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Using small spatial units to refine our perception of rural America

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Abstract More than half of the US rural population lives inside metro or micropolitan areas and even at more disaggregated scales, such as the census tracts, most spatial units mix rural and urban population. At a national scale, only 30% of the country are inhabited by 100% urban or 100% rural population, implying that more than two third of the US territory are somewhere in between both situations. As the rural/urban dichotomy appears today to be blurred by the emergence of new phenomena like rurbanization or exurbanization, our perception of rural America may be somewhat twisted and the reality of rural areas underplayed. This paper focuses on using finer-grade spatial units such as the census blocks and block groups, in order to provide new elements about the extension, localization and characteristics of rural America as well as about its inner dynamics. To that end, we analyze and process geographical and social data at these two levels of information, and use population density as a main factor of analysis. This allows us not only to propose new measurement of the extent of rural space in the USA but also to propose a new vision of its spatial dynamics by studying how several social indicators such as income, median age or sex ratio reveal regional and micro-regional variations and situations in the rural part of the US.

Introduction

Defining rural and urban areas is a difficult tasks are many definitions exist internationally and even at the national level. In the US for instance, three major agencies (the Census Bureau, the Office of Management and Budget and the Department of Agriculture) give a different definition of the rurality, with the result that the rural population is estimated at 19.3, 14.99 or 16.55% of the total 2010 population.[1] Furthermore, once adopted one of the definitions, most analyses of the rural population dynamics of the US fall into what Isserman (2005) called the "county trap", meaning that they rely on statistics at the level of counties (using non-micro/non-metropolitan areas as a proxy for rural areas), although it is well known that those areas incorporate a diversity of situations: the Grand Canyon, for instance, lies inside the Flagstaf metro area, and according to the Census

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[1] See a synthesis of the three ones at https://www.ruralhealthinfo.org/topics/what-is-rural.

2010 results, more than half of the US rural population lives inside metro or micropolitan areas (US Bureau of Census 2012). What's more, even if they help painting the overall portrait of rural America, such data generally put a mantle of uniformity on the rural counties whereas most of them are extensive and may see very different dynamics in different part of their territories.

Even at more disaggregated scales, such as the census tracts, the situation remains complicated, with a mixture of rural and urban population in the same units. At a national scale, the total cumulated area of urbanized and urban clusters areas is little above 275,000 km^2, or around 3% of the national territory, while the total cumulated area of the counties with only rural inhabitants is only about 2.46 million km^2, or less than 27% of the national territory. The sum of both figures implies that more than two third of the US territory are somewhere in between both situations, composed of a mixture of rural and urban spaces and dynamics, which calls for finer scale of analysis in order to approach them. At the same time, the rural/urban dichotomy appears today to be blurred by the emergence of new phenomena like rurbanization or exurbanization, which make difficult to define and locate clearly the divide between rural and urban areas. As a result, our perception of rural America may be somewhat twisted and the reality of rural areas underplayed.

Our proposal in this paper is therefore to explore if, by using finer-grade spatial units such as the census blocks and block groups, we can provide new elements about the extension, localization and characteristics of rural America as well as about its inner dynamics. To that end, we analyze and processed the geographical and social data at these two levels of information, electing population density as a good proxy when it comes to draw the division between urban and rural areas. This allows us not only to propose new measurement of the extent of rural space in the USA but also to have a new comprehension of its dynamics by studying how several social indicators such as income, median age or sex ratio reveal regional and micro-regional variations and situations in the rural part of the US. Also, by mapping those units, we provide a new vision of these dynamics and of the repartition of different phenomena which currently frame the rural space of the USA.

Rural and urban areas in the US

Rural and urban: two apparently clear but today elusive concepts

The emergence of urban civilizations has resulted in the elaboration of conceptual distinctions of landscape types principally in terms of urban/non-urban (Berque 2011). As "the city" was often surrounded by walls, the distinction between both universes was obvious. Moreover, the two universes had quite different economic activities. This distinction was progressively blurred when cities started to exceed their walls and expand in rural areas, especially after the Second World War. From that time on, low-density settlements (suburbs) were constructed at growing distances from the urban centers and they were inhabited by urban populations, which started to rely on their car to commute from those living areas to their employment. This led to difficulties to classify what is urban (and therefore what is rural). The number of different definitions of urban areas just shows this complexity. As said in introduction, in the U.S., there are at least three different definitions which each yield a different proportion of rural and urban population. The problem is the same when world statistics are calculated, each country having its own definition.[2]

Cities have traditionally been characterized by high population concentrations, secondary and tertiary activities, and soil artificialization.[3] The countryside was a place of sparser settlements where activities and landscapes were linked to agricultural production, and where isolation was often a distinctive feature. Nowadays, the limits of urban areas are very difficult to perceive as urban inhabitants flow in rural areas, eventually maintaining the landscape, but having jobs or activities totally connected with the urban world. Outside the suburbs, the US now display an "exurbanization" front which is a mixture of rural and urban features clearly linked to urban economies (Theobald 2001, 2005; Brown et al. 2005), where some new settlement types like the "ranchettes" of the US West

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[2] See a table with all the national definitions of statistical urban areas in the UNO *Demographic Yearbook* of 2005 (notes from Table 6: https://unstats.un.org/unsd/demographic/products/dyb/dyb2005/notestab06.pdf).

[3] Changes of the land cover where the original soils are covered by hard impervious surfaces.

(Travis 2007) can be identified. Those relativize enduring distinctions between rural and urban since, for example, one of their key characteristic is a low population density (in general considered as a rural feature), even if they are a projection of urban population and activities. In any case, rural and urban areas are increasingly connected and interdependent (Lichter and Brown 2011).

In a similar way, notable differences in landscape which were formerly associated with rural/urban categories cannot any more be linked to economic activities or a specific lifestyle, as the emergence of another concept, the "rurban" shows (Antrop 2000b). The reverse is also true. Economic activities in rural areas are now disconnected from the agricultural production for most part: "*even in the most rural counties the average employment share of manufacturing […] exceeds and the average share of services is several times that of agriculture*". (Schaeffer et al. 2013:89). The resulting blurring of the boundaries between urban and rural is well exemplified by the idea of a "continuum" which underlays the USDA Rural–Urban Continuum Codes which allow to classify counties in a scale of 9 levels from metropoles to "completely rural".[4]

If where the city stops and where the rural area starts is not clear, where both end and where the wilderness starts is not clear either. As Antrop (2000a) reminds us, Ancient Greece and Roman Empire identified four categories of landscape: *urbs* (city), *ager* (country), *saltus* (rangeland) and *silva* (wilderness). Each of these could be linked to a degree of human presence and human intervention on the landscape. Rural areas, which were defined as twofold, one part being the landscape heavily transformed by agriculture (*ager*) and the other territories used for grazing (*saltus*). The wilderness was composed of spaces unused or used only for sporadic activities like hunting. Today, the expansion of suburbs or exurbs in the rural areas is strongly linked with the search for amenities. What people seek in such areas is exactly the "non-city" side, which in general is thought about as "nature" and encompasses a gradient from heavily transformed agricultural areas to pristine landscapes (Berque 2011). Von Reichert et al. (2014:68) underline the importance of the rural characteristics in such

moves: "*Proximity to natural landscapes was valued for its own sake—people expressed a sense of satisfaction, even a spiritual benefit, just knowing that wild lands were nearby: "It's just something about wide open spaces.*". The current rush towards high amenity areas therefore incorporates "rural", "rangelands" and "wild" in the same category of "natural spaces", exemplifying the fact pointed out by some studies that "rural" is a social construction more than a tangible reality (Woods 2009).

The definition of rural America in the US census

As the official statistics in the US generally offer distinctions between urban and rural populations and areas, it is tempting to think that both categories are well defined and that a clear divide may be established between both. The question however is more complex. First, as stated, not all agencies use the same definitions of those terms. The Census Bureau, which data we will use in this paper, even uses a non-definition of the rurality by stating that "*The U.S. Census Bureau defines rural as what is not urban—that is, after defining individual urban areas, rural is what is left*" (Ratcliffe et al. 2016), thus encompassing countryside, rangeland and wilderness in a single category which only distinctive feature is its non-urbanity. What's more, as the same authors show, the definition of what is urban has changed over the twentieth century, which creates distortions when comparing data from different census at a detailed scale. Murdock et al. (2011) point out the various difficulties that both these characteristics create when it comes to analyze the dynamics of rural population.

The definition of urban areas in the census starts by identifying blocks which compose the "urbanized areas" and "urban cluster" categories (Ratcliffe et al. 2016). The first ones are areas grouping more than 50,000 inhabitants. The second ones are areas grouping more than 2500 people but less than 50,000. Those areas may include empty areas within their limits, and aggregate areas which are not adjacent to them using and "hop and jump" criteria which takes into account the accessibility by road of the discontinuous zones. In 2010, 486 urbanized areas and 3087 urban clusters were identified, containing more than 80% of the overall population in about 3% of the country's area. In order to qualify as urban, blocks must be inserted within an urbanized area or an urban cluster and have a

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[4] See https://www.ers.usda.gov/data-products/rural–urban-continuum-codes/documentation/.

population density superior to 1000/mi^2. As stated above, all the blocks which do not qualify are considered as rural.

Only the most disaggregated units of the census (the blocks) are uniformly classified between rural and urban. The upper divisions may mixture blocks from the two universes. Thus, only a very small number of counties are only rural, and even the most urbanized counties include a fraction of rural populations, and in general an important fraction of rural space.

Other categories frequently used in studies about the US population, like metropolitan or micropolitan areas do the same. Most of them thus falls in the "county trap" pointed out by Isserman (2005), where extensive counties are completely included in those urbanized areas regardless of the concrete status of most of their territory. The definition of rural as "non-metro areas", frequently used, then misses important parts of the rural territory of the US, as well as the majority of the rural population, which is paradoxically located inside metro areas. Moreover, as Landis (2009) points out, the list and repartition of metropolitan and micropolitan areas varies for each period, according to the dynamics of the US population and economy, which complicates the comparison between urban and rural population in time.

Thus, when trying to analyze the dynamics of the U.S. territory, one has either to accept a definition of rurality based one the exclusion from urban clusters, at the most disaggregated scale, or to use very large spatial units as the counties, which fail to capture the complexity of territorial changes at small and intermediate scales. Abandoning the qualitative distinction between urban and rural for more simple criteria, like population density, may thus prove useful to take advantage of the most disaggregated information available in the Census.

Recent trends in rural America

A number of topics dominate in the recent studies about rural America. On the spatial point of view, as Laidley (2016) reviews, the question of the urban sprawl and its detection has been a consistent focus. Many studies have tried to come up with a typology of landscapes, especially at the rural/urban interface (Meentemeyer et al. 2013) and to quantify the extension of sprawl in the US (Lopez 2014) or predict its evolution (Terando et al. 2014). This topic largely connects with the general Land use/Land cover change literature. It is also connected with the discussion about the so-called "wildland–urban interface" and its management. According to Thomas and Butry (2014), 6.3% of the US population live in such areas, which are also more concerned by wildfire hazards (Calkin et al. 2014).

As far as population dynamics and demography are concerned, the historical trajectory of rural America is complex. Outnumbered by the urban population from the 1920 census on, the rural population grew increasingly distant from farming or agricultural activities, frequently leaving rural inhabitants at odds with such rapid changes (Fitchen 1991). While they were traditionally areas of high fertility and out-migration, during the 1990s the situation of rural areas changed dramatically. An important in-migration was then registered towards rural areas (Johnson and Cromartie 2006), slowly modifying local societies and attitudes on certain topics, like the environment (Jones et al. 2003). Somehow hidden by the net gain from immigration, another major change has been recorded regarding fertility. Rural areas are now experiencing "more deaths than births" (Johnson 2013) and as a consequence see their population ageing (Glasgow and Brown 2012), leading to consequences in terms of changing racial composition (Johnson and Lichter 2012; Barcus and Simmons 2012). This question relates to another important topic which is the migration between urban and rural areas and their motivations. If the general trend has been an out-migration from rural areas towards the cities (Mc Granahan et al. 2010), in some places there is on the contrary important fluxes of urban population towards rural areas. This is especially the case of high-amenity areas, even if the great recession endured since 2008 did partly modify these dynamics (Ulrich-Schad 2015). Aside from the economic circumstances, the outcomes in terms of revitalization of the affected areas may be mixed, as pointed out by Winkler et al. (2011). As Brown (2014) points out, ageing, migration and other rural phenomena are not independent from one another. On the contrary, there are interrelated and they interact, along with an array of other factors in which the relations with urban areas are key.

As we said in the introduction, all the studies referred to in the previous sections use county or metro/non metro areas as their basic unit of analysis.

Methods and data

All the analyses in this paper were made on data produced for the 2010 census and obtained from two sources: US Bureau of census and NHGIS.

The first source was used for the data at the "block" level. Blocks are the most disaggregated units used in the census. They represent very small portions of land, and are primarily aimed at orienting the work of census surveyors. The block repartition fits inside most of the administrative and political boundaries, which means that they respect state, county, tribal land and other type of limits. They offer an extremely precise vision of the US territory since the total database for the 50 states contains more than 11 million units. Not every block is associated with a population. On the contrary, an important number of blocks are made of "empty" territory, be it inside the urban or inside the rural areas. In addition to the areas occupied by rivers, streams or lakes, empty blocks may be roads, parking lots or wasteland in the urban setting, and road, fields, forests, etc. in the rural areas. Blocks are tagged "urban" or "rural" by the US Census Bureau (see "The definition of rural America in the US census" section). When associated with a population, some core demographic data are available. Among those, we will mainly use the total population, sex ratio, median age and family size. Although a number of data about race or housing may also be used at this level, income is not included.

Regarding the geographical data, we downloaded the state databases and assembled them into a nation-wide geodatabase. Afterwards we created a few sub-tables, first making the difference between rural and urban blocks, and then between water blocks (which were set apart), unpopulated rural blocks and populated rural blocks. The demographic data were associated with the latter and the population density of each block was calculated. To do so, we used the "land size" provided in the data as the denominator, so that our figures would be consistent with official estimates and also that the density would be calculated against "land" (i.e. theoretically habitable) area.

Block groups are, as the name indicates, an aggregation of a number of blocks, with a population in general comprised between 600 and 3000 people (there are however about 900 empty block groups). According to the US Bureau of census "*Most BGs were delineated by local participants in the Census*

Bureau's Participant Statistical Areas Program" (US Bureau of Census 2012: A10), meaning that they represent units which are relatively coherent with the population's view of their territory. We downloaded the Census 2010 data associated with block groups through the NHGIS service, as well as the associated geographic database, composed of 220,334 units. Aside from a number of variables already available at the block level (total population, sex ratio, median age, family size), the block group can be associated with income. Another data sums the total number of "rural" (i.e. people living in a rural block) and "urban" (i.e. people living in an urban block) people in the group. The statistics provided do not however allow to further differentiate between both groups. For instance, the median age is calculated in function of the whole block group's population and not for its urban or rural population. Like for the census blocks, we associated the data with the spatial coverage and calculated the population density (also using the official "land" size of each unit). Statistical data were chosen in the different variables available at the block group level, and core indicators were calculated by processing them. These core indicators were chosen because of their relevance regarding the trends highlighted in "Rural and urban areas in the US" section. We therefore elected the sex ratio (in the form of male population percentage), average family size, and median age in order to reflect the changing demography of the rural areas. Proportion of the population with an income less than $20,000 a year and proportion of the population with an income greater than $100,000 a year were selected as proxies for the economic trajectories of the block groups. Last, the proportion of rural population in each block group was to serve as a factor, which could help differentiate between different types of low-density areas.

For lack of space in a single paper, the question of the evolution of the characteristics of the spatial units over time will not be addressed here. However, it must be acknowledged that one of the main limits of the analysis at the blocks and block groups level is that their boundaries do change over time, due to the necessity of the Census Bureau to accompany the dynamics of land occupation and land use. The same fluidity existing with other levels or classifications (see "The definition of rural America in the US census" section) and this is one of the reason why counties have become the reference unit, even if they

Table 1 Basic analysis of the census blocks

Type of block	Sub-type	Number	% number	Area	% area	Population	% population
Rural	Total	5,570,512	52.88	8,872,054	96.99	59,492,267	19.27
	Populated	2,602,312	24.70	4,928,116	53.87	59,492,267	
	Unpopulated	2,968,200	28.17	3,943,937	43.11	0	
Urban	Total	4,964,686	47.12	275,539	3.01	249,253,271	80.73
	Populated	3,604,715	34.22	236,018	2.58	249,253,271	
	Unpopulated	1,359,971	12.91	39,521	0.43	0	
Total		10,535,198		9,147,593		308,745,538	

1. The blocks only composed of water have been subtracted. 2. The analysis include the blocks of all 50 States but do not include Puerto Rico

are too large to capture most changes. Even if serious, the question of the fluidity of the boundaries is not, from our point of view, unsurpassable. First of all, some institutions, such as NHGIS, do provide datasets which are compatible across the decennial censuses. Even if based on aggregation methods which may offer biases, this method allows for comparison across time. Also, even if not comparing directly unit to unit, the parallel study of the situation at different periods at the finer scale is also a way to cope with the redefinition of boundaries. Thus, as a further development of this paper, we plan to carry on the same analysis for the 2000 census and cross the results with the present study.

Several processes were run on the resulting data or subset of this data (see "Results" section), mainly correlation analysis (Pearson) or k-means classifications.

Results

At the block level, three Americas

As we discussed in the methodology, the first step in processing the data has been to differentiate between urban and rural blocks and then between empty and populated blocks. The results of this first basic processing is in Table 1.

Even if simple, this first analysis already yields a few interesting results. The first one is that a very important number of blocks in rural areas are empty,[5]

and that they cover a very large area: more than 3.94 million km^2 or about 43.1% of the US. Empty blocks are also numerous in urban areas, but in general they are small and their total cumulated area does not reach 15% of the total urban area. In the case of rural empty blocks, even selecting only blocks with more than 1 km^2 in size, there are still 426 183 of them, covering more than 3.63 million km^2.

From Table 1, we can thus define not only two (rural and urban) but three Americas. The first one may be called 'concentrated America', with little over 275 000 km^2, but more than 249 million inhabitants, indicating an average density of 904 people per km^2. Those are the regions where the population, economic activities and wealth are concentrated, and corresponds to what is generally considered as urban. The second one may be called 'sparsely populated America', composed of the populated rural blocks. It is a vast region of slightly less than 5 million km^2, populated by almost 59.5 million people. As the mean density of 12 people per km^2 tells, it is a sparsely populated area, regrouping agricultural and extractive activities as well as other types of territories, like indigenous reserves, but also like very diffuse exurbanization landscapes. Last, the third America may be labelled as 'empty America'. As stated above, it covers up to 43% of the US, mainly located on the western side of the country (but also present in other regions, especially Appalachian Mountains.

Taking aside empty block groups and associating census data with the populated ones, we can calculate

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[5] This fact has been pointed out in the geographical blog "mapsbynik", see "Nobody lives here: The nearly 5 million

Footnote 5 continued
Census Blocks with zero population" (see http://tumblr. mapsbynik.com/post/82791188950/nobody-lives-here-the-nearly-5-million-census, consulted on Feb, 3, 2017).

Table 2 Demographic indicators about rural and urban census blocks

	Rural blocks	Urban blocks
Average median age	41.96	37.47
Average family size[a]	2.69	3.01
Proportion of male population	50.01	48.81
Mean density	283	2597

[a] This average is calculated by block and may thus differ with an average calculated against rural and urban population as wholes

a few basic statistics about rural and urban populations which reveal important trends. As Table 2 shows, there is an important difference in the median age between both groups, which clearly reflects the ageing of the rural America. Also the average family size is smaller, which does not necessarily show that big size family are less frequent, but may reflect the migration of elderly people towards rural areas (see "Block group analysis" section). The proportion of male population is higher than in the cities, which is a recurring feature of rural areas where men can find work more easily than women (Snyder and McLaughlin 2004). Finally, the average density shows an expected big difference between urban and rural blocks, but in the case of the latter, the average density is much higher than what could be expected from rural areas (and from the 12 people/km^2 average density calculated by dividing the overall rural population by the total area). This means that a great number of the blocks were cut short around the residences of the surveyed people, yielding an elevated population density in very small units and leaving "empty" great part of the surroundings. As a matter of fact, the mean size of the blocks is only 1.89 km^2, and 1.7 out of the 2.6 million populated rural blocks are smaller than 1 km^2. Hence, the design of the census block may not make them the ideal level to approach the dynamics of rural America, which is why we have also focused on the block groups as an alternative.

Block group analysis

If the detailed vision given at the block level reveals interesting features, it does not allow for studying a number of social parameters which are only available at block group level, like income distribution. In addition, the approach of population density at this scale is somehow twisted by the small size of many rural blocks. Finally, the entire dataset is very heavy to process even on modern computers. For all those reasons, working at the block group level can appear as a promising endeavor.

Block groups, however, are not labelled urban or rural nor do they respect the limits between those types of blocks. On the contrary, they associate rural, urban and empty blocks. Therefore, the main problem when working at the block group level is to decide which criteria will be used in order to differentiate between (mainly) urban and (mainly) rural block groups. Two options may be chosen. The first one is fix a threshold proportion of rural population in the total population of the block group. As shown in Table 3, selecting only block groups where rural population is a majority would yield a total of 43,644 block groups, covering 8.4 million km^2, and nearly 88% of the total rural population. The other option is to select a population density threshold since, as we saw in "Rural and urban areas in the US" section, small population densities are an enduring feature of rural areas. Using a trial and error method, we chose that a density of 70 would include a territory slightly larger than the rural/urban definition (8.6 million km^2 against 8.4), occupied by a smaller population (51 million against 56) and representing a smaller proportion of the overall rural population (75%).

The difference between the results of both selections already indicates how the definition of rural may be confusing. Our focus in this paper being more about the territories than about the other attributes of rurality, we chose to use the second one, which has the advantage of bypassing an eventual bias linked

Table 3 Number, area and population of "rural" block groups in function of selection criterion

	Over 50% rural BG	Under 70 pers/km^2 BG
Number of BG	43,644	40,875
Area (km^2)	8,408,313	8,665,243
Total population	56,545,036	51,013,447
Rural population	52,143,182	44,611,408

Table 4 Correlation matrix of statistical variables associated with <70 pers/km^2 BG

	DENSITY	PCT_MALE	FAM_SIZE	PCT_RUR	PCT_UND_20K	PCT_OVER100K	MED_AGE
DENSITY	1	−0.124	0.068	−0.334	−0.086	0.186	−0.055
PCT_MALE	−0.124	1	−0.088	−0.023	−0.108	0.020	−0.103
FAM_SIZE	0.068	−0.088	1	−0.044	0.061	0.014	−0.355
PCT_RUR	−0.334	−0.023	−0.044	1	0.020	−0.082	0.187
PCT_UND_20K	−0.086	−0.108	0.061	0.020	1	−0.502	−0.011
PCT_OVER100K	0.186	0.020	0.014	−0.082	−0.502	1	0.128
MED_AGE	−0.055	−0.103	−0.355	0.187	−0.011	0.128	1

with the labelling of rural population by the surveyors. In both cases, it is worth to point out that the resulting urban territory is about twofold or more the urbanized areas and urban clusters defined in the census.

Selecting all block groups with a density greater than 0 and smaller than to 70, we processed them in order to see how the social characteristics described by the statistical data are correlated with the population density and if such an approach may yield new insights about the dynamics of sparsely populated/rural areas. The first step of this analysis was to build a correlation matrix between the selected variables.

As Table 4 shows, most variables are weakly correlated with one another, which allows for further processing on this same variable group. A few points may however be noted. First, a significant negative correlation exists between population density and the proportion of rural population. If this is not a surprise, the relatively low level of correlation (−0.334) is more surprising, reinforcing the conclusion that sparse population are not necessarily rural. Second, the most significant correlation occurs with the two levels of income, which is logical: the more poor people there is in a block, the fewer rich persons… Other evident slightly significant correlations are between the median age and the family size (negative correlation, since old couples do not have children living at home any more) and between median age and income (younger people have an average income which is smaller than older people in general). A slight correlation between the proportion of rural people in a block and the median age is another clue about the ageing of rural population.

We ran a k-means classification on the 40,875 blocks selected. The best result was attained with 8 classes, which barycenters are described on Table 5.

The interpretation of the values associated with each class allowed for the characterization of each as follow.

1. "Rural average": this class is centered around sparsely populated areas and regroups almost exclusively rural population. Peculiar characteristics are a male population exceeding the female population, and a quite even repartition of low and high income. This class regroups the larger number of block groups in our sample (14,021).

2. "Poor rural": this class resembles the first one except for the distribution of income, since lower incomes are much more frequent than higher incomes. Being the second largest class, it may be considered as the declassed rural America. Interestingly it spans on most tribal areas of the US. This class reminds of the "chronically poor rural America" pointed out by Hamilton et al. (2008).

3. "Rich rural and exurb": this class has a higher population density, even if it remains low compared to urban areas. Its main features are that, contrary to the prior one, higher incomes are much more frequent than in the other classes, and median age also is significantly higher. This class regroups either prosperous parts of the agricultural lands or high-amenity areas where retirees seek a better lifestyle "close to nature" (Von Reichert et al. 2014).

4. "Military and extractive areas": this class features a much younger median age, a lower income level, a predominantly non-rural population and a significantly higher proportion of male in relation to female. It regroups block groups influenced by military bases or by extractive industries.

5. "Rural and small towns": this class features a low population density along with mixed rural/urban population. Other characteristics are quite aligned

Table 5 Barycentres of classes after k-means classification on <70 pers/km^2 BG

Classes	Density	% male population	Avg family size	% rural population	% income und 20K	% income over 100K	Median age	Number of BG
Rural average	11.49	51.09	2.95	99.16	13.51	15.29	42.61	14021
Poor rural	11.88	50.26	2.99	99.32	32.31	6.70	42.24	8737
Rich rural and exurb	38.12	50.47	2.99	95.71	7.42	38.40	44.06	3239
Military and extractive areas	18.24	52.96	2.99	17.37	19.97	12.64	32.27	1246
Rural and small towns	20.98	50.18	3.01	62.22	19.50	15.60	40.99	2150
Urban dominated peripheries	52.78	49.98	3.04	21.17	18.69	19.23	39.95	1750
Mixed rural dominated peripheries	54.05	49.61	3.01	59.23	18.26	17.24	41.15	2219
Poor rural dominated peripheries	45.40	49.95	2.99	97.89	20.10	11.50	41.25	6710

on the two first classes. Most probably this class regroups rural small towns and villages.

6. "Urban dominated peripheries": this class sees a significantly higher population density and a small proportion of rural population. The sex ratio is almost on balance, as well as low and high income proportions. It resembles the first class except for density and the proportion of urban population, which pinpoint the influence of urban areas and urban encroachment.

7. "Mixed rural dominated peripheries": as with the previous and with the next classes, the higher population density denounces periurban influences. The other features are quite aligned also with classes 6 and 8, except for the proportion of rural population which, around 60% indicates a mixed situation between the two.

8. "Poor rural dominated peripheries": this class has a similar profile than the previous, except it is almost completely rural and that low incomes are more frequent. As a reflection of a higher rurality, median age is significantly higher.

Discussion

The extension of rural America

Working at the scale of block or block groups, we may offer fresh insights into simple but important questions regarding rural America. The first one would be to try to quantify the extension of the non-urban part of the US.

As simple as the question is, the answers we can derive from our data are not completely aligned. Working at the block level, the extension may be 8.8 or 4.9 million km^2 depending if we are considering all the land blocks named as "rural" or only the populated rural blocks. The difference between the two figures is quite important and reflects the question about how to classify wild or preserved areas, which goes largely unnoticed if one only uses the urban/rural distinction. Should they be considered as rural space, in a two terms dichotomy, or should they be set apart in a different category, as in the latin quaternary partition City/Countryside/Rangeland/Wilderness (Antrop 2000a, see "Rural and urban: two apparently clear but today elusive concepts" section)? Then, how could we determine the *saltus* limits, which are probably part in the populated and part in the unpopulated rural blocks?

Working at the block group level, the question is complicated by the fact that most of the blocks are not uniform. They contain a mixture of urban and rural population, and therefore a mixture of rural and urban space. As we saw, considering as rural the blocks with more than 50% of rural population yields a total rural population consistent with the total population of the rural blocks. However, the overall area covered by those block groups (about 8.4 million km^2) is much smaller than the area of the rural blocks (including

Table 6 General characteristics of <70 pers/km² BG

	Rural (inf 70)	Urban (sup 70)	Total
Density	23.73	2925.22	2385.28
% male population	49.40	48.67	48.81
Average family size	2.91	3.14	3.09
% rural population in BG	86.55	5.53	20.61
% earning less than 20K	18.81	19.45	19.33
% earning more than 100K	14.54	20.73	19.58
Median age	41.41	37.12	37.83

empty blocks, see Table 1), making a difference of 0.4 million km². If we consider that the total area covered by urban blocks is 0.275 million km², such a difference is highly significant because it would more than double the urbanized area of the US. Using a density criterion gives another figure of 8.6 million km², half the way between the two other results. Interestingly, in terms of population the mixture is quite different since this larger space encompasses a smaller number of inhabitants, and inside them a higher proportion of urban population.

From those results we conclude first on the great difficulty in making the difference between urban and rural population and spaces, as remembers Murdock et al. (2011). The population density criteria may be one of the most valid ones since it is relatively objective and since there is a quite straightforward relation between the definition of rurality and low density areas.[6] Furthermore, we could also consider that instead of considering the difference between rural and urban, the pertinent divide today is between empty, sparsely populated and densely populated areas. Second, even considering the lowest hypothesis, 92% of the US space is still rural (82% for the coterminous US states). Even in a context of urban sprawl and exurbanization, rural and wild areas still largely dominate in the US, and probably more attention should be given to them and to their inhabitants if climate change or environmental issues are to be correctly addressed (Brondizio and Le Tourneau 2016).

Older, poorer and sparse: the population of rural areas

The classification of rural block groups according to our core variables shows that those describe well the situation of rural America, and that their variation is meaningful. At a global level, the averages for the rural block groups[7] show that the median age is significantly higher (Table 6) and that the average proportion of higher income is smaller than urban areas. Another interesting feature is that the proportion of male population is more even than in urban areas, but remains smaller than 50%, indicating a feminization of rural areas. Other statistics confront some common ideas about rural America. As we have seen, the average family size, for instance, is significantly smaller in relation to urban areas. Most probably, this characteristic and the previous one are signs of the transformation of rural areas with the massive arrival of retirees. Old people generally have lower average family size (in general one or two people) and as women have a longer life expectancy than men have, this may explain why women are in slightly superior in numbers as men. Not surprisingly, the average population density is extremely different between both groups, which shows, to our opinion, that the criteria which was chosen is a good discriminator.

Regional dynamics

The variation of the variables inside the rural block groups are also very interesting in terms of understanding the regional dynamics of rural America and pinpointing the underlying phenomena. As shown in

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[6] The threshold, however, may vary a lot in function of where in the world it is applied, since there are high density rural areas, especially in Asia.

[7] Using our definition, i.e. block groups with a population density <70 persons/km².

Table 7 Repartition of <70 pers/km^2 BG according to the k-means classification and regions

Classes	Area (km^2)					Total
	Midwest	North-East	South	West	Alaska/Hawaï	
Rural average	1,206,918	178,578	800,791	1,742,032	732,205	4,660,524
Poor rural	446,484	67,697	838,089	864,800	735,813	2,952,882
Rich rural/exurb	37,646	29,322	46,005	36,960	1,492	151,425
Military rural	10,196	2196	53,249	114,499	13,916	194,056
Rural and small towns	49,510	12,258	117,019	151,417	5764	335,968
Urban dominated peripheries	13,874	3339	19,136	13,460	825	50,634
Poor rural dominated peripheries	53,582	32,763	122,858	11,846	501	221,551
Mixed rural dominated peripheries	14,563	10,758	32,345	7,503	151	65,320
Total	1,832,774	336,911	2,029,492	2,942,516	1,490,667	8,632,360
% of the total region land	94.29	80.34	90.23	96.77	99.74	94.29
Classes	Population					Total
	Midwest	North-East	South	West	Alaska/Hawaï	
Rural average	6,366,819	1,923,736	5,568,012	2,286,472	128,702	16,273,741
Poor rural	1,877,341	543,869	6,543,184	1,023,530	41,696	10,029,620
Rich rural/exurb	1,241,602	1,100,775	1,536,941	713,763	36,703	4,629,784
Military rural	205,158	35,517	521,996	679,992	63,492	1,506,155
Rural and small towns	741,781	272,171	1,421,785	588,130	37,107	3,060,974
Urban dominated peripheries	698,503	173,339	969,236	668,771	41,178	2,551,027
Poor rural dominated peripheries	2,263,612	1,397,341	5,248,865	517,736	22,803	9,450,357
Mixed rural dominated peripheries	755,012	573,780	1,714,099	380,023	7781	3,430,695
Total	14,149,828	6,020,528	23,524,118	6,858,417	379,462	50,932,353
% of the total region population	21.14	10.88	20.54	9.82	18.33	16.50

the "Results" section, a k-means classification yielded 8 different classes which may be considered as different segments of rural America. By regionalizing (Table 7) and putting this information in the form of a map, we can provide new insights on these regional dynamics, especially looking at the conterminous states (Fig. 1).

The repartition of the two most numerous categories of "rural average" and "poor rural" highlights several features of the US. In general terms there is an obvious opposition between the west and north-east region, where the first category is dominant, and the south where "poor rural" block groups are much more frequent. Giving attention to this category, what emerges is that it is mainly concentrated around and in the Appalachia mountains, in the deep south and, in the West, around indigenous reserves. Such interpretations of the map are confirmed in Table 7. "Average

rural" occupies 1.7 million km^2 in the West region and groups 2.2 million people, 1.2 million km^2 and 6.3 million people in the Midwest, whereas "poor rural" occupies 0.8 million km^2 and 6.5 million people in the South region.

The category of military rural reflects in great part the repartition of US military bases in the country (Marine corps bases in Florida, Air Force bases in Arizona, etc.) and also some extractive sites, even if it doesn't appear to reflect the recent push of oil exploration in North Dakota. It is mainly concentrated in the West region, which alone represents 58.7% of its area and 44.6% of its population. The "rural small town" category appears more concentrated in the South and West regions (Table 7).

The last three classes, along with the "rich rural/exurb" category appear to form crowns around the urban space, confirming their participation to the

Block group type

Rural average
Poor rural
Rich rural / exurb
Military & extractive rural
Rural villages & small towns
Urban dominated peripheries
Poor rural dominated peripheries
Mixed rural dominated peripheries

Block group population

8000
6000
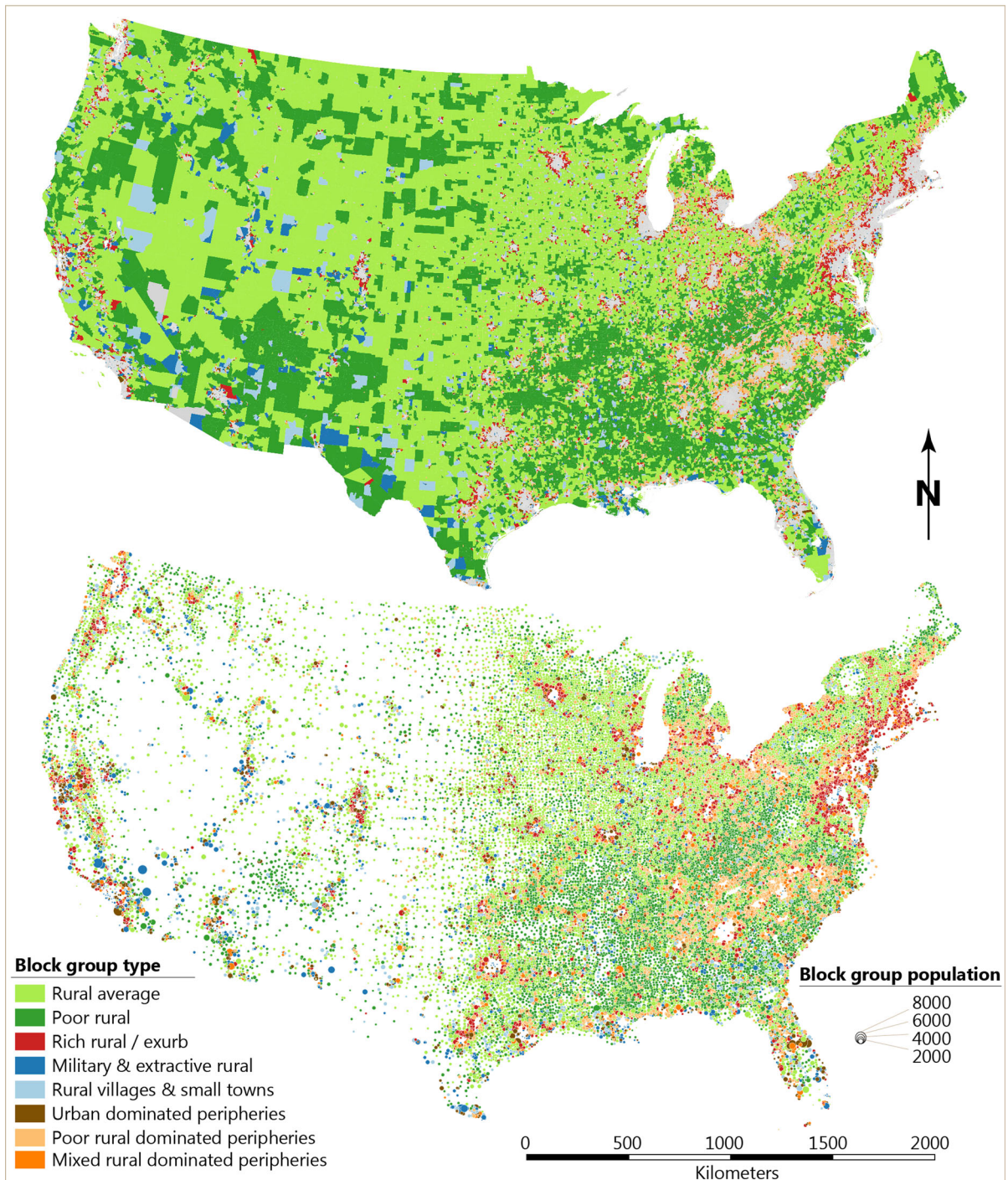4000
2000

0   500   1000   1500   2000
Kilometers

Fig. 1 two representations of the block groups according to the k-means classification

urban/rural interface and its dynamics (i.e. rural sprawl and exurbanization front). This is an important point since it could imply that little less than 0.5

million km^2 be withdrawn from rural America in the conterminous US, relativizing somehow its overarching domination of the US space. If these classes are not

the most numerous in terms of block groups or area, they regroup a very important number of people: little under 20 million people, or over 39% of the overall population of the sparsely populated block groups.

The vision given by the choropleth map however has a number of distortion, especially linked to the fact that the rural population is essentially concentrated in the eastern part of the US, occupying tiny spatial units, whereas block groups of the western part occupy much more space but are occupied by a small fraction of the rural population. In order to mitigate the bias associated with these points, we provide a second map where block groups are represented with symbols in proportion with the size of the associated population (Fig. 1). This second map is complementary to the first one and useful to pinpoint many interesting phenomena. First, aside from the asymmetry between east and west of the Mississippi River, the "empty spaces" which appeared at the block level are quite clearly revealed in the Rocky Mountains. Second, the classes which are linked with the urban dynamics are much more visible. "Rich rural or exurb areas" form distinct crowns around most of the country metropolises, but they are much more frequent near the east coast. "Poor" or "mixed" rural peripheries dominate around Atlanta and around the Appalachia mountains. On the west coast and in the Rocky Mountains, such peripheral crowns seem to be much less developed, whereas "urban dominated peripheries" are much more noticeable.

Conclusion

By using the most disaggregated data available and by analyzing simple criteria like the population density, we were able to put forward new insights on the dynamics of a very large part of the US territory, which is in general labelled as "rural". The study of the population repartition between census blocks—acknowledging their limits as analytical units—and block groups shows that the US space may be divided in three parts which we named as 'empty America', 'sparsely populated America' and 'concentrated America'. Each of those has quite distinct characteristics and occupy distinct functions. Of course, they also form a system of interactions at all levels, from the ecological and physical level to the economic and to the symbolical levels. The new categorization and

the use of population density to differentiate between them offers an objective approach that does not depend on qualitative appreciation of rurality and urbanity. It is also useful in the light of the debates about public services, where the focus is very much on isolation and its implications in economic terms, as is well exemplified by the broadband networks "digital divide" (Prieger 2013).

The analysis of how several social indicators play in the less densely populated part of America is another interesting point. It confirms core differences between the rural space and the cities and highlights at the same time the influence of current phenomena on those, such as the impact of the settlement of retirees in rural areas which may locally modify substantially the social and spatial configurations.

Finally, working at the block and block group level may lead to a questioning about the very nature of population density and the ways of mapping it. At a technical level, new directions in mapping can be explored (Trusty 2004; Owens et al. 2010). At a more fundamental level, questions can be raised about the space against which a population must be divided in order to produce a density. Are only the areas effectively and permanently inhabited valid? Or all the areas where people have their routine activities (i.e. the fields in the case of farmers)? All the spaces where people travel (and in this case many National parks would have important densities)? Obviously not every solution is available due to a lack of data, but the answers to those questions could dramatically reshape our perception of urban and rural spaces in the US and at a global level.

Compliance with ethical standards

Conflict of interest Author declares that there is no conflict of interest.

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