Compact City – Sprawl City: two interacting urban forms

Introduction

From the perspective of mobility relation-city design, the automobile is placed at the center of the problematic dichotomy compact city/ sprawl city. This paper analyses the role of transport as one of the factors which generates unsustainability in urban areas associated with mobility and the exponential growth in car usage and distance travelled.

Within this framework, this work supports the hypothesis that the higher energy consumption produced by transport depends on the forms adopted by urban expansion. Hence, a highly consolidated urban network allows higher energy saving than a spreading urban network which generates higher mobility and, thus, higher energy consumption. Previous considerations prove the need for a systimic approximation to compact or sprawling urban growth to verify our hypothesis. This hypothesis stems from some previous considerations: the partial focus on the area of analyses on energy saving, the absence of coordination between transport and population location and their activities, and the limited treatment of urban network characteristics in studies referred to energy saving in houses. Although international forums have been taking the problem of compact city/sprawl city as fundamental in discussions on urban growth, the absence of precision in the definitions of 'compact' and ‘diffuse’ is confirmed. Hence, the need for asking about the factors related to population mobility which determine the sustainability or lack thereof in both urban forms.

The methodological approach to address this problem coordinates housing and mobility variables considered from two urban growth representative forms: compact and sprawl. Five areas situated in La Plata (Buenos Aires Province, Argentina) are compared. Three are located in the outskirts and two in the central area. The population socio-economic level, the consolidation and structuring of each area, and the housing energy consumption per area are considered.

Compact City and Sprawl City Models

The compact city-sprawl city dichotomy is presented as a theoretical model, in a 'pure state’, while –in fact– both models interact in the same space-time equation. The problem is presented in the expansion processes and urban growth, as it can be seen in our case study.

In the international field of study, there are some interpretations as regards compact city-sprawl city. The first one is presented as the adequate model to decrease unsustainability and the second one as encouraging an excessive consumption of energy, land and information. The contradiction between the complexity of the compact city given by its multifunctionality and proximity, and the unifunctionality of the disperse city is also relevant. Lack of complexity in the latter case would be replaced with a major consumption; therefore, it is possible to state this as one of the causes for unsustainability. The challenge for the city of the future would be to increase the complexity without increasing unsustainability which derives from the disperse expansion model (Rueda, 2001).

City dispersion has been the feature defining the urban process in big and middle cities in Argentina since the 1940s when rapid growth started, expanding distances and worsening life quality, moving the city away from areas which produced fresh food for daily use and increasing transport flow.

Cities grew chaotically as a consequence of speculation in the real estate group which, along with the financial group, control the logic which establishes the dominating city model. This urban expansion, resulting from an increase in population and economic dynamics, transformed rural land into building space, generating spontaneous and chaotic growth which Urban Planning regulated later.

During the 1990s, the increase in closed urbanization by big financial capital in the real estate business transformed productive rural areas into residential areas encouraging the expansion of a low density population area intended for high income social classes.

The State's lack of control in supply and demand allowed the outskirts expansion, thus occupied, not only by the poorest classes but also by middle and high urban classes. Certain factors such as the aspirations and wishes of those sectors stemming from an ideology which proclaimed safety, benefits from nature and the deterioration of life quality in the city contributed to the success of this new residential model.

Urban Form, Mobility and Energy Consumption

This process of expansion towards the outskirts is reinforced by an increased automobile use without which the proposal to live in a far residential area would not be so attractive.
The OECD already considered in 1995 the following: "the current urban and transport policies are promoting an excessive growth in car trips to the city and its outskirts, being this the cause for the rise in traffic congestion, air pollution, noise, acid rain and the risk of global warming."
However, to discourage the use of the private car is a complex task since it is an object of value in every social sector. It is not only a means of transport and a tool for everyday life planning, but it has also become an object for social identification which, as well as the household, shares the symbolism of having certain social status.
By making access to the the sprawl city easy and fast, the automobile has become an essential factor associated with this urban model.
Contradictorily, easy access is affected by these three factors: traffic congestion in the urban center access, unlikely door-to-door parking and the lack of capacity in most urban and interurban roads which reduces speed below the authorized maximum. The environmental problems posed by this and, thus, in population life quality, constitute a key element for the definition of urban sustainability.
The interacting compact and sprawl urban forms are correlated by the private car-public transport dichotomy based on studies which state that:
a) Transport efficiency depends on the distances to be travelled. For walking, an optimum distance between 300 and 500 m is considered, while for cycling the distance is more efficient, up to 7 or 10 km. Underground performance reaches optimum results as from 10 km. The bus, compared with the use of biclycles or underground, is in disadvantage because of the number of stops and traffic congestion in the road system, sharing the same inconvenient with the bus (Molina, 1980).
b) The standard spatial automobile occupation is larger than a bicycle or a bus (a car driver takes 15 times the space of a cyclist and more than 20 times the space of a bus passenger).
c) Taking into account an average autombile and public transport occupational rate, the energy consumption per person (measure in Kg equal to oil) is four times higher in the automobile than the bus. Considering non-renewable energies and energy consumption, the automobile is in disadvantage compared with the railway, the underground, the bicycle and walking (Estevan, 1994).
d) The increase of the automobile in compact or sprawl areas of the city provokes traffic congestion and its consequent polluting fumes emission; this is not only translated into time and economic loss, but also into the housing market relative depreciation. The delay provoked by the congestion in the travelling of people and goods is directly transmitted to the associated activities and processes, affecting the whole productive system.
In this context, the issue of the mobility and the sustainability must be treated dialectically, since the unsustainability is inherent in the mobility process. In the sprawl city, distances travelled are longer and the concomitant energy consumption is higher than in the compact city.
The outskirts growth is translated into an increase in the numbers of roads which increases the traffic and promotes new urbanization, resulting in a vicious circle that must be avoided by taking into account integrated proposals of urban growth and transport system.
All in all, this is a shift of the problems to those areas farther from the original urban centre and the consequent loss of social complexity and multifunctional aspects that characterizes

these spaces. As the model of sprawl city is based in a growing consumption of non-renewable resources, it is unsustainable.

La Plata: the urban area and its periphery (A case study)

The city of La Plata, capital of Buenos Aires Province, located at 60 km from the country capital, constitutes with its neighbour towns Ensenada and Berisso and their peripheries a conglomerate of 750,000 inhabitants, approximately, which we call Micro-region of the great La Plata.

La Plata was conceived in the late XIX century, in the framework of an external context of technological innovations that are incorporated to the project of the city allowing a level of development that today can be vaguely seen. These innovations contemplated the local and regional scales including the railway and the tram as the project structural axis. Besides, its organized map of roads allowed the later incorporation of cars without much inconvenience until some years ago. Its location, decided by its proximity to the port, the existence of railway infrastructure and roads to the country capital and to the interior of the province, defined since its origin its integrative character within the country and abroad.

La Plata profile was shaped by three axes: The productive (port and cold-storage plant), the administrative, as the capital of the Province of Buenos Aires and link between the humid pampas and the great metropolis (England, in this case), and the cultural activities of international scope and the University as education, investigation and transference centre.

However, this region, which incorporated the most advanced technologies as regards means of communication, started to lose its initial innovative characteristics. The tram disappeared in 1966 and the railway started to suffer a slow deterioration since the 1960s, from which it will be difficult to recover. Soon, the port was absorbed by the port of Buenos Aires. The public motor transport system loses during the 1980s 30% of its passengers and, so far, the historic levels have not been re-established. The exponential growth of private automobiles during the last decade completes the list of factors which produced a model of city different from the one thought from the hygiene criteria. The population growth exceeded the original layout creating a sprawling periphery with different degrees of consolidation, and socially differentiated, too. This social and physical asymmetry corresponds to the expansion criteria which operate in diverse ways: a tendency to grow towards the Federal Capital, centre of attraction, following the organized road axis and according to the economic guidelines of soil valuation/depreciation.

The analysis proposed concerning the role of the urban form in La Plata is possible to be developed according to the concepts of compact/sprawl city, where each category refers to sustainability or unsustainability guidelines. The urban compactness is related to reduction in the public or private vehicle routes, and the latter, at the same time, is related to energy savings and emissions reductions.

With the aim of quantifying the indicators which allowed the comparison of the unsustainability degree of the models described, energy consumption variables within the transport and residential sector were analyzed.

In the same way, three intercensus periods (1970-1980-1991-2001) were analyzed with the aim of recognizing the variables in the population growth and the tendencies according to the different urban areas.

In each of the two first periods a population increase of 13% was registered, while in the intercensus period 1991—2001 the increase was of only 5.4%. A decrease in the population that reached -6% and -8% respectively was verified in different areas in the centre of the city (INDEC [National Institute of Statistics and Censuses], 2001)

Contrary to population decrease in the historic city core**,** important growth is verified in the towns located nearby the railway stations and the road network. This growth reaches 33.8%, 22.3%, and 21% in agglomerations situated on the northeast axis that links La Plata with the Federal Capital (Villa Elisa, City Bell and Gonnet) with a population of 21,800; 26,210, and 22,859 respectively. Other population centres which register a growth of 10%, are located, on the one hand, on the southwest periphery (Los Hornos), traditional settlement where extractive activities related to the construction of the city are located, and on the other hand, on the southeast periphery (Villa Elvira), where the growth is connected with the low value of the land, in comparison with the values in the rest of the district. These tendencies respond to the market dynamics, but not to a city project designed from the regulation, or to sustainability criteria.

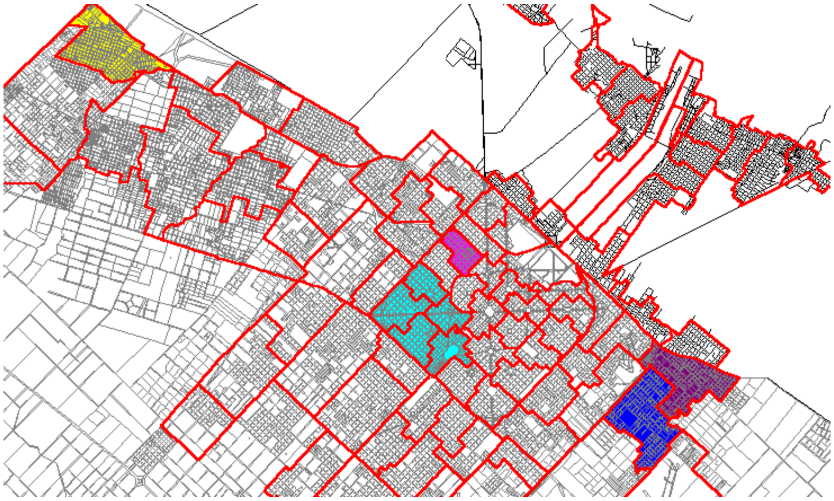
The population growth considered by the "Ordenamiento Territorial y Uso del Suelo" of the Municipality of La Plata city policy establishes a central area growth by means of a densification process; meanwhile, for the periphery growth it proposes an expansion of the urban surfaces. This regulation does not consider problems associated with the density growth in the center of the city: Increase in the activities, journeys, traffic and the need of parking space, and the lack of capacity of the infrastructure system. What is more, it does not consider the necessary expansion of the surfaces of green spaces in order to maintain the original relation between the constructed and the natural environment, foreseen by the foundation layout. As regards the growth in the peripheral areas, the changes in mobility which such expansion would imply (necessary modifications in the transport infrastructure, increase in the journeys, and the relation passenger/distance travelled) are not considered either. Finally, the bylaw is not accompanied by any specific regulations that control the building characteristics of the housing market or the road network and the public spaces from the perspective of a sustainable future development.

The need to deal with the problem of sustainability as an integral conception arises from what was said before; this is, the energy savings that can be obtained from the use of sustainable practices in building construction can be minimized when analyzed from the mobility perspective in connection with the location of residential areas and their activities.

In this context, we present a comparative analysis between three residential areas located in the periphery of the city of La Plata, examples of the urban sprawl form, and two areas from the consolidated central area, examples of compact urban form. The aim is to show the effect of the global energy saving (and therefore the reduction of polluting emissions) in the mobility of the population and the residential sector, taking, for the latter, electricity and gas consumption, housing characteristics and location as variables of analysis.

The first case, **Villa Elisa** (northeast area) is located 20 km away from La Plata urban centre. It has a multimodal connectivity system with the city centre and the Federal Capital: a highway, interurban lines and the railway. The number houses rises up to 3,218 and there is a population of 11,263 inhabitants. It is part of a consolidated residential area with low density, between 20 and 50 inhabitants per hectare with heterogeneous characteristics in terms of social and professional status. It shows a higher density area of approximately 200 inhabitants per hectare where a state-subsidized housing programme was developed.

Figure 1. Areas of study. La Plata



Source: author's drawing up (2007)

The second case, **West Villa Elvira** (southwest area of the urban centre) is located 15 km away from the city centre to which it is connected by means of a medium transport line. There is a population of 5,760 inhabitants and 1,471 houses. It is a low density area with approximately 20 inhabitants per hectare. As for the previous case, this area is located in a state-subsidized houses neighbourhood which reaches higher density rates than the average area (between 100 and 150 inhabitants per hectare).

The third case, **East Villa Elvira** (southern area of the city) is a neighbourhood that borders with the previous one. It is located 15 km away from the urban centre to which it is connected by means of a medium transport line. There are 2,050 low density houses (around 40 inhabitants per hectare) and a population of 8,428 inhabitants.

The study of these peripheral neighbourhoods highlights the limited accessibility of the public transport as a common feature. People's requests are moderately satisfied since there are few frequencies and some areas are not covered.

The fourth case corresponds to the western side of the urban centre which is highly consolidated. There is a population of 40,403 inhabitants and 12,828 households and its density varies –according to areas– from 50 to 123 inhabitants per hectare with an average of 100 inhabitants per hectare. It is characterized by its spatial nearness to the most multifunctional area (the commercial centre) and by its immediate accessibility and its wide range of facilities: education, health care, culture and leisure, commerce and services.

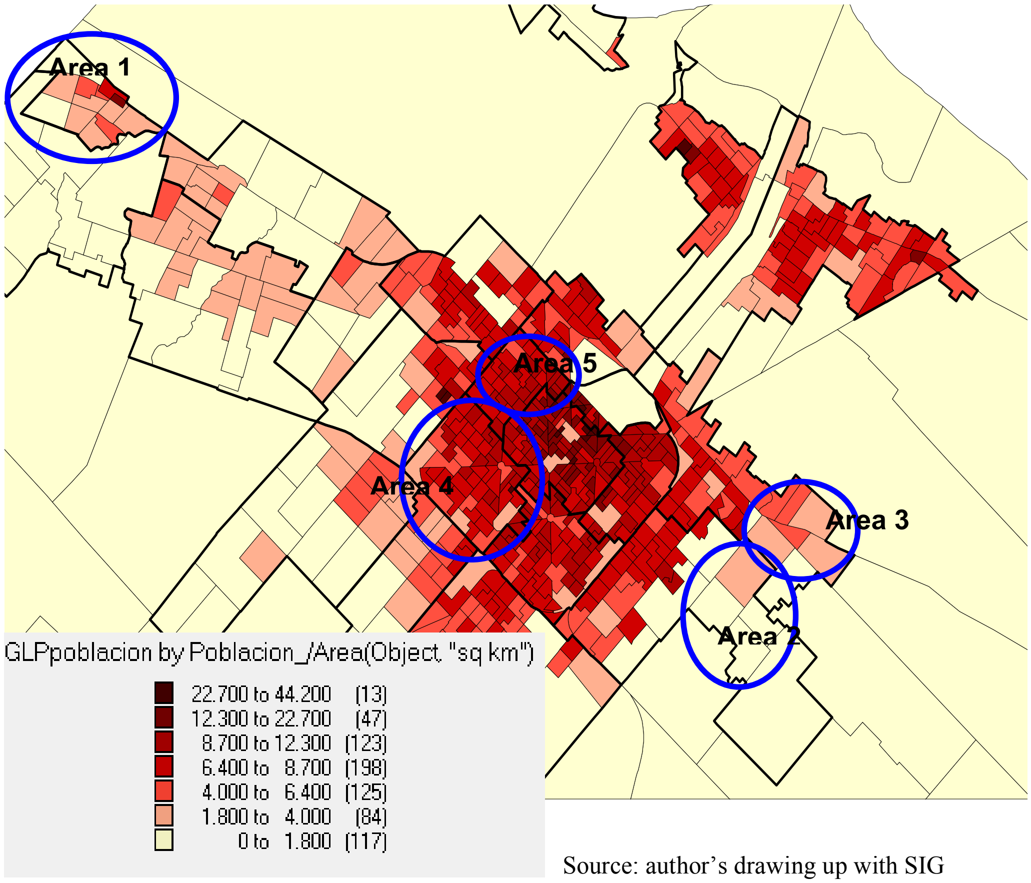
The fifth case is the northern zone of the urban centre which is highly consolidated. There is a population of 8,456 inhabitants and 2,967 households and its density varies –according to areas– from 50 to 123 inhabitants per hectare with an average of 100 inhabitants per hectare. Local regulations allow the highest residential occupation rate, that is to say, to reach a density of 800 inhabitants per hectare.

Residential energy behaviour analysis

The study was based on the analysis of energy behaviour in the residential area as well as in the emergent mobility. With regard to the residential area, an average consumption of 0.52 TEP (Ton of Equivalent Petroleum) per inhabitant and per year was considered. It includes gas consumption, especially for cooking and heating, and electricity consumption for lightning and the use of electrical gadgets (Rosenfeld, 2000).

Table 1 shows this broken down consumption for each presented area. The observed differences show a consumption variation that is closely related to people's purchasing power. The lowest consumption implies less environmental comfort due to less financial resources.

Figure 2. Density of the 5 studied areas. (2001)



Source: author's drawing up with SIG

Table 1. Energy consumption per inhabitant (in TEP)

Case	Population	House	Inhabitants/house	Energy consumption		Gas consumption		Total consumption	
				TEP/house/year	TEP/house/year	TEP/house/year	TEP/house/year	Total TEP	TEP/Inhabitant/year
1	11,263	3,174	3.5	0.206	0.059	1.75	0.5	6,307	0.56
2	5,760	1,471	3.9	0.2095	0.053	1.7599	0.45	2,895.4	0.50
3	8,428	2,050	4.11	0.205	0.05	1.77	0.43	4,045	0.48
4	40,403	12,828	3.2	0.2095	0.065	1.7599	0.59	25,163	0.61
5	8,456	2,967	2.85	0.208	0.073	1.77	0.62	5,834.6	0.69

Table 2. Population, households and population mobility

Studied Cases	Population	House	Density Inhabitants/ha.	Number of trips			
				Total	Internal	External	% Ext.
1	11,263	3,174	Low 20 to 50	6,533	1,758	4,775	73
2	5,760	1,471	Low 20	3,540	742	2,798	79
3	8,428	2,050	Low 40	4,473	648.6	3,824.4	85
4	40,403	12,828	Middle-high 50 to 100	46,567	19,069	27,498	59
5	8,456	2,967	Middle-high 90-95	15,000	540	14,460	96

Source: author's compilation (2005)

Tables and 2 show the energy consumption per inhabitant in TEP and the relationship among population, house and mobility.
The average energy consumption has been considered taking into account the household occupation status as a variable to determine the number of TEP per inhabitant in each case. The obtained results allow us to infer that the consumption level is related to a higher purchasing power. This is observed by means of comparing the central area with the other three peripheral areas; and to compare case 1 with cases 2 and 3 as well. A particularized study to determine the state-subsidized houses behaviour (Czajkoski, 2004), in cases 1 and 2, has allowed us to compare the energy consumption of these areas with the general average consumption. In case 1 as well as in case 2, a 20% and a 40% of the houses were built by means of government housing plans. For both cases, the study through audits of energy produced the following results: in the housing located in the area of case 1 residential energy consumption per inhabitant and per year is 0.2117 TEP while in the housing of case 2 the residential energy consumption reaches only 0.1768 TEP per inhabitant per year. These figures are below the average consumption for both cases (see table 7) and they are explained not by means of technical reasons but by means of consumption habits associated with people's purchasing power. According to IRAM (national standards) regulations 11,604, reaching the minimum level of comfort requires a consumption of 0.42 TEP/inhabitant/year. General level reached in the studied cases according to Table 1. However, in order for the areas with state-subsidized households to reach such a level they need an estimated consumption increase that doubles the current one. This would lead to the application of energy conservation techniques of the houses so as to lessen this increase.
If we compare both cases from Villa Elvira, we can verify that in the west area energy consumption TEP(inhabitants/year) is slightly higher than in the east area, both being lower than in Villa Elisa and the two zones in the urban centre. In this last case, the northern area registers higher residential energy consumption per inhabitant (0.69 TEP/inhabitant/year).
These rates must be analysed taking into consideration the fact that the number of inhabitants per household in each of the areas is different, as the gas consumption per household is similar in cases 4 and 5; there exists a difference when consumption values per inhabitant are compared. It is important to highlight that in west Villa Elvira the number of inhabitants per house is 4.11 while in the urban centre and in Villa Elisa the figures are 2.85 and 3.5; respectively.

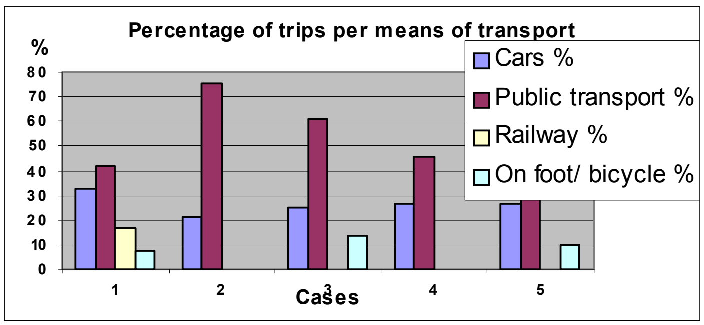
Mobility energy behaviour
1. Displacement analysis
As for the emergent consumption of the mobility, data was obtained from our own research on origin and destination, as well as calculations made as regards energy consumption.
Table 3 shows the numbers of trips in each of the areas. Study trips are differentiated from those that are from the city centre to other areas of the city. This defines the features of each analysed area in relation to the existence of availability of services and/or activities. (Ravella, 1995).

Table 3. Distribution of trips according to mode of transportation

Case	Total trips	Modes							
		Car	%	Public Transport	%	Railway	%	On foot/ bicycle	%
1	**6,533**	2,178	33	2,748	43	1,120	17	499	7.6
2	3,540	771	21.7	2,686	75.8				7.5
3	**4,473**	**1,140**	**25.5**	**2,715**	**60.7**	**0**	**0**	**618**	**13.8**
4	46,567	12,582	27	21,461	46				25
5	**15,000**	**3,945**	**26.3**	**9,555**	**63.7**	**0**	**0**	**1,500**	**10**

Source: author's compilation (2004)

Bar chart 1. Trips distribution according to mode of transportation



Source: author's compilation (2004)

Table 4. Trip destination per case

Case	Destination	
Case 1	External	70% urban centre (3324 trips)
Case 2	External	80% urban centre (2238 trips)
Case 3	External	80% urban centre (3059 trips)
Case 4	External	39.5% town centre (10099 trips)
Case 5	External	65% town centre (9399 trips)

In **case 1**, a total of 6,533 trips are made: 1,784 are internal and 4,749 are external (Table 2). Public transport is used to make 2748 trips. The train is used to make 1,120 trips. Mode distribution is 23% by train, 42% by public transport and 33% by private car (Table 3). Trips within the area show the following mode distribution: 28% by bicycle or on foot, 46% by public transport or *remisse* (a door-to-door transportation car service) and 26 % by private car. The destination of 70 % of external trips is the urban centre. (Table 4)

In **case 2**, the total number of trips made within the area is of 3,540 distributed as follows: 742 internal trips and 2,798 trips to other areas, 80% of which are made to the urban centre (Table 4). Trips are made by public transport (75.8%), private car (21.7%) and by bicycle or on foot (7.5%). (Table 3).

In **case 3** the number of trips made within the area is 4,473 distributed in the following way: 648 internal trips (14, 5%) and 3,824 external trips (85, 5%), 80% of which are done to the city centre. Out of the total number of trips, 2,715 (60.7%) are made by public transport, 1,140 (25. 5%) by car and 618 (13, 8%) by bicycle or on foot.

In **case 4** the total number of trips made in the area is 46,567. Their destination distribution is as follows: 19,069 are internal trips and 27,498 are made to other areas, 10,099 (39.5%) of which are made to the town centre (Table 4). Public transport is used to make 21,461 (46%), by car 27%, and by foot and bicycle 25% of the total number of trips (Table 3).
In **case 5** the total number of trips within the area is 15,000. Five hundred and forty (3.6%) are internal trips and 14,460 (96.4%) are external trips. Out of the total number of trips, 9,555 trips (63.7%) are made by public transport, 3,945 (26.3%) by private car and 1,500 (10%) by bicycle or on foot (Table 3).
Finally, from a detailed analysis of the tables above, it can be assumed that 73% of the population in case 1 travels to outer areas and that this percentage increases up to 85.4% in case 3. This higher percentage can be explained by taking into account the higher rate of urban consolidation in case 1. Mobility decreases up to 59 % in compact areas near the city centre. However, although case 5 shows a consolidated area with an average density, 96% of the population needs to travel to other areas. This demonstrates that its spatial arrangement is merely residential with insufficient services and workforce (Table 2).

2. *Analysis of combustible consumption*

Energy consumption in terms of mobility depends on trip distribution by modes, kilometres travelled and average consumption, shown in tables 5 and 6. In table 5 the percentage of cars driven by petrol and diesel fuel are shown. To analyze consumption by cars, 0,09L/km and 0.05L/km were considered as petrol and fuel diesel average consumption respectively. The number of passengers per car 1,6 pass/car was also taken into account (Ravella, 2000).

Table 5. Combustible consumption break down by mode

Mode	**Private car**		**Taxi and *remisse***
Total %	80%		20%
COMBUSTIBLE	Petrol	Diesel Fuel	Diesel Fuel
Mode %	80%	20%	100%
Total %	64%	16%	20%
Combustible %	64%	36%	

Source: author's compilation (2005)

For public passenger transport, an average diesel fuel consumption of 0,29 L/km and an occupational rate of 18 pass/car are considered (Sate Department of Transport, 2000). On the basis of these data, consumption is analysed according to type of combustible, transport mode per passenger/km, kilometres travelled by the population of the neighbourhoods in this study (see Table 6).

Table 6. Compared energy consumption by cars and public transport among the five study cases

Case	**Number of trips**	**Mode**							
		Car	**Km travelled/ day**	**L/pass/ km**	**Total L/day/pass/ km**	**Public transport**	**Km travelled/ day**	**L/pass/ km**	**Total L/day/pass/ km**
1	6,533	2,178	89,120	0,05	4,456	2,748	98,619	0,016	1,578
2	3,540	771	20,625	0,05	1,031	2,686	80,570	0,016	1,289
3	4,473	1,140	29,868	0,05	1,493	2,715	71,133	0,016	1,138
4	46,567	12,581	83,623	0,05	4,181	21,459	158,822	0,016	2,541
5	15,000	3,945	26,826	0,05	1,341	9,555	64,974	0,016	1,040

Source: author's compilation (2005)

By analysing trips by public transport, a variation between 42% (up to 59% if trips by train are considered) and 76% was found. A smaller variation between 21.7% and 33% was found for cars. The biggest number of trips made by car was reported in case 1, which clearly

correlates with the purchasing power of its population. This area shows, in turn, a smaller number of trips by public transport, although it is located within a longer distance from the urban area. In the urban area for cases 4 and 5, 27% and 26% of trips made by private cars were found respectively. This shows the greater influence of purchasing power compared with distance and consolidation factors. The analysis of the variables in this study shows different mobility behaviours in terms of certain characteristics of the population. This makes energy consumption per inhabitant in each study case possible to be analysed.
In **cases 1, 2 and 3** considered as sprawl city, energy consumption per inhabitant per year is not higher than 0,16; 0,12 and 0,09 TEP respectively with a difference of 0,07 TEP. The comparison of the three cases shows that longer distance and purchasing power in case 1 prevails over multimodality and consolidation.
In **cases 4 and 5** considered as models of compact city, the highest energy consumption is 0,05 and 0,08 TEP respectively. The difference between the two cases can be explained by taking into account the multifunctionality in case 4 which requires less mobility than in case 5 which shows a merely residential profile.

Bar chart 2. Total energy consumption

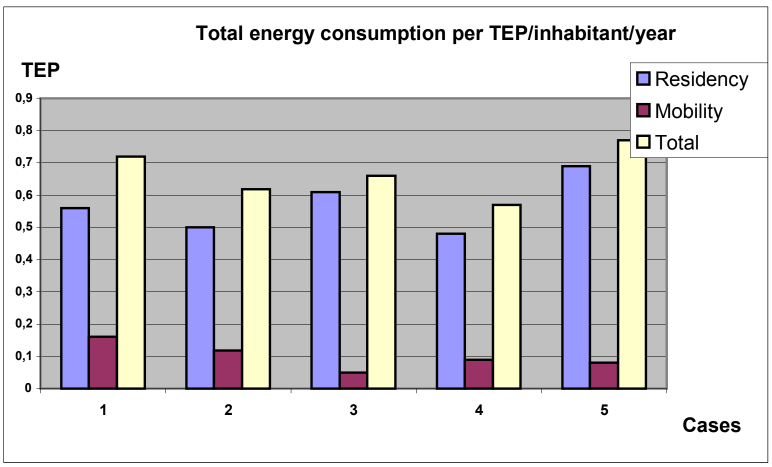


Table 7. Energy consumption residential zone and mobility

Case	Total energy consumption TEP/inhabitant/year		
	Residential	Mobility	Total
1	0,56	0,16	0,72
2	0,50	0,12	0,62
3	0,48	0,09	0,57
4	0,61	0,05	0,66
5	0,69	0,08	0,77

Source: author's compilation (2005)

Table 7 and bar chart 2 show total energy consumption in terms of residential area and mobility. It is evident that values for transport are determinant in dealing with the complex interrelation between accessibility and consolidation node rates, although they are lower than those for housing. For example, in case 5, total energy consumption is 0,77 TEP/inhabitant/year being the highest value in comparison with the rest of the cases, which correlates with the higher purchasing power of its population. When residential energy consumption is compared by areas, case 5 also shows the highest value. In terms of mobility, case 5 divides the table (the median) into sprawl city and compact city.
Energy savings per inhabitant in terms of mobility have been reported (approximately 50%) when there is a consolidated node and a high accessibility rate since both promote shorter

distances and the use of non-motorized vehicles. This is demonstrated by the difference in TEP energy consumption between cases 5 and 1.

Conclusions

The current study has demonstrated the suggested hypothesis; that is to say, transport energy consumption depends on the adopted modes due to urban expansion. However, this variable defined by physical-space criteria is not enough to describe urban models oriented from the perspective of sustainability. The problem can be solved by means of a complex equation introducing social and economical aspects. Thus, it can be suggested that high incomes in the residential area determine housing comfort conditions and auto-regulated energy consumption. In terms of mobility, there is evidence that the accessibility-mobility relation is not so determined since there is a minimum threshold of trips under which the mobility-immobility continuum can be observed.

The analysis in terms of mobility makes possible to consider, from the point of view of urban form, that a high rate of urban consolidation node promotes higher levels of energy savings. This is clearly shown by case 1 compared with case 4 in which energy savings reach up to 68%. Moreover, 37% of energy savings per inhabitant is also reported in the compact multifunctional urban centre (case 5) in comparison with the residential area (case 4).

It is evident that the analysis of the transport energy consumption seems to be shadowed by the analysis of the total energy consumption in the residential area. The latter is intersected by the economical variable related to the income of the population and shows a higher consumption in compact areas with less mobility. This means that considering energy consumption as the main energy efficiency indicator in certain areas is not enough, so it should be complemented with other factors that contribute to delimiting exact minimun and maximun measurements in both compact and diffuse areas. Therefore, modality should be taken into account. High mobility consumption in peripheral areas could be reverted by planning transport systems including rail ways. Furthermore, a higher centralization of activities in those zones could lead to a decreased mobility.

These particularized studies show the need of jointly developing energy conservation norms for building environment and urban design along with decisions on lands use planning related to transport policies. Therefore, environment sustainability depends on the appropriate decisions taken in the political administrative sphere.

References

- Aón, L. et all (2003) “Evaluación de consumo energético y emisiones contaminantes del sector transporte en la Microregión del Gran La Plata”, Revista Avances en Energías Renovables y Medio Ambiente (ASADES), Vol. 7, Nº 1, octubre.
- Czajkowski, J. (2004) Propuesta para publicación “El problema de los modelos de consumos simplificados en la determinación de la demanda de energía en viviendas de interés social”.
- Cortés, Luis (2002) “La ciudad difusa” Revista Ciudad, Vivienda y Ciudadanía., Junio, Madrid.
- Estevan, A.; Alfonso Sanz Aludan (1996) “Hacia la reconversión ecológica del transporte en España”, Los Libros de la Catarata, Barcelona.
- Ferrás Sexto, Carlos (2000) “Ciudad Dispersa, Aldea Virtual y Revolución Tecnológica. Reflexión acerca de sus relaciones y Significado Social”, Scripta Nova. Revista Electrónica de Geografía y Ciencias Sociales. Nº 4, Vol. 69
- Frediani, J. (2004) “Modelos Urbanos: La ciudad compacta y la ciudad difusa. Su análisis a través de las redes de servicios y transporte en el Partido de La Plata”. Informe de beca de Formación Superior. Universidad Nacional de La Plata. La Plata.
- Molina, Eduardo et all. (1980) “Consideraciones generales en torno a la política de transporte urbano”. *Ciudad y Territorio*. Pag 7-17. ISBN/ISSN 02100487 (April-June)
- Monclús, F. Javier (1999) “Ciudad dispersa y ciudad compacta. Perspectivas urbanísticas sobre las ciudades mediterráneas”. Cicle de Conferències "Ecología Urbana". Centre

Cultural la Mercè, Girona, 1997. *D´Humanitats*, 7, Pág.: 95-110. Ajuntament de Girona. Universitat de Girona.
- Pozueta, J. (2002) "Movilidad urbana para una planificación sostenible". En: *Revista de Urbanismo* N 6, ISSN 0717-5051. Universidad de Chile- FAU (July)
- Ravella, O et all. (1995) "Modelo de optimización del Autotransporte Público de Pasajeros". Unidad de Investigación 6B, IDEHAB, FAU, UNLP.
- Ravella, O.; Giacobbe, N.; Frediani, J. (2004) "Forma Urbana, Movilidad e Insustentabilidad. El Caso de la ciudad de La Plata". Seminario "La Cuestión Ambiental Urbana: Experiencia y Perspectiva". Seminario NEUR/CEAM/UnB -Centro de Estudios Avanzados Multidisciplinares. Brasilia (July)
- Ravella, O., Giaccobe, N. y Frediani, J. (2003) "Rupturas y tendencias en la expansión urbana analizadas desde la movilidad". En: *Revista Estudios del Hábitat*. Vol. II No. 8 Instituto de Estudios del Hábitat, Facultad de Arquitectura y Urbanismo, Universidad Nacional de La Plata.
- Rosenfeld, E. et. all. (2003) "El uso de la energía en el sector residencial del Gran La Plata. Discriminación de consumos, cambios tecnológicos y opinión de los usuarios en las décadas del 1980 y 1990". Rev. Avances en energías renovables y medio ambiente (ASADES). Vol. 1, pag. 01-06. ISSN 03295184
- Rueda, Salvador. (2001) "Modelos de Ordenación del territorio más sostenibles". Zaragoza. http://habitat.aq.upm.es/cs/p2/a009.html (April)