : AAGR_{m-n,i,j} = $a_0 + r_{0,j} + \epsilon_{i,j}$

 $Model\ 2: AAGR_{m-n,i,j} = a_0 + b_1\ CAP_i + b_2\ MONO_i + b_3\ AIRPORT_i + b_4\ GAS_i + r_{0,j} + \epsilon_i$

Model 3: $AAGR_{m-n,i,j} = a_0 + b_1 CAP_i + b_2 MONO_i + b_3 AIRPORT_i + b_4 GAS +$

 $r_{0,j} + r_{1,j} CAP_{i,j} + r_{2,j} MONO_{i,j} + r_{3,j} AIRPORT_{i,j} + r_{4,j} GAS_{i,j} + \varepsilon_i$

with: AAGR_{m-n,i,j} the annual growth rate of city i, located in region j, between years m and n, in %.

CAP, being 1 if city i is a capital city, 0 otherwise.

RAIL, being 1 if city i is located less than 10 km away from a rail track, 0 otherwise.

AIRPORT, being 1 if city i has an airport, 0 otherwise.

GAS, being 1 if city i is located on an oil and gas basin, 0 otherwise.

 $r_{\text{0,j}}\text{the}$ regional residual summarizing the effect of belonging to region j for a city i in terms of AAGR

 ε_{ij} the individual error term summarizing informations kept out of the model.

Table 4. Multilevel regressions on urban growth rates

Coefficients 1989-2002	Model 1	Model 2	Model 3	Standard-deviation of regional residuals - Model 3
Intercept a ₀	-0.33 ***	-0.51 ***	-0.53 ***	0.48
CAP = 1		1.11 ***	0.77	1.63
MONO = 1		0.11	0.06	0.54
GAS=1		0.51 ***	0.48 ***	0.71
AIRPORT = 1		-0.69 ***	-0.41	1.20
Pseudo-R ² , %	-	-7.9	-34.3	-
Share (%) of inter- regional variance	32.8	31.3	31.9	-

Coefficients 2002-2010	Model 1	Model 2	Model 3	Standard-deviation of regional residuals - Model 3
Intercept a ₀	-0.55 ***	-0.75 ***	-0.78 ***	0.40
CAP = 1		0.56 ***	0.46 ***	0.47
MONO = 1		-0.13	-0.08	0.38
GAS=1		0.38 ***	0.43 ***	0.53
AIRPORT = 1		0.27 ***	0.37 ***	0.73
Pseudo-R ² , %	-	-10.0	-20.9	-
Share (%) of inter- regional variance	30.5	30.0	28.48	-

Source: DARIUS, 2014.

39

During the last decade, everything being equal with respect to a city's attributes and regional location, the specialised function of monocity (*monogorod*) is not associated with a significant variation of average growth rates. This finding is interesting because the list of monocities was created in order to identify cities vulnerable to decline and shrinkage, and to help them reshape their economic basis through public subsidies. We can therefore conclude that classical urban functions (such as administrative status, infrastructure and resource accessibility) are more robust to represent variations in demographic dynamics. We also note the persistent adequacy between regional and urban evolutions. This study enables to recall the importance of taking into account the diversity and differentiation of the territory with which cities interact for policy purposes, especially in a shrinkage context.

Conclusion

- This paper was an occasion to prove the interest of looking at urban shrinkage from a systemic point of view, using harmonised data at different scales. We were able to measure the extraordinary magnitude of urban shrinkage experienced by Russia recently (when compared to other systems in time and space). This process varies in its manifestations across the different parts of the country, and in terms of the dominant cause for shrinkage (natural balance or net migration). Through statistical modelling, we isolated the potential influence of several urban functions and their regional differentiation.
- Shrinking cities nowadays are looked at because they represent "projection spaces" for future demographic trends and governance (Florentin *et al.*, 2009, § 76). Therefore, a quantitative multi-level description of the phenomenon makes it possible for us to go deeper into the

understanding of these cities' dynamics and try to orientate possible political scenarios aiming at rebalancing the Russian territory. Yet, it needs to be complemented by more qualitative approaches, taking local stakes into account [Lappo, Polyan, 1999; Slepukhina, 2014; Averkieva, 2014].

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Notes

- 1 Except for France: agglomerations (*Unités Urbaines*) of more than 5000 inhabitants.
- 2 According to the official list of 342 monogoroda http://www.veb.ru/common/upload/files/veb/br/mono/list342.pdf
- 3 Reference: USGS, 2001 for railways and coal basins www.pubs.usgs.com Flightstats for aiport locations http://www.flightstats.com/
- 4 Logically, the spatial autocorrelation of the residuals and of the raw average growth rates are similar: values for the Moran's index are respectively 0.11 and 0.9 in 1989-2002 and 0.11 and 0.12 in 2002-2010.
- 5 Significant likelihood ratio tests on the likelihood values for linear null model with one and two levels. For details about the measures and implementations in R, cf. [Szmaragd, Leckie, 2011].

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Résumés

The demographic shrinkage of Russia, as measured by harmonized data on different geographical scales, appears unprecedented, geographically and historically. Using multivariate and multilevel statistical analysis, we show that shrinkage in cities is associated with different urban functions, and demonstrate the territorial disparity of their influence. This sophisticated description of urban and regional attributes of shrinkage provides insights into the probable consequences of different demographic policies in tomorrow's Russia.

Portrait de la Russie urbaine en décroissance

La décroissance démographique de la Russie, mesurée à plusieurs échelles géographiques par des données harmonisées, se révèle d'une ampleur inégalée dans le temps et dans le monde. À partir d'analyses statistiques multivariées et multi-niveaux, on montre dans cet article la disparité des fonctions urbaines associées à cette décroissance et la disparité territoriale de leur influence. Cette description raffinée des attributs urbains et régionaux de la décroissance permet d'évaluer les conséquences probables de différentes politiques démographiques sur le territoire russe.

Entrées d'index

Mots-clés: shrinking cities, décroissance, Russie, système de villes, multi-niveaux *Keywords*: shrinking cities, shrinkage, Russia, system of cities, multilevel