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Benefits and Opportunities of increasing the Building Potential of Brownfields in the Metropolitan Area of Barcelona

A case study of the city of Barcelona

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Abstract

Evidence from previous censuses highlights a continuing decline in population and employment growth in the municipality of Barcelona and other intermediate cities of the metropolitan area, while small municipalities have experimented rapid growth of employment and population. As a result, land is rapidly urbanised in the periphery, at an average rate of 1,000 hectares of undeveloped area been urbanised per year. This process is covering the currently most productive soils used for agriculture in the metropolitan area. Since 1975, urbanised area in the periphery has grown 122 per cent, while population has increased 7 per cent. As a result, the density has decreased from 200 to 85 inhabitants per urban hectare. As a consequence, low-density urbanisations have high maintenance expenditures per capita, and population and activities are dispersed, with implications for increased travel distance and higher levels of mobility. As a result, sprawl have resulted in settlements becoming less socially cohesive, less sustainable, and less economic efficient. By evaluating the new Catalan Land Act 2/2002, it is expected an increase of sprawl through the territory. In addition, the current national and municipal taxation system are encouraging developers to sprawl. National government and communes at the periphery subsidise the building cost of connecting new out-of-town urbanisations with the current grid of services and existing roads, with the taxation revenues from inhabitants living in big and intermediate cities. If communes in the metropolitan area encourage developers to re-use previously urbanised land, then maintenance expenditures per capita are reduced in small municipalities, and current agricultural land, public open space, ecological habitats and biodiversity are preserved in the metropolitan area of Barcelona. If planning policies in Barcelona increase the building potential of the city, this will provide local employment, services, facilities and dwellings that may reduce the current travel distance and increase the proportion of short journeys capable of being travelled by non-motorized modes. In addition, there will be fewer maintenance expenditures of the current urbanised area and infrastructure per capita in Barcelona, and the commune will increase taxation income, which might be used to increase the quality of the built environment, and to improve the public transport.

Table Of Contents

1. Introduction

1.1 Background

According to the European Environmental Agency, over the last 20 years the built-up area in major western and eastern European countries has increased by some 20 per cent, much faster than EU population growth over the same period –6 per cent. This has caused loss or disturbance of natural areas and significant fragmentation of animal and plant habitats in most of Europe (EEA, 1999a). Loss of agricultural land through sprawl and transport infrastructure is high and similar in several countries. In the United States, one million hectares of prime farmland have been taken-up for low-density urbanisations in the last decade (Carley and Spapens, 2001), and pollution from cities has already reduced crop production by almost 10 per cent. We are the first generation that has ever faced a simultaneous and worldwide expansion of our metropolis, depleted land resource and eroded the environment like never before.

Every day the metropolitan area of Barcelona grows at a size of 3-football stadiums of new urbanised land (Carrera, 2002: 85), and yet population does not grow. The dispersal of population and activities has resulted in settlements becoming less sustainable and less socially cohesive, with implications for increased travel distance and higher levels of mobility in the metropolitan area of Barcelona. For example, the time spent travelling on the roads is increasing over time and reached a daily lost of 2 million man-hours in Barcelona (ATM, 2000: 120), with more than 4 million motorized journeys causing Barcelona's massive traffic congestion (ATM, 2000: 120) and more than 2 million litres of petrol burned out daily in the motor engines in 1998 (ATM, 2000: 101 and 113).

> *"Cities, conurbations, metropolitan areas, megalopolises, urban corridors, diffuse nebulae are all successive phases in a large-scale urbanisation process in the suburbia of Barcelona, the extent and scope of which have not been fully accepted either politically or culturally, and whose final outcome is as yet unknown."*
>
> Barcelona Metropolitan Masterplan (PTMB, 1999: 283)

The exactly long-term effects of the current land-use trends in the metropolitan area are not yet clear, but planning decisions are demanded before any certainty. Given the uncertainty concerning their precise effects we may draw decisions in the face of what is commonly termed the *Precautionary Principle*. The notion of preventative and anticipatory action is central to accompany this principle, pondering how to anticipate the indeterminate or unknown.

There is a clear link between climate change, sustainable development, environmental quality and city planning decisions. Scientists agree that Earth's climate is being affected by the increase of greenhouse gases caused by human activities –mainly by burning fossil fuels- and also the land-use changes. Inhabitants living in the metropolitan area of Barcelona generate the majority of greenhouse gases, and scientists warn of the disastrous likely effects of current levels of greenhouse gas production on the global warming and the depletion of the ozone layer. Climate change could lead to urban degradation. At the same time, virgin land been artificialized cannot play any role on the sequestration of atmospheric carbon. Soil organic matter and soil organic carbon are lost through land paved over, and so, its capacity to act as a carbon sink. Moreover, virgin land is the

vital resource for agriculture and farmers, and its reduction affects the fragmentation and depletion of ecosystems.

Urbanism theories must be redefined in order to find solutions to problems posed by contemporary cities. Current urbanism culture and practice, is based largely on conventional theories and methods, and the fact is that from the middle of this century, has been overflowing its boundaries and has been invading outlying zones, swallowing up neighbouring villages and towns in the process.

Current urbanism is based on requirements for car space of parking and access within the city. Parking standards require at least 15 m2 for a single car. After the second half of last century, the entire city of Barcelona has been designed around road specifications for the benefit of cars. Thus, the densities of the city, the spacing of buildings, or the overall shape of streets -34 per cent of the space in the Eixample district is for the use of cars. In addition, motorization and the use of car are increasing every year so the planning authorities in the communes are proposing to decrease the density of the city to avoid its collapse.

New concepts of urban planning that integrate social responsibilities are needed. For example, in 1999, 13 percent of the total population in the metropolitan area - half million of inhabitants–-living in 30 per cent of urbanised area –14,000 hectares- had no access to public transport (PTMB 1999). This situation creates segregation of households with less or no access to car -such as the young, the poor, and the women. Once the land has been developed, it is very difficult to revert to a more sustainable concentrated or public transport orientated urbanisation.

The current planning legislation in the metropolitan area is an expensive and irreversible process for the society, the economy and the environment, and its attempt at the aesthetic control over the city and the landscape has failed.

1.2 Problem definition

The objective of this chapter is to outline the historical background of the demand of land for dwellings, activities, mobility, services and facilities in the metropolitan area of Barcelona, the inertia that results from it and the most likely future tendencies.

The metropolitan area of Barcelona –BMA- is a region of 3,350 Km2 located at the north-eastern extreme of Spain, with 110 km of coastline. The region is made up of two relatively flat strips of land that run up along the entire length of the coastline. The first is approximately 10 km wide, and is located between the cost and the Coastal mountain range; the second is 25 km wide, and is located between the Coastal and Pre-coastal ranges. In this area there are 4.2 million inhabitants (1996). The growth of the urbanised land in the metropolitan area is the result of simultaneous processes of extension and dispersion of activities and households on the 136 different municipalities –*see figure 1-1* and *figure 1-2.*

Figure 1-1 Catalonia in the European Union.

Figure 1-2 Barcelona Metropolitan Area in Catalonia

The proximity of these municipalities in the periphery with the city of Barcelona, with 1.6 million inhabitants (1996) living in 97 km2, has induced to similar and simultaneous urbanisation processes –*see figure 1-3*.

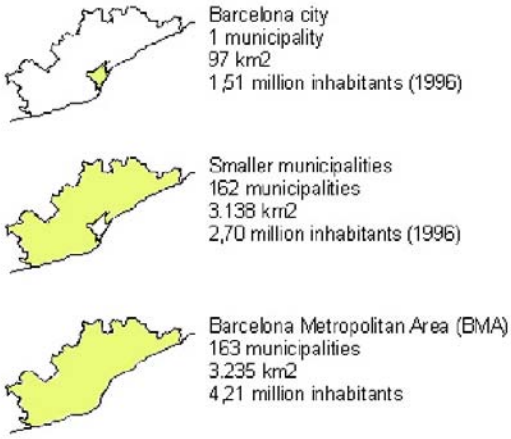

Figure 1-3 Administrative divisions within Barcelona Metropolitan Area.

Evidence from previous censuses highlights a continuing decline in population in the municipality of Barcelona and other intermediate cities[1]. The number of inhabitants in Barcelona has decreased by 250,000 on the last 15 years (Nel.lo 2001: 120). The highest percent of increase of population is for small municipalities with 1,000 to 10,000 inhabitants. *See table 1-4.*

[1] Intermediate city: municipality with more than 100,000 inhabitants and less than 250,000.

Inhabitants in the municipality	Absolute change[2]	% of average change
<1.000	+1.624	+19,59%
1.000/5.000	+23.763	+25,25%
5.000/10.000	+42.085	+23,16%
10.000/20.000	+37.784	+13,63%
20.000/50.000	+49.364	+10,18%
50.000/100.000	+31.765	+7,33%
100.000/250.000	-19.122	-1,30%
>1.500.000	-4.921	-0,33%

Table 1-4 Change of population from larger to smaller municipalities from 1996 to 2001 in the metropolitan area of Barcelona. (Source: Roca 2002)

This phenomenon is called the "*counterurbanisation cascade*", thus population is moving from larger to smaller municipalities and from inner urban areas to peripheral and remote municipalities of the metropolitan area (Barton 2002:31). *See figure 1-5 and 1-6.*

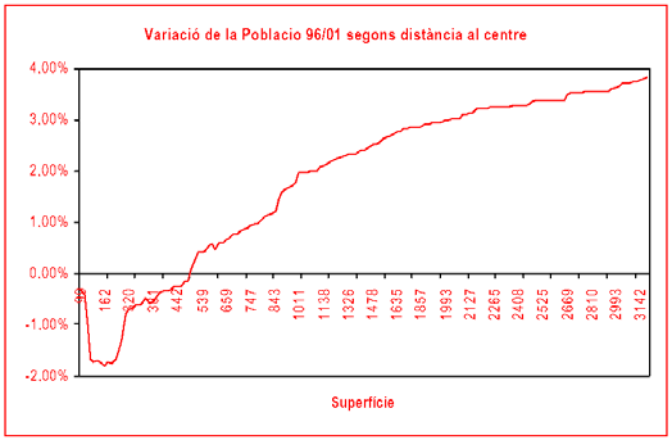

Figure 1-5. Change of population with the distance from the Barcelona city centre in the BMA. (Source: Roca, 2002)

[2] Absolute change: change in the total number of inhabitants in one municipality

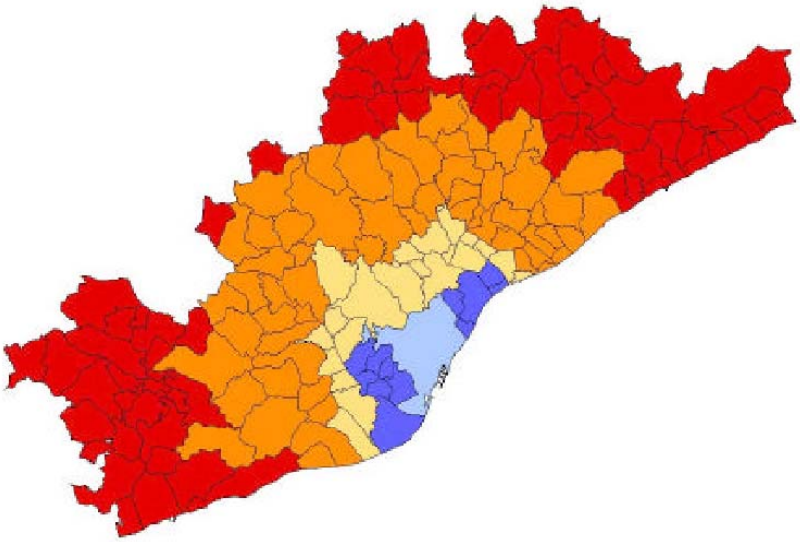

Figure 1-6 Movement of population from inner Barcelona to remote areas in the BMA. (Source: Roca, 2002)

Over the last decades, small municipalities have experimented rapid growth of population and employment, and as a result, land is rapidly urbanised in the periphery. In 1972, there were 21,000 hectares of urbanised land in the metropolitan area and, twenty years later, the urbanized land has increased to 45,000 hectares (PTMB, 1999). From 1972 to 1986, an average of 1,700 hectares have been urbanised every year in the periphery (Serratosa, 2000), and after 1992, this figure is still as high as 1,000 hectares per year.

The covering of soil is affected by land been developed[3]. Land is developed through urbanisation of greenfield land, new transport infrastructure -like roads, airports, railways, ports, telephone network, or electric grid- and a wide range of periurban uses occurring on non-urbanisable land, such new out-of-town isolated activities and services close to the roads. For example, from the total 54,000 hectares developed in 1992, there were 3,000 hectares of roads, and almost 7,000 hectares of services within non-urbanisable land (PTMB, 1999: 75).

This process is called soil sealing. The European Environmental Agency (EEA 2000: 13) defines soil sealing as the covering of soil as a result of urban development and infrastructure construction, with the result that soil is no longer able to perform the range of functions associated with it. According to the EEA, *"land sealing is not adverse per se; rather it is the irreversibility in practical terms of sealing the soil and the consequent loss of soil functions that is significant."*

25 per cent of the total surface area in Barcelona metropolitan area is agricultural land. This land is subject to intense pressure to become available for urbanisation, mainly due the high value of the housing sites. Value of agricultural land varies greatly depending on its location, productivity and the demand for urban land in the municipality. For example, the price of one hectare of agricultural land in Penedes can cost 20 times less than in Maresme municipalities (PTMB, 1999: 299).

The evolution of the cultivated agrarian area from 1982 to 1989 shows a drop of 16,600 hectares – *see table 1-9*. Thus the existing area has decreased 20 per cent in only 7 years. Agricultural land is subject to pressures of developers demand. Farmers sell their land to developers –*see figure 1-7-*

[3] Developed land: land occupied by transport infrastructure or been urbanised.

and developers often abandon first-class agricultural land in the expectation that one day this land will be developable.

Land-use	Hectares in 1989	Loss of hectares 1982-1989	Hectares in 2006	Decrease in % 1989-2006
Total agricultural area	180,000	-22,600	126,000	-30
Forestry area	96,000	-6,000	80,000	-17
Agrarian land	82,000	-16,600	46,000	-56

Table 1-7 Loss of agriculture land in BMA from 1982 to 1989. Expected loss in 2006. (Source: Rueda, 2002)

Edaphic studies permitting the basic characterisation of the agricultural land have been carried out in the region (PTMB, 1999: 300), and show the agricultural land that is supported by first-class soil conditions. The highest productive areas in the metropolitan area are located in the two relatively flat strips of land that run up along the entire length of the coastline. Residential and industrial uses demand districts to be developed in these zones, along the riverbanks and the coastline. Deltas, valleys and the coastline area are morphological zones very suitable for both agricultural production and industrial and residential uses. As a result, new developments are covering the most profitable soils of the region.

Land is a limited resource and there is competition between concurrent uses of land due to concentration of activities in the same area. According to the planning previsions in the region, the capacity of the current bulk of *urbanisable*[4] land may be finished in the next decades (PTMB, 1999: 298). The competing demands result in more urbanisation of land, and the reduction of unprotected non-urbanisable area, which ultimately leads to a gradual reduction in the available resources. This process is illustrated in the causal loop diagram below. *See table 1-8.*

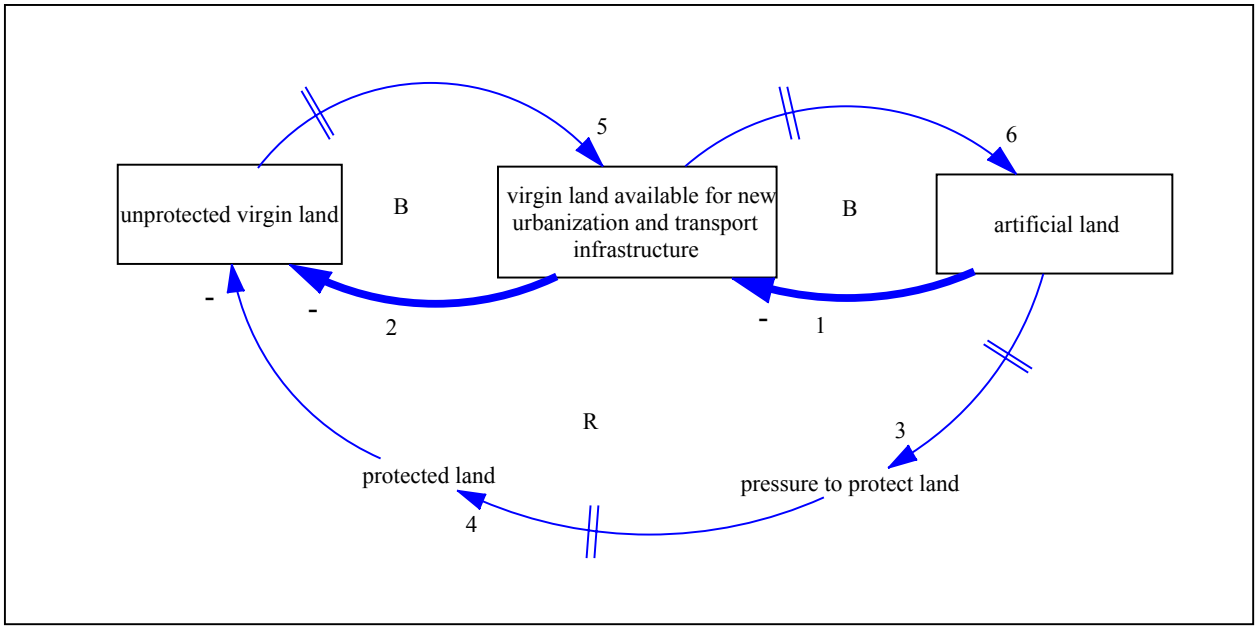

Table 1-8 Causal Loop Diagram of the unprotected virgin land, land available and artificial land flows.

[4] Urbanisable land: undeveloped land available for new urbanisation

Furthermore, biomass is reduced with urbanisation growth and land looses its capacity to absorb carbon dioxide and store carbon, thus reducing the built-up of greenhouse gases. In addition, when land is urbanised there is the risk of losing ecological habitats and biodiversity in the metropolitan area. *See table 1-9.*

In addition, according to Holmes Rolston, there are other areas of value associated with undeveloped land and nature, that allow a wide range of human and non-human activities, such as its life support value, its aesthetic value, the diversity, the dialectical, the sacramental, etc. (in Connelly and Graham, 1999: 21).

In 1999 *non-urbanisable* land[5] was 75 per cent of the total area in the region, accounting for 244,000 hectares, but only 29 per cent of it was *protected.* Regulations on protected land are contained in the Land Act *–Llei del sòl 10/2002-*, the Coast Act *–Llei de Costes 22/1988-*, the Natural Spaces Act *–Llei d'Espais Naturals 12/1985-*, and the Plan of Spaces of Natural Interest *– Pla d'Espais d'Interès Natural, PEIN 12/1992-* and protect the most outstanding environmental interest areas against urbanisation [6].

Protectionists pressurise to the government to increase the area of protected on non-urbanisable land against urbanisation growth *-see table 1-10, links 3 and 4*. As a result of all this process, unprotected land decreased 44,500 hectares in two decades. *See table 1-9.*

1980	62,000	230,500	31,000
1990	72,000	200,000	51,500
2000	75,000	186,000	62,500

Table 1-9 Hectares of protected, unprotected and artificialized land in Barcelona Metropolitan Area. Source: (Source: Serratosa, 2000; Solans, 2002: 56; PTMB, 1999: 202; Rueda, 2002: 78)

1.2.1 Travel distance increase

> *"Thirty-four man-years are spent per day commuting on the freeways in Houston. Yet the ride heals, soothes, and eases the jump cuts between home and work, between nature and culture, between byway and freeway, between his and hers"*

[5] Non-urbanisable land: land that cannot be developed with the current municipal planning. Non-urbanisable land can be protected or unprotected. When land is unprotected, planning can make it urbanisable.
[6] Protected land: agricultural or natural land that cannot be urbanised. Yet, protected land can be developed with transport infrastructure and other periurban activities.

Lerups (2001: 19)

Since 1975, urbanised area in the periphery has grown 122 per cent, accounting for 28,000 new hectares of urbanised land, while population has increased 7.5 per cent in the metropolitan area. As a result, the density[7] has decreased dramatically from 200 to 85 inhabitants per urban hectare -*see figure 1-10*- with 40 per cent of the developed area of isolated[8] low-density districts of single-family dwellings with only 10 per cent of dwellings (PTMB, 1999: 291).

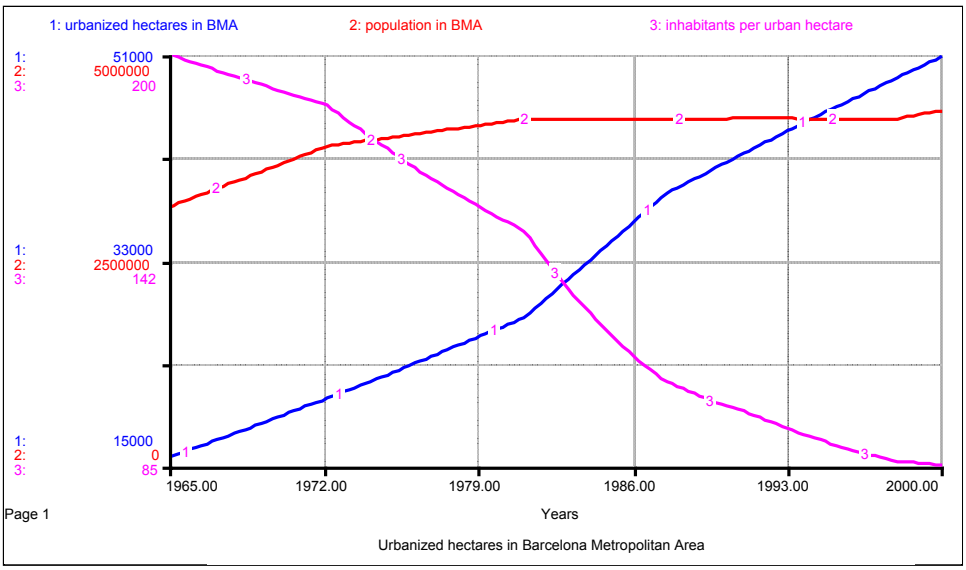

Figure 1-10 Urbanized hectares, population and inhabitants per urbanized hectare in Barcelona Metropolitan Area from 1965 to year 2000 (Source: Carrera 2002: 20; Rueda, 2002: 78; Serratosa, 1999; Solans, 2002: 56; PTMB, 1999: 202)

As a result of a reduction of density in Barcelona, the number of inhabitants living in Barcelona and working in the city has decreased over the last years, while the number of inhabitants in Barcelona that are working in smaller municipalities and remoter areas is slightly increasing –11 per cent. The *real* [9] price of car travel, including the insurance, servicing, repairs, road tax, fuel and oil fell by almost 8 per cent over the last 20 years in Europe (Barton 2002:31). Thus, the real price of travel does not increase over time as the real price of land and the quality of life in the city of Barcelona do. As a result, there is more population commuting to the city over time. From 1986 to 1996, this accounts for 71,600 employments -*see figure 5-6*- which is 27 per cent of the new employments in the region.

Second, there is an slightly increase on the number of inhabitants living and working in intermediate cities -17 per cent of total employment growth over the same period - while the number of inhabitants in smaller municipalities commuting to Barcelona and other intermediate cities has dramatically increased –60 per cent of the total employment growth. Price of land in small

[7] Density: inhabitants per urbanised hectare
[8] Isolated district: out-of-town development
[9] Real price: increase of price with respect to the increase of disposable income.

municipalities is low compared to bigger municipalities, and the real cost of travel is inexpensive compared to the price of land. Population flows are illustrated in figure 1-11.

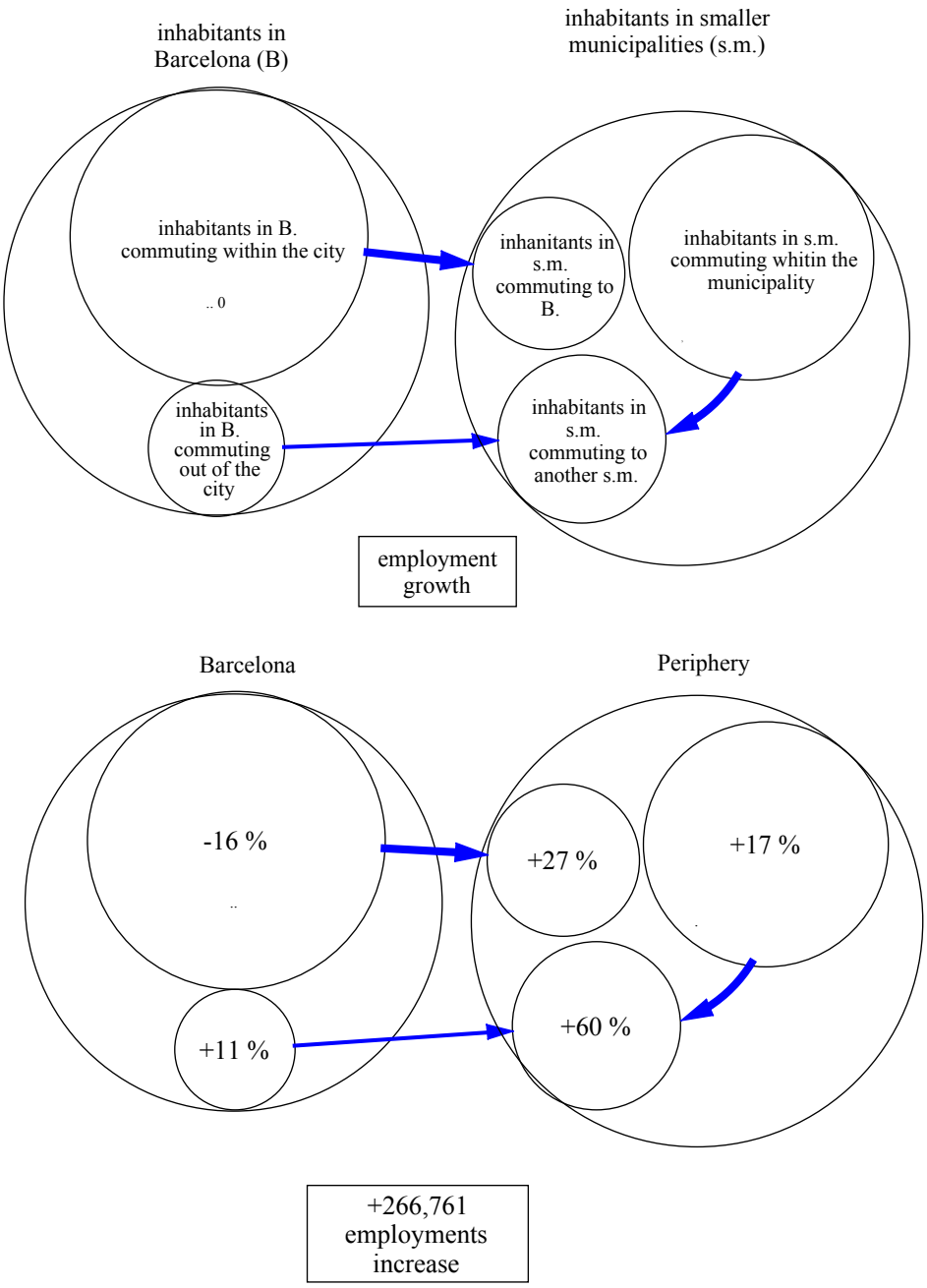

Figure 1-11Population starting to commute in the Barcelona Metropolitan Area, from 1986 to 1996. Data from different sources (Clusa, 2002; Nel.lo, 2001; PTMB, 1999

At the same time as the dispersal of the population, employment, leisure and retail developments move to remote locations, although a lot of employment remains within large urban areas. This is reducing the employment growth in the city. For example, if we look at the total number of households commuting within the city in 1996, the employment was reduced 16 per cent of the total in 1986, accounting for a loss of 42,000 employments. While 71,500 new commuters from the outer

periphery started working in the city –11 per cent of the employment growth in the metropolitan area. See figure 1-11.

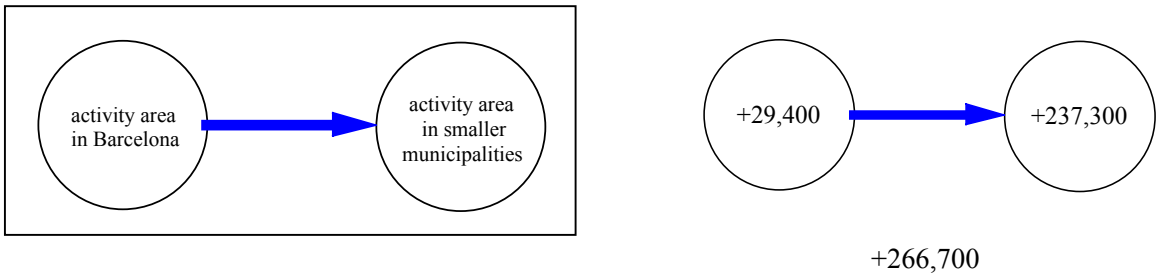

Figure 1-12 Migration of employment and total employment.
Data from different sources (Clusa, 2002; Nel.lo, 2001; PTMB, 1999)

As a result, there were 29,400 new employments in the city, while employment in the periphery had 237,300 new employments. *See figure 1-12.* The employment growth in Barcelona was 10 per cent of the total growth in the region. Yet, there was an increase of 71,500 new commuters from the periphery. This makes a total amount of 242,000 commuters from the periphery to the city in 1996.

This results increasing travel distance. Everyday 2 million cars drive off through the streets of Barcelona with pollution and congestion that divide communities in the city. In 1996 commuters in the metropolitan area spent more kilometres - 500 million kilometres- and more time -26 million hours- than 10 years before (Nel.lo 2001: 154). Inter-municipal journeys[10] in the metropolitan area increased 16 per cent from 1991 to 1996 (PDI 2002: 13). Motorization rate increases an average of 2.8 per cent every year –in 1998, 425 cars every 1,000 inhabitants (PDI 2002: 13). The number of journeys using public transport for inter-municipal commuting increased one-third in 15 years, while the number of journeys by car increased 3 times. In 1981, 50 per cent of journeys used public transport, and in 1996, only 27 per cent, and according the PDI (2002:14) this trend is estimated to continue increasing in the next decades. As a result, virgin land remains subject to significant pressure from the expansion of the transport infrastructure.

[10] Inter-municipal journeys: journeys from one municipality to another within the metropolitan area.

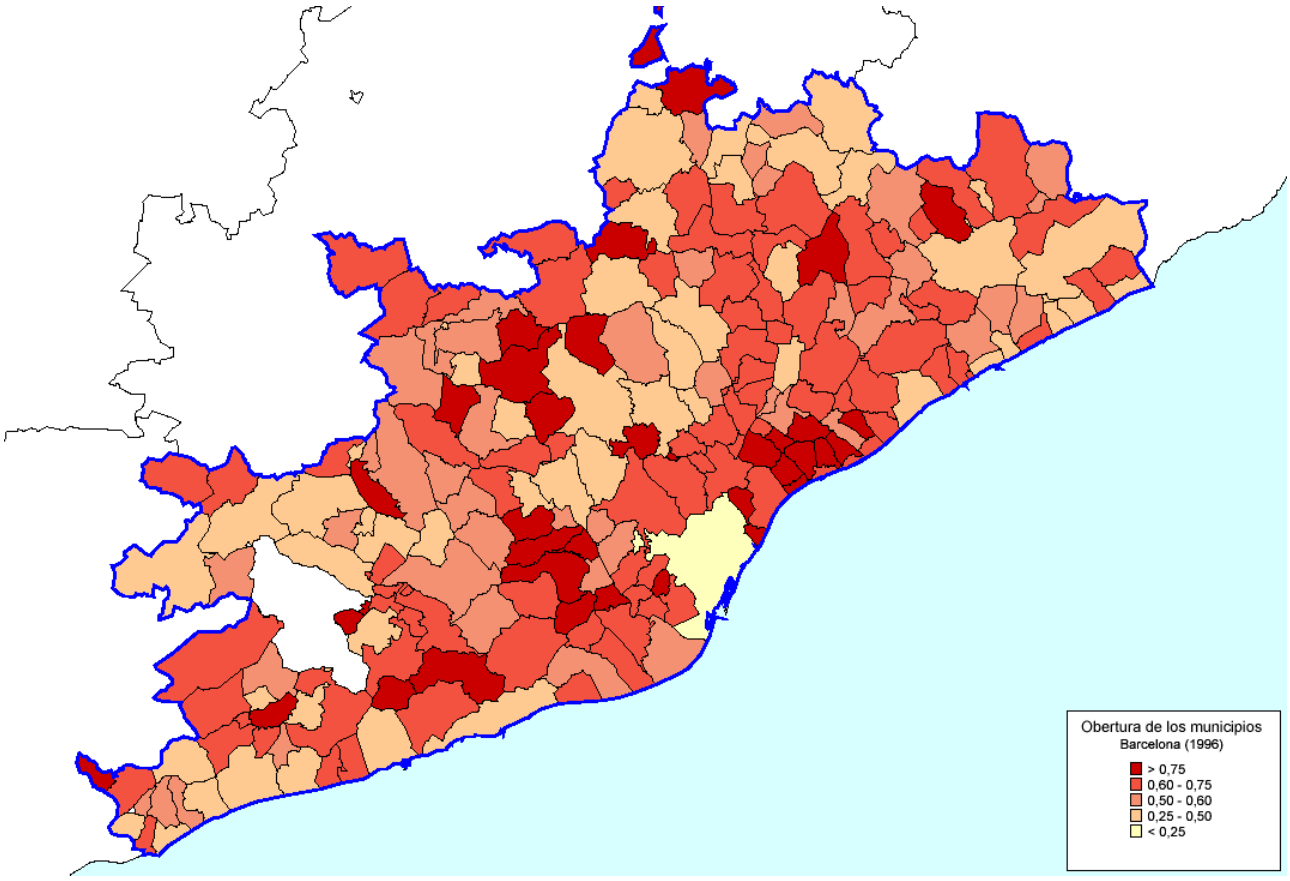

Figure 1-13 Per cent of Inter-municipal commuting within the municipalities of Barcelona metropolitan area.
In white, less than 25 % (Barcelona); grey 25 to 50 %; dark 50 to 60 %; darker from 60 to 75 %; darkest more than 75 %. Source: CPSV (2001)

In 1986, 67 per cent of the employed population in the metropolitan area was commuting within the municipality, and 10 years later the rate decreased to 55 per cent, while Barcelona municipality has more than 80 per cent of employed residents commuting within the city (Nel.lo 2001: 119). According to different authors, this trend is expected to continue in the next decades (PDI 2001:14, Nel.lo: 119). *See figure 1-13.*

1.3 Research Objectives

> *"There is insufficient data available to enable an assessment of the extent to which the re-use of previously developed land is reducing pressures for development on virgin land".*
>
> EEA (2002)

Over the last decades, agricultural land and ecological habitats have been dramatically reduced together with the loss of public open space and biodiversity in the metropolitan area of Barcelona. The current annual urbanisation growth is expected to continue over the next decades, and yet it has

economic, social and environmental impacts on society and individuals. Therefore the purpose of the thesis is:

1) To propose procedures for decreasing the current agricultural land reduction, and the current loss of ecological habitats, public open space and biodiversity in the metropolitan area of Barcelona.
2) To propose urban planning policies in Barcelona that increase the building potential of the city, providing local employment, services, facilities and dwellings that may reduce the current travel distance and increase the proportion of short journeys capable of being travelled by non-motorized modes.

1.4 Research Question

In order to fulfil the research objectives described above, the following research question should be investigated and deeply analysed.

"How can municipal planning authorities reduce pressures of development on greenfield land[11] in the metropolitan area of Barcelona?"

Subquestions

The following subquestions are necessary to understand the nature of the problem and its current status and, finally to explore the possible solutions that are presently being managed in order to deal with the problem stated before.

1) *Is the re-use of previously developed land reducing pressures of development in greenfield land?*

2) *Why small municipalities allow or promote sprawling?*

1.5 Expected Outcome

Compared to urbanising undeveloped land, re-using previously developed land has social, economic and environmental benefits. If travel cost increases, tax to property is raised in the sprawled areas and authorities allow re-development of brownfield sites[12] within the city, then there will be less depletion of agricultural land

[11] Greenfield: undeveloped land
[12] Brownfield: previously developed land that can be re-used or is not in current use.

2. Methodology and materials

The research has been conducted through several stages. The first step is based on the problem definition of the current problems of sprawl and increase of travel distance in the metropolitan area of Barcelona and my understanding of the problem. Then I have done a preliminary data review from literature of different environmental, economic and social impacts of sprawl in the metropolitan area of Barcelona. For this I have used data collected by different metropolitan institutions in the development of projects within the geographical and systems boundaries of my research, such as the Metropolitan Authority of Transport (ATM, 2000), the Barcelona Metropolitan Masterplan (PTMB, 1999), and the Plan of Integration of Inter-municipal Public Transport (PDI, 2002). The research question and subquestions were defined during this stage while narrowing the scope and limitations of the thesis research.

The second stage included the study, verification and analysis of my understanding of the problem through the data previously collected. The case study research approach is based on system dynamics principles. The advantages of using dynamic principles lies in their ability to reveal the underlying relationships of complex processes, and find simple explanations to complex problems. The causal loop diagram is our interpretation of the reality, and helps understanding the cause and effects between these relationships and the behaviour of the system.

Models have been designed to understand the driving forces behind sprawl and increase of travel distance in the metropolitan area. The current urbanisation in the metropolitan area of Barcelona has been analysed with different models, which are mental projections of my understanding of the process and feedbacks of the system. The first model analyses the causes of increase of travel distance and demographic shift. The second model analyses the current price of land in the periphery, as a driving force of sprawl. The third model shows my understanding of the current situation in the city of Barcelona, and the price of land as a driving force of dispersion of residents and activities in the periphery (Chapter 4). Thereafter, two alternative scenarios are suggested to decrease the current urbanisation and travel distance, with different solutions for both the commune of the city of Barcelona, and for the rest of communes in smaller municipalities (Chapter 5).

Finally, different recent projects of urbanisation in the metropolitan area have been analysed and discussed (Chapter 7) in order to compare developments on greenfield and re-development on brownfield sites. Two examples are placed in Sant Feliu de Buixalleu, one small municipality with less than 1,000 inhabitants that is located in the remote periphery of the metropolitan area of Barcelona. The third example is a re-development project on brownfield in the inner city of Barcelona. The three projects are:

1) A project of low-density district of family-dwellings in a small municipality in the remote periphery in 1999, “Can Noguera” residential district, in Sant Feliu de Buixalleu

2) A project of industrial district in a small municipality in the remote periphery, “Industrial district Sector III” in 2000, in Sant Feliu de Buixalleu

3) A project of re-development of brownfield in the Barcelona city in 2000; Poblenou district, with diversity of uses, such as commercial, offices, industrial and dwellings, available online at: www.bcn.es/22@bcn/cast/planesyproyectos/plan22@/bajar_pdf/22@cast_actuacion_estud_econom.pdf

Data concerning the precise amount of hectares of urbanised land every year is insufficient and contradictory. This has been largely discussed among different authors. This data is based on satellite and airplane images. According to Joan Antoni Solans (2002: 49-72), statistical data from studies carried out during the last decades have tended to misunderstand the real amount of area been urbanised in the region. According to Solans there are three different reasons; first, in some statistics the time in which occupation takes place might be incorrect. Second, there are difficulties of identifying the land uses from pictures. And finally, some statistics do not take into account a part of the buildings that have been demolished.

This shows once more that urban growth is not under control in the regional level. All of the 163 municipalities have their own urban planning schemes, and the majority were drawn and approved since the early eighties (PTMB 1999: 291). The regional Directorate of Urban Planning coordinating the municipal programmes –*Direccio General d'Urbanisme de Catalunya*- cannot control the number of hectares developed every year, because the municipal programmes do not feet with the reality.

It has also been determinant my experience of living in a flat on the streets Provenca-Casanovas, two very congested streets in the centre of Barcelona – the Eixample district- with 100,000 cars driving through every day, and 34 per cent of the total area to be used exclusively by cars (ATM, 2000).

3. Theory

In this chapter, I analyse the driving forces behind the demographic shift of the population in the metropolitan area (Chapter 3.1). The *counterurbanisation cascade*[13] phenomenon in the metropolitan area is analysed as a result of different socio-economic factors, and the benefit of living in a location with higher quality of life standards. The current planning of new development and its associated infrastructure in the metropolitan area is based on a predict-and-provide approach, where local authorities' projections are used to plan for future demand. This approach is contributing to the dispersal of inhabitants, facilities and activities, with implications for increasing travel distance and mobility over time. A theoretical case of two firms selling a finite resource is assumed. The resource represents the area available for new buildings in Barcelona municipality (firm A) and in small municipalities in the periphery where land is urbanised (firm B). Thereafter, the current urbanisation in Barcelona and in small municipalities is analysed in chapter 3.2 and 3.1.2.

3.1 Theory of the demographic shift

Various economic, social and quality of life factors influence households to live in a certain location. This is what we will call *cost of living*. Cost of living is the direct cost that a household must pay for living in one location compared to living in another location. This cost is composed by three main costs: cost of transport, cost of land cost and quality of life -s*ee figure 3-1*.

[13] Counterurbanisation cascade is the phenomenon of population moving from larger to smaller municipalities, and from the inner city to remote areas in the periphery

The willingness to buy residential area in Barcelona will depend on the direct cost for a household to live in the city, compared to live in another smaller municipality. In addition, when families increase the income there will be more willingness to buy residential area –*see figure 3-1*.

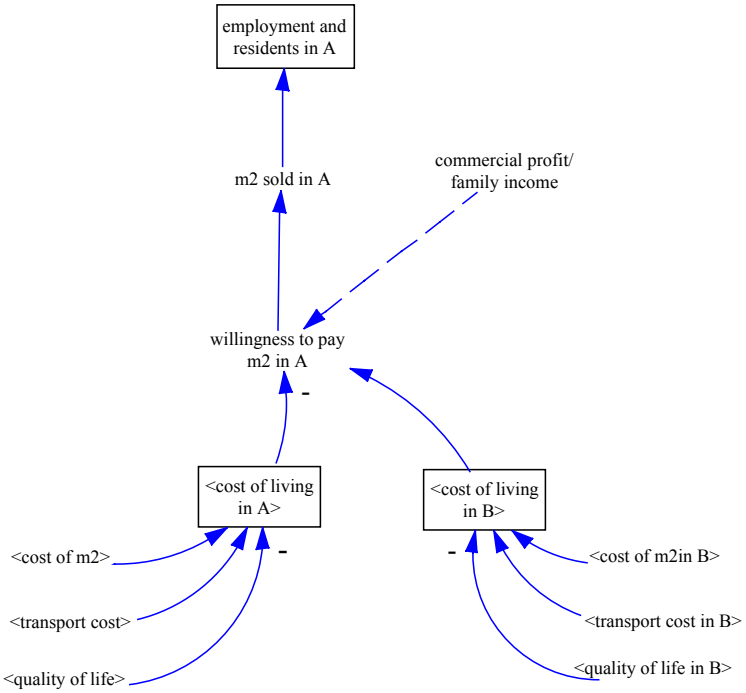

Figure 3-1 Cost of life in location A.

Obviously, there are other driving forces behind location of the economic activity area, because companies look at the expected profitability of buying building area in one location compared to another location. In general, most of the companies want to move to the city because it is more attractive for clients to visit them, and the image of the company is improved, but the land cost is too high.

According to Harris and Ullman (1945), different uses of land are located in separate single-use developments. Each land-use is located depending on the price of land and its especial functional requirements. More efficient uses of land will be located in the inner areas of the city, and less efficient in the remote periphery. This is what today is called zoning. Zoning is both, created from the market pressures, and the predict-and-provide planning approach. The dispersal of population and activities has resulted in settlements becoming less socially cohesive, since households live in a location depending on the price of land compared to their disposable family income. In addition, zoning and dispersal of population and activities is less sustainable, since this approach has contributed to increase travel distance and energy consumption.

3.1.1 Quality of life

This is the direct cost that a household must pay every year to commute, or to access to services, such as shopping, hospital, schools, etc. and it is proportional to the distance of travel, and the taxation to commuting.

There are many factors that can decrease the quality of life, but the most important in a city are first, different costs affecting the environmental standard -such as noise from cars and air pollution cost- both for human health and the environment. Second, there are costs affecting households standard of living -such as congestion of the streets, safety, security, quality of the municipal services and vitality. Other costs might include lower quality of the urban design, such as access to open space, access to services, public green quality, and finally other factors concerning the housing design, such as isolation, natural light or ventilation. *See figure 3-2.*

When the cost of transport is high, there will be higher density growth of the developments. For example one century ago, the transport cost in Barcelona was so high that the city was extremely concentrated.

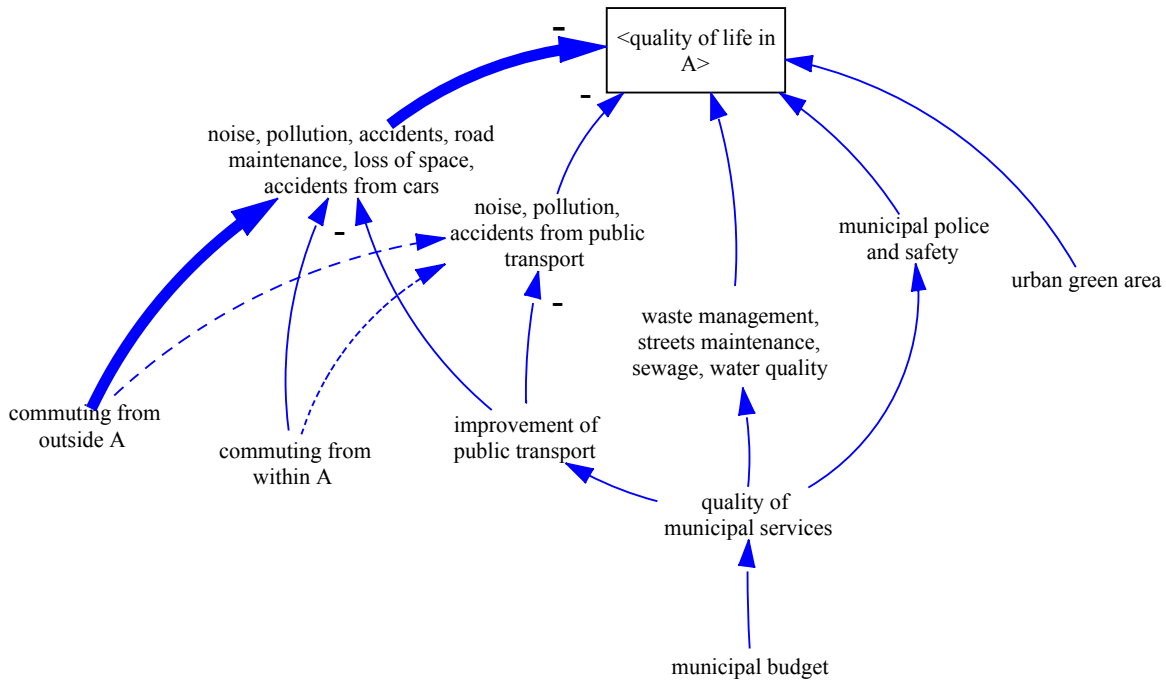

Figure 3-2 Quality of life in Barcelona

3.1.2 Price of land

Price of land is the direct cost of buying a new dwelling. Landowners sell their farmland when municipality increases urbanisable area. After some time, urbanisable land is developed and developers build new dwellings or new activity built area within the urbanisation. If area available increases, price decreases, and households or enterprises will increase the willingness to pay

building area. The willingness to pay will increase with commercial profit or disposable family income. This process is the same in B. *See figure 3-3.*

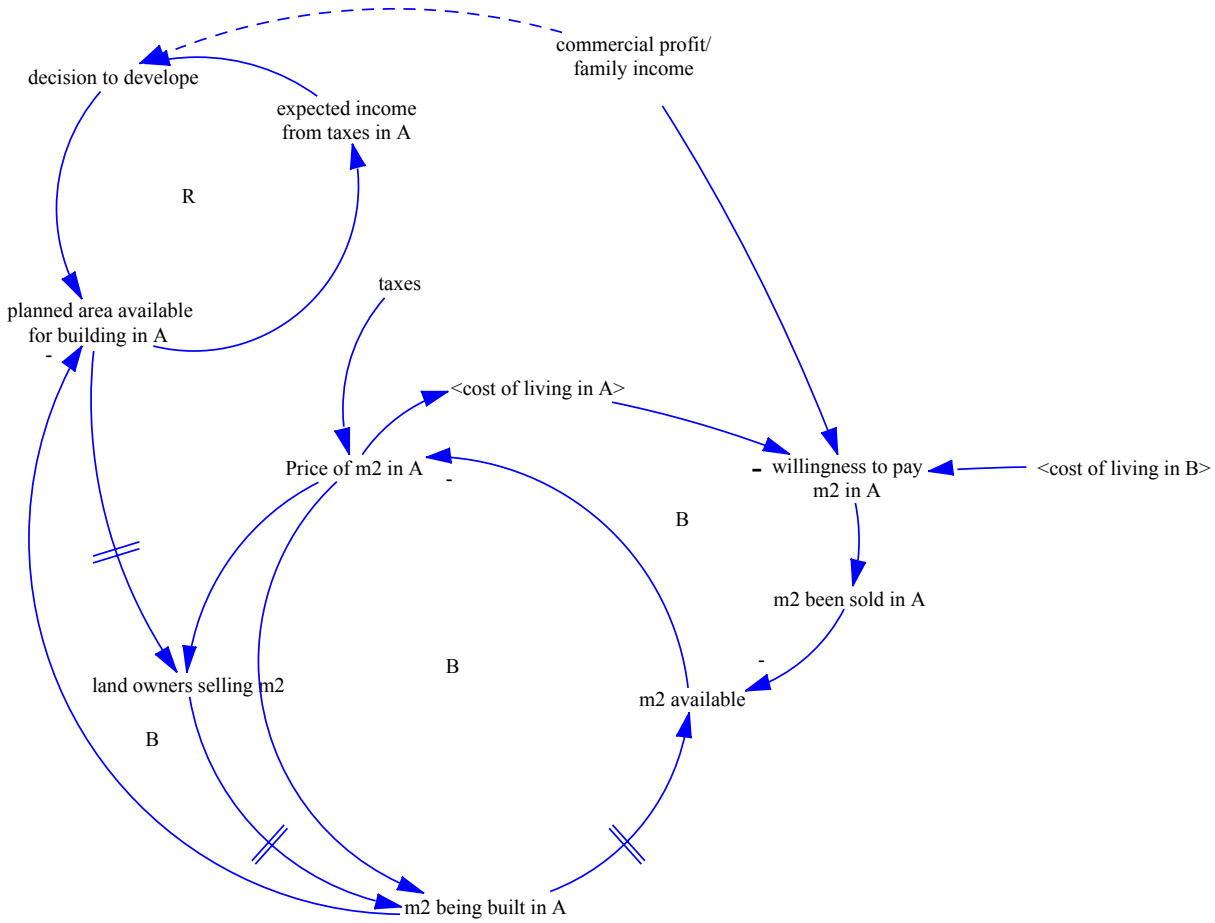

Figure 3-3 Land cost in A

Table 3-4 shows the difference between the cost of buying a dwelling in the periphery and the cost of buying a dwelling in the centre. In 2001, a family in Barcelona needed 7.5 years of disposable income to buy a dwelling in the city, thus 3.7 years less than in the periphery.

years	DFR in Barcelona	DFR in smaller municipalities
1986	3,2	2,8
1987	4,0	2,9
1988	6,3	3,2
1989	**7,5**	**3,8**
1990	7,2	3,7
1991	7,2	3,7
1992	7,3	3,8
1993	7,2	3,7
1994	6,6	3,4
1995	6,5	3,3

1996	5,6	3,0
1997	5,3	2,8
1998	5,3	2,8
1999	7,0	3,7
2000	7,0	3,7
2001	**7,5**	**3,8**

Table 3-4 Years of disposable rent in a family (DFR) to pay a new flat or house. (Source: Nel.lo 2001: 105)

Households in Barcelona move to the periphery where cost of living is cheaper. Table 5-3 shows the real price of building area in the city of Barcelona compared to small municipalities.
The cost of transport is not increasing with respect to the price of land in the city and the disposable income (Nel.lo, 2001: 105). This also shows that the willingness to pay a flat is very high in Barcelona compared to the periphery, because households are demanding to live in Barcelona, but still most of them may not afford to pay for it. In addition, prices also increase because the building area is very scarce.

Residential and commercial uses compete each other to buy building area in Barcelona. Since there is no more unprotected land in Barcelona municipality, the increase of building area can only be obtained demolishing the current buildings in the city or building in brownfield sites. The area on sale is very scarce, so prices increase over time with constant demand. In addition, economic activities increase the profits and households increase disposable income. Companies demand to increase the used area by the activity to obtain more profit, and households may demand second residence or bigger flats with higher incomes. As a result, there is a daily loss of 50 inhabitants moving out of Barcelona since 1981 and a decrease in revenues with it (Nel.lo, 2001; CPSV, 2002), and maintenance expenditures per capita are increasing daily, since annual maintenance expenditures from developed area is constant, and the commune obtain fewer revenues from fewer economic activities.

Barcelona city has 1,200 km of streets. Thirty per cent of them – 432 km- have more than 20,000 cars driving through every day on each lane (ATM 2000: 23). This is especially dramatic in the Eixample, where streets have 4 and 5 lanes with a capacity of 1,000 cars per hour and lane. As a result, these streets have 100,000 cars driving through at a high speed every day. For example, in 1998, cars produced a decrease in the quality of life in these streets, with noise -640,000 euros per year and km- and air pollution -2.8 millions of euros per year and km (ATM, 2000: 119).

Yet, it is surprising to see who *pays* for this cost, and who *benefits* from this scenario. The municipality does not get any revenue from the petrol tax, neither from the car licenses of these 242,000 outer commuters, and yet, they use the roads, streets and infrastructure. *See figure 5-8*.

As a result of all these flows, in 1996 there were 260,000 commuters more than 10 years ago. This is the 98 per cent of the total employment growth in the region over the same period. Thus, in 1996 the half of the employed population was commuting outside the municipality.

Figure 3-5 shows the daily commuting to Barcelona and other intermediate cities from small municipalities. This shows both, the polycentrism and the centralism of the metropolitan model.

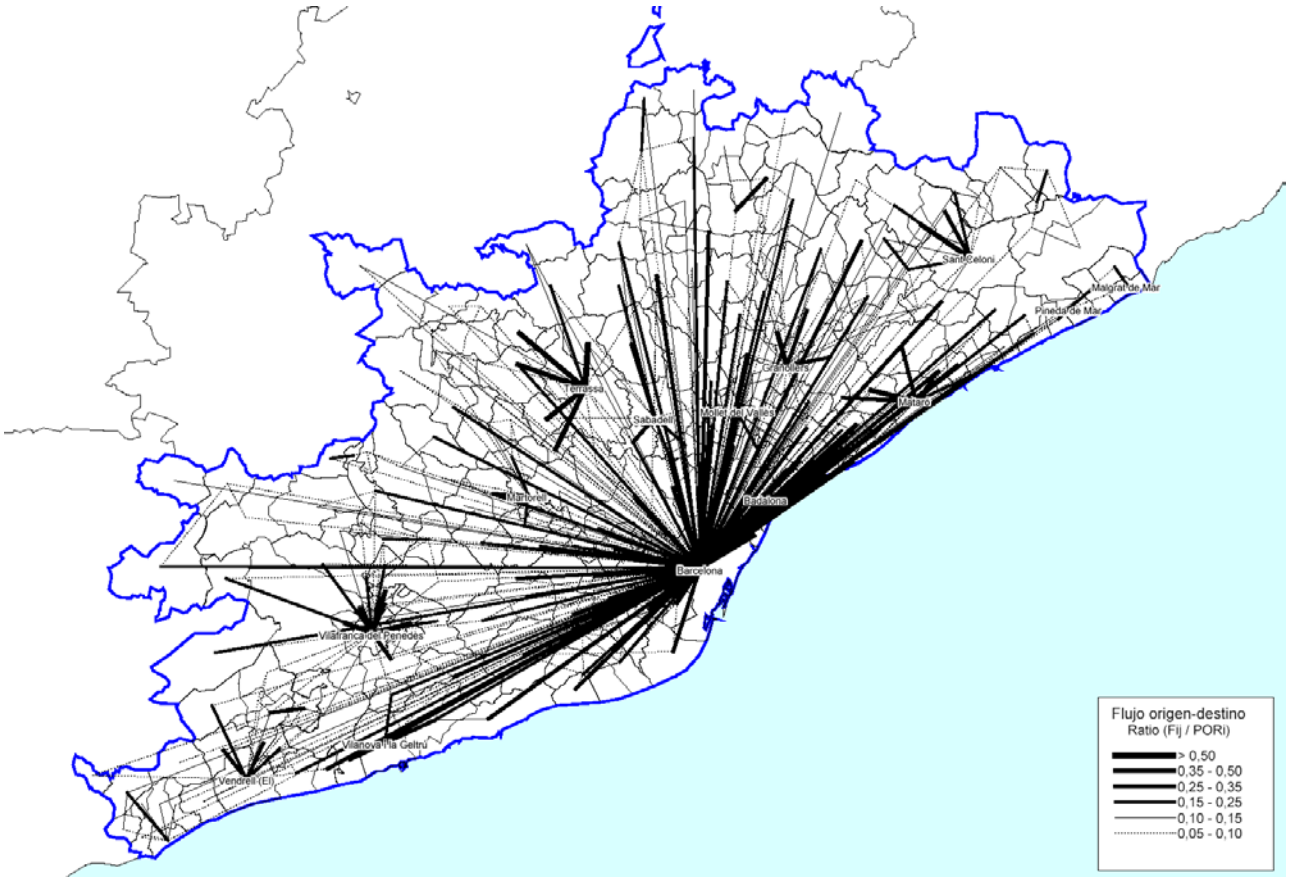

Figure 3-5 Inter-municipal commuting in the Barcelona metropolitan area. Source: CSPV 2001

Theory of the Competitive Scarcity

> *"To begin our position-fixing aboard our Spaceship Earth we must first acknowledge that the abundance of immediately consumable, obviously desirable or utterly essential resources have been sufficient until now to allow us to carry on despite our ignorance. Being eventually exhaustible and spoilable, they have been adequate only up to this critical moment. This cushion-for error of humanity's survival and growth up to now was apparently provided just as a bird inside of the egg is provided with liquid nutriment to develop it to a certain point"*
>
> Buckminster Fuller (2001)

We will assume the theoretical case of two resource-extracting firms, when the resource is finite. We will turn our attention to the problem of finding an optimal path of deciding to increase the inventory through time over the lifetime of this finite resource. Once the initial points on the optimal path of the two firms are identified, the two systems behave optimally over time. For some authors this is a mechanistic approach of understanding the dynamics of a system, and it can be

contrasted with other views where prediction of a system's future behaviour is impossible based on knowledge of its past and current states (Ruth, M and Hannon, B, 1997: 171 and 283).

We assume two firms with different reservoirs of land, and reservoir A is much smaller than reservoir B. Land is a finite resource. If the reservoir is finished in one municipality, then there is no more land available to be sold if reservoir is not renewed with new brownfield land available to re-develop. Assuming further, the size of the reservoir is perfectly known and its quality is uniform. Therefore, the firms want to maximize the current value of profits from selling their inventory. Land is an irreplaceable need: there are no effective substitutes for it, and it is *consumed* when it is used. To keep the model simple, we will ignore all government subsidies, depletion allowances, and price supports.

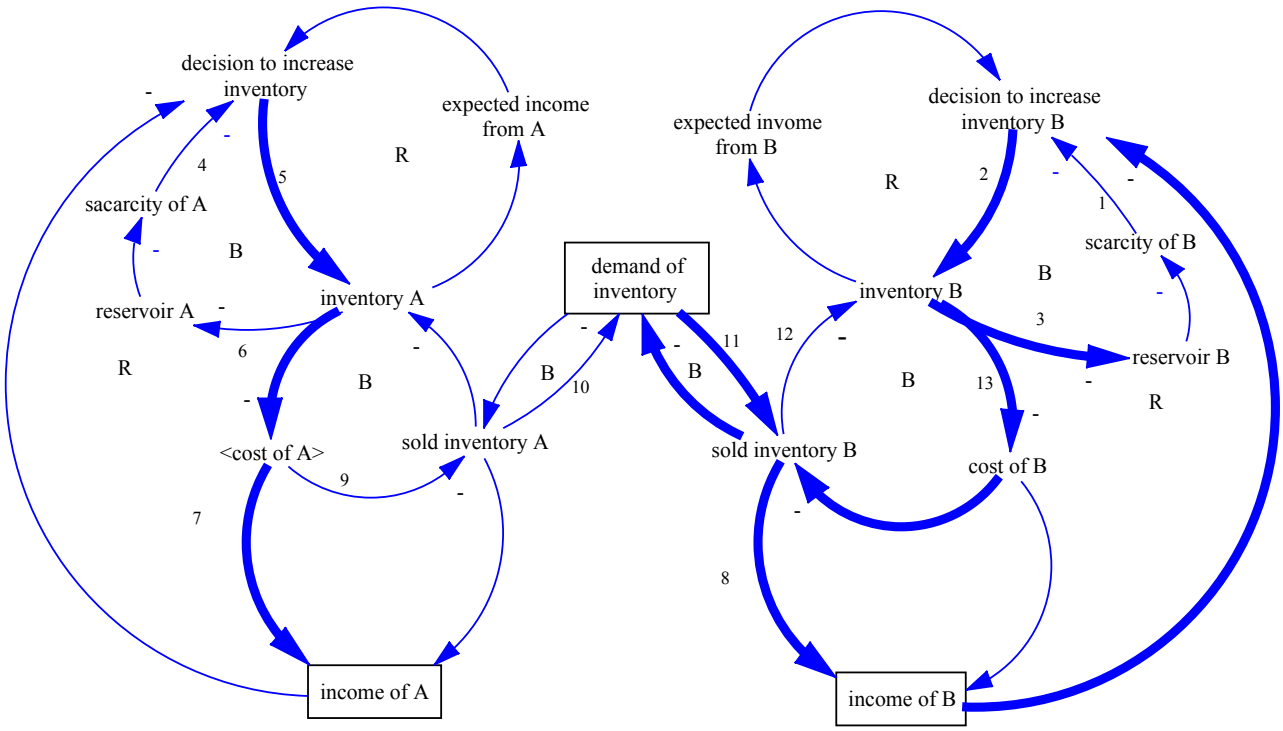

Figure 4-1 Theory of the competitive scarcity, assuming reservoir A < reservoir B

The reservoir of land B has enough for the next decades, but the current reservoir of land A holds a small amount of inventory. The firm A will control the rate at which the land is sold. *See figure 4-1 links 4 and 5*. Then firm A has two alternatives. First option is to sell the entire reservoir, and second, not selling more inventory. By thus, keeping land off the market, firm A helps to drive up the price of land. If price of land in the city rises up, price of land in the periphery will also increase -*links 9, 10, 11, 12 and 13*. Reciprocally, if price of land in B drives up, price of land A increases, assuming the decision to increase inventory A to be constant.

During the period when land is not sold, some of the costs continue for firm A, losing the present use of the profits. What can firm A do? According to Ruth and Hannon (1997: 172) the optimal choice seems to lie between the two extremes: selling all the land or not selling until the price goes up.

Ruth and Hannon (1997), defines optimal behaviour, in the sense of "*maximizing the present value of cumulative profit"*, thus selling land at a rate that is continuously raising its price. Firm B is selling a large amount of land. This is giving them high present value of profits. The amount of land in the reservoir is reduced by the amount that they are selling. Therefore, less land will be available in the future. This lower supply will lead to higher prices along the demand curve. With higher price of land, and less of it in the reservoir, firm B sells less land in the long-term future.

The two firms represent the Barcelona municipality (A) and the small municipalities in the periphery (B) where virgin land is depleted. Of course, municipalities are not firms selling land, but they earn income from taxation to new area been built. As illustrated in the figure 4-1, Barcelona municipality may allow developers to build at a rate estimated to be continuously raising -*links 6 and 7*- and smaller municipalities have high present profits by allowing urbanising large amounts of land -*links 2 and 11*.

3.2.2.2 Price of land in Smaller Municipalities

Smaller municipalities are legislative divisions of the metropolitan territory with fast growing populations. They may have a lot of non-urbanisable land used for farmland or forestry, and lacking of services due their current population growth. In small municipalities, most of revenues providing public services come from property taxes levied on all buildings and properties based on their economic value. Local authorities seek for their re-election, so normally focus on short-term rather than long-term issues to solve in the municipality. If they increase the services being built, then the electorate will appreciate it. Thus, mayors always try to raise revenues by promoting new development or economic growth to meet the expanding services, instead of increasing taxation revenue per capita. *See figure 4-2 link 7.*

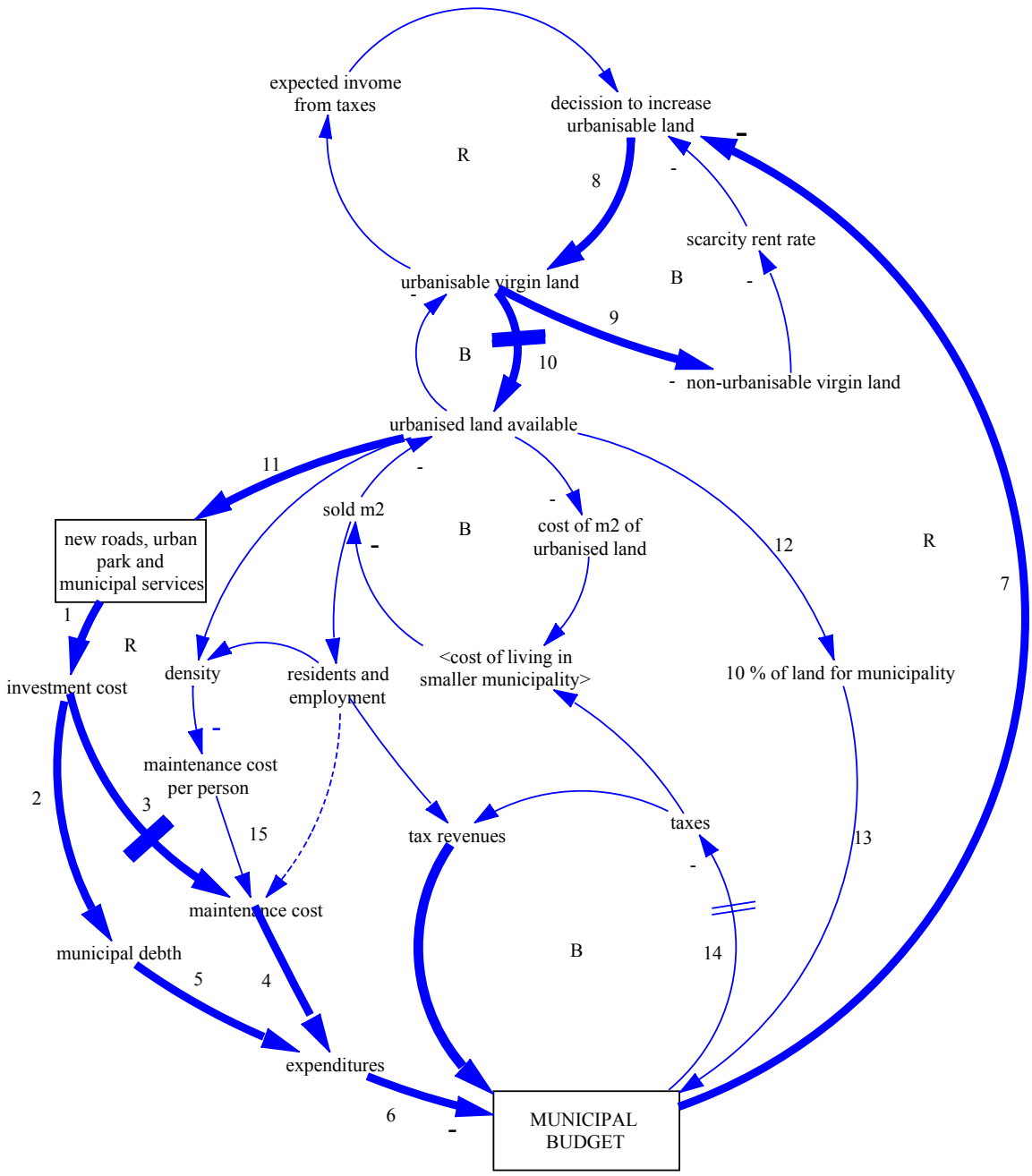

Figure 4-2 Competitive Scarcity in Smaller Municipalities. Current situation.

First, authorities in small municipality decide to provide residents with new roads, and services – normally a theatre, a school, a sport pavilion, a swimming pool or a museum[14] -s*ee figure 4-2 link 1*. Initial investment is too high for small municipalities' budget, so public debt increases -*see link 2*. The infrastructure and buildings have determinate lifetimes, so higher maintenance expenditures are expected over time from new built infrastructure. According to Vergara (2001: 11) maintenance expenditures are high and proportional to the building cost. For example, the appropriate annual maintenance of the transport infrastructure in Spain is normally 3 per cent of the building cost. Yet,

[14] For example, we have built one big multi-purpose building with an estimated cost of 2 million Euros and two roads new across a the National park of Montseny, and yet the municipality have a population of 835 inhabitants.

according to Vergara (2001: 11) the local authorities and the government are currently expending below this rate in the metropolitan area, and transport infrastructure is normally under-maintained – *see link 3, with delay*.

Assuming the same building standards and characteristics of greenfield land to be constant, lower density developments will require higher maintenance expenditures per capita compared. If there are few activities or residents within the urbanisation, there will be higher maintenance expenditures per capita –*link 15.*

Expenditures increase every year to pay municipal debt and maintenance -*link 4 and 5*- so municipal budget decreases – *see link 6*. Then officials use to make the decision to increase the built up area, expecting to increase the revenues -*link 7*- instead of increasing taxes to the current built-up fabric -*link 14*. As a result, there is less virgin land in the small municipality every year -*link 9*.

The Catalan *Land Act 2/2002*- establishes on Chapter III (Llei del sòl, 2002) that developers must pay the entire cost of building the urbanisation within the developed land –at least electric grid, sewage pipes, water supply, lighting, and streets within the urbanisation- and the municipality subsidizes the cost of connecting the district with the existing grid of services –at least municipal roads, electric grid, sewerage and water pipes, and sometimes gas, telephone or cable grid. The connection is paid with municipal budget or debt, and subsidies from the Catalan regional government budget, the national budget, and the EU budget (PTMB 1999). Most of the national and regional revenues come from the cities, therefore, it is surprising to realise that sprawl is both subsidised by inhabitants living in big or intermediate cities and by future generations –municipal debt.

Since developers do not pay for the cost of connection to the existing grid of services, new urbanisations in small municipalities are normally out-of-town developments, preferably close to the highways or the main roads where the price of land and the cost of travel are cheap.

Developers must grant 10 per cent of the urbanised area to the municipality. According to the Land Act -Article 45.3- the granted land must be used to increase or maintain the municipal housing stock. Yet, it is too expensive for small municipalities to build new housing, and instead they sell the land to a new developer -Article 156. This is an extra income for their budget (*links 12 and 13*, reinforcing).

Small municipalities compete each other for being attractive to developers, companies or households. Thus, authorities try to reduce the price of land by planning new developments and lowering property and activity taxation to new residents or employees. As we have seen in figure 4-2, the long-term result of this process is a destructive positive feedback loop of more environmental degradation (Miller, 2002: 659) –*see the reinforcing bold loop in figure 4-2, representing the current scheme.*

Increase of maintenance expenditures

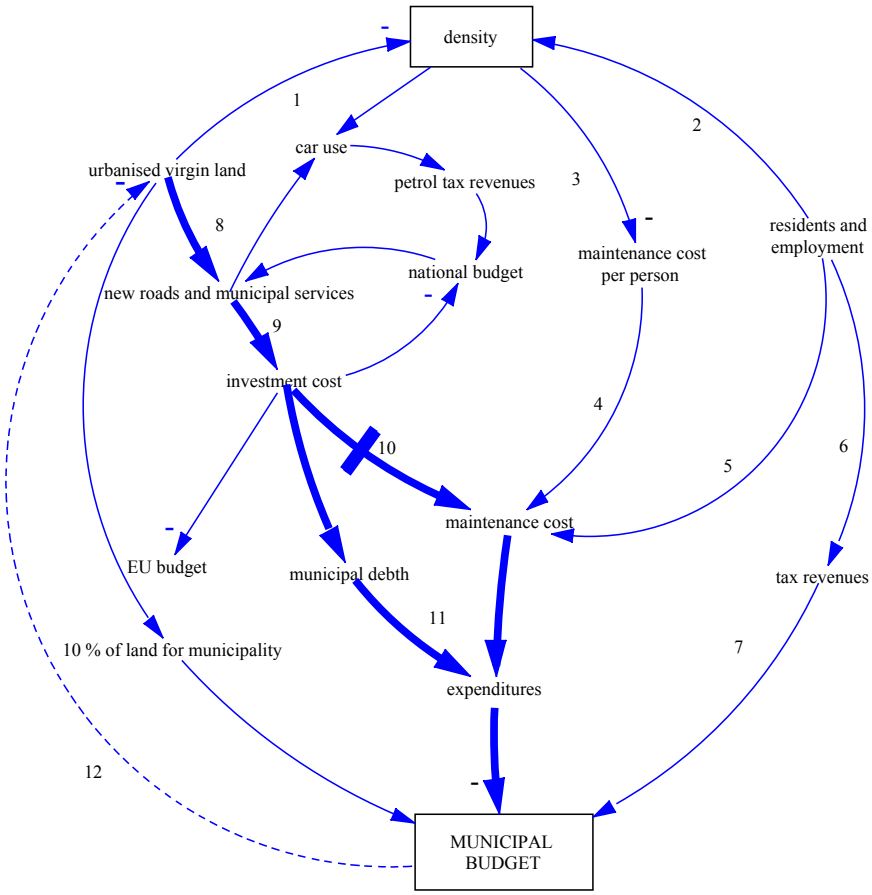

Figure 4-3 Economic costs and benefits of sprawl in smaller municipalities

As analysed in figure 4-2, the building cost of connecting the out-of-town site with the grid of services and roads is paid with municipal debt, but also with the national budget and the EU subsidies (PTMB, 1999; Vergara, 2001). The government spends indirectly to encourage sprawl, using the revenue from the petrol's tax to finance roads and infrastructure of services. With new roads the use of cars is encouraged, and the national government expects an increase on the revenues from petrol tax. *See figure 4-3.*

Authorities in small municipalities promote sprawl because of its short-term economic revenues, from land granted in new developments –10 per cent of the developed area- and also from the expected taxation revenues on new households and activities.

3.2.2.3 Price of land in the city of Barcelona

Expenditures of the current urbanised area maintenance in Barcelona city are high –*see figure 4-4 links 1 and 2*. In addition, the existing infrastructure located in un-used urbanised area is old and has to be maintained –the current streets, gas, electricity grid, water pipes, sewage, and streetlight. Since the commune set taxation values, expenditures pressurise the commune to keep taxes high -*links 3 and 4*. In addition, taxation is based on the economic value of properties. Since land is a finite resource, we must add to the marginal price of land a rent to represent the irreversible loss of the limited resource, what Ruth and Hannon (1997: 175) call the "*scarcity rent rate"*. Barcelona commune can maximize the price of land by following a time path in making land available in the city, to raise the economic value of all the buildings and properties in the city in order to increase the revenues. Thus making available less annual building area than demanded -*links 5 and 6*.

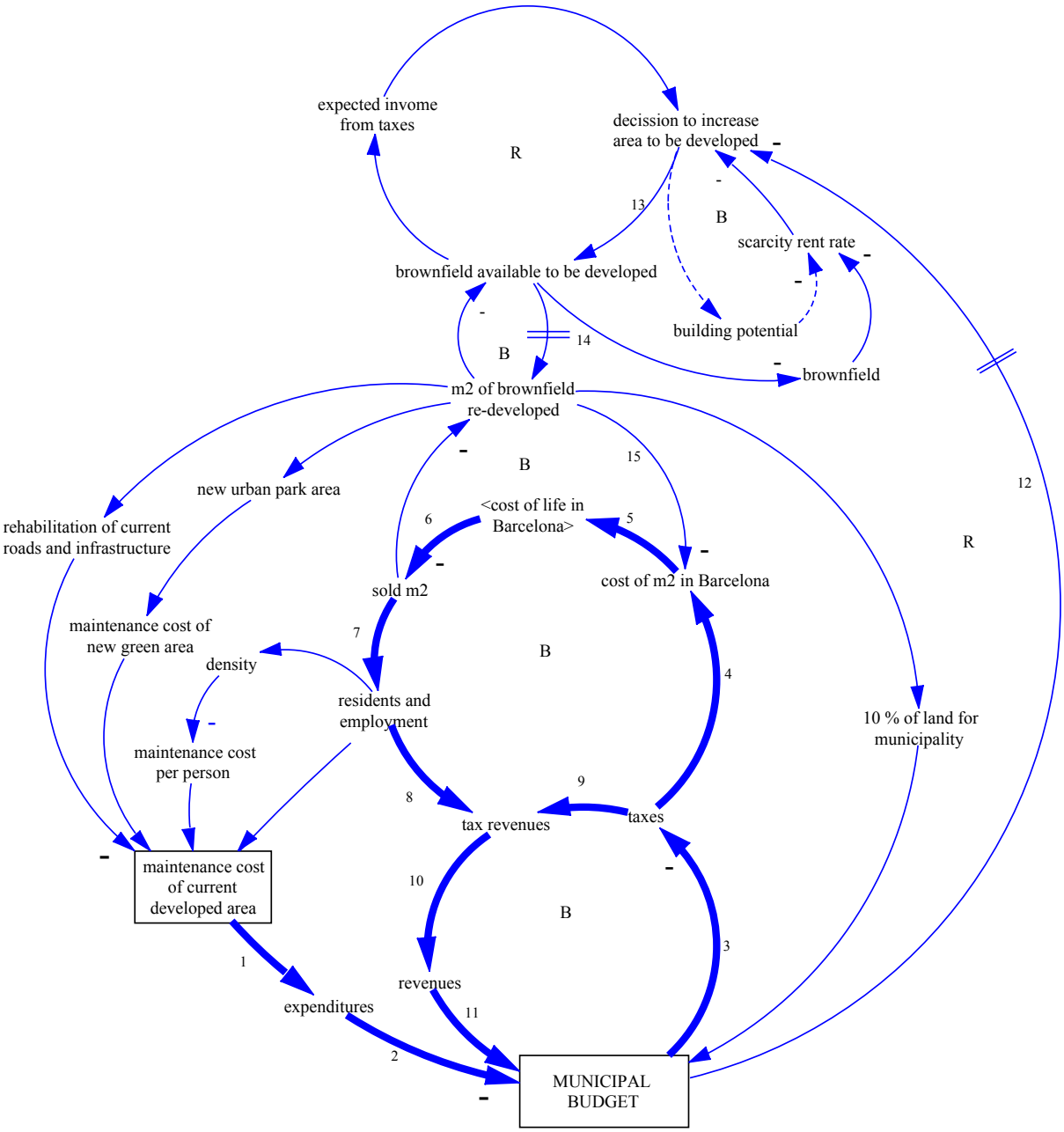

Figure 4-4 Competitive scarcity in Barcelona. Current situation.

The number of households per dwelling is decreasing over time and the number of dwellings in the city is the same over the last decades. As a result, there are fewer inhabitants in the city over time - *links 7 and 8*.

The activity tax is high in the city, so industrial plants in Barcelona may move to peripheral municipalities or to other countries where land and tax is inexpensive -see figure 4-3.

4. Hypothesis

In order to understand the driving forces behind sprawl and increase of travel distance in the metropolitan area of Barcelona, 3 hypotheses have been formulated, and will be analysed and verified through 4 different models:

1) First, communes in small municipalities promote sprawl because they seek for short-term revenues. In the long term, sprawl is economically inefficient –high maintenance expenditures-, environmentally unsustainable –dispersal settlements implicate increased travel distance and less socially cohesive for both small municipalities and the city of Barcelona (Chapter 4)

2) Second, if Barcelona commune decides to increase the building area available in the city, then there will be more employment, more economic activity, more green area, more services, and more revenues from taxation in the future. An increase of income from taxation might be used to increase the quality of the built-up area, and authorities may increase the possibility of been re-elected. If the building potential increases in the city, there are fewer maintenance expenditures of the current urbanised area and infrastructure per capita. At the same time, there are fewer commuters from the periphery to the city every day, thus less pollution, less noise, less accidents, and less deaths and injuries (Chapter 5).

5. Application: suggestions

5.1 Suggestions for reversing sprawl in small municipalities

Communes in small municipalities have to deal with high maintenance expenditures from the current out-of-town sprawled areas. Yet, authorities can set higher values of taxation to properties and economic activities if they are not above the legislation limits. But this increase will effect on the price of land in the municipality and households or activities will move to other municipalities where taxation is not as high. Therefore, this measure should be adopted in a regional level, where all the small municipalities in the metropolitan area will have the same taxes to households and activities.

The commune could also plan to re-use the consolidated urban areas in the municipality that are not used (if any)– *see figure 5-1, link 4*. Thus the commute obtains more revenues within the same urbanised area. This approach may decrease the maintenance expenditures of the urbanised land per capita.

As we have seen, the cost of connecting the urbanisable land with the current grid of services is very high. Local and national authorities subsidise these costs because no private developer can ever pay for this cost. The authorities must increase the property taxation and the taxation to economic activities on out-of–town new districts, to reflect the cost of this publicly financed

infrastructure –*links 1 and 2*. This increases the relative competitiveness of the city sites and encourages developers and retailers to consolidate the centres.

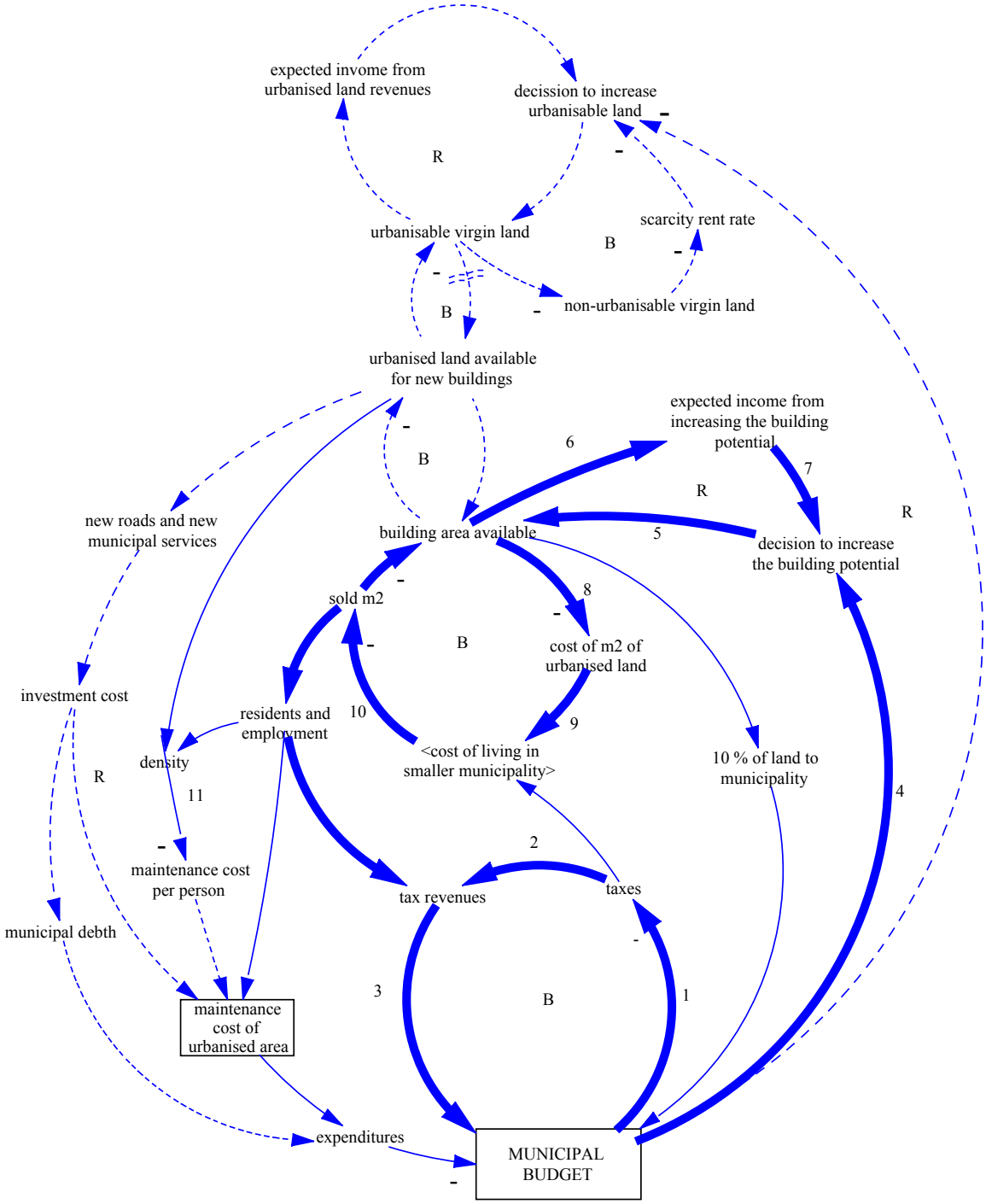

Figure 5.1 Second scenario: benefits from increasing taxation and building potential in smaller municipalities

This could be done in many different ways. First, the municipal planning legislation can increase the building potential of the existing developed land or the current urbanisable land. Second, encouraging the refill of empty sites in the consolidated town. Third, by financing the rehabilitation

of the historic centre of the town, currently abandoned. And finally, financing the rehabilitation of unused buildings in the municipality, such as farms, factories, etc.

If the commune re-uses the brownfield sites within the municipality, the quality of the urbanised land increases and also degraded landscapes can be restored. This may increase the willingness for other households to live in the municipality. In addition, soils with first class conditions for agriculture use close to urbanised land must be protected, to contribute to the preservation of the local farming production and landscape.

5.2 Suggestions in Barcelona city

In the last decade, industrial districts with large plants are becoming incompatible with the current prices of land in Barcelona –such as *Zona Franca* district, *Poblenou* or the harbour (Districte 22, 2000: 5), and they move out to the periphery.

As a result, there are 930 hectares of un-used industrial brownfield in Barcelona (Districte 22, 2000: 9). The current building potential of this brownfield is 0.87 m2 of net built area per m2 of brownfield. This accounts for 8.1 million m2 of building area. Promoting the renovation of this available un-used urbanised land, and particularly, increasing its building potential, permit the relocation of new employments, new activities, new dwellings, new facilities and new municipal services. Furthermore, the urban green can be increased and improved. According to our estimations the building area could be increased at least by 20 million m2 only in Barcelona.

This is the key strategy for relocating the outer commercial and business areas in the city, and the development of the new industry and the new technologies in Barcelona and other intermediate cities -such as *Terrassa* and *Sabadell*- with other brownfield sites available (PTMB 1999: 293). *See figure 5-2.*

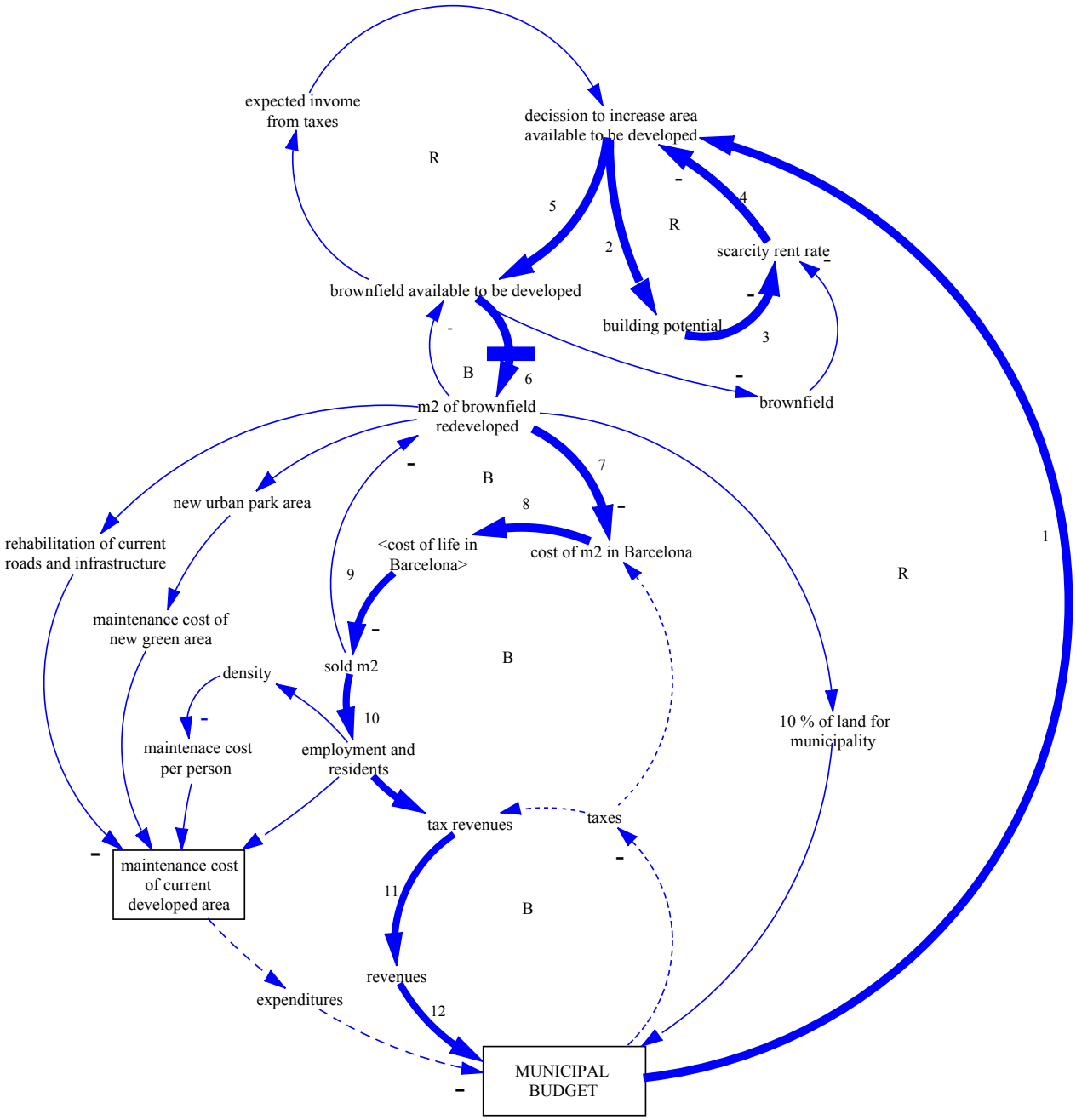

Figure 5-2 Second scenario: benefits from increasing the building potential and reducing taxation in Barcelona Municipality.

As we have analysed before, the un-used brownfield area is very expensive to maintain, because the area is big – 930 hectares - and yet there are no taxation revenues from the abandoned activities. If the commune is increasing taxation to used urbanised area, then the real price of land in the city increases, and household will decrease their willingness to buy building area in the city. As a result there will be less population growth and less employment growth in the city. Municipality might look for long-term rather than short-term revenues – see the two balancing loops above. Second, the municipality might not decide to increase the redevelopment rate of brownfield, because this would deplete much faster the brownfield available – the scarcity rate increases. Instead, the municipality must increase the building potential of the current developed area every year seeking for a sustained

long-term income –*link 1 in figure 5-2*. If they do it, the price of land in the city will decrease, and the price of land in the city will be similar to smaller municipalities. Thus, more households and activities can be relocated within new built area -*see links from 1 to 12*.

6. Results

6.1 Driving Forces behind the sprawl

As we have seen, population exhibits a slightly download trend over some periods and fertility rate is expected to continue decreasing in the metropolitan area, and yet sprawl has been increasing.

The main driving forces behind sprawl are four. First, companies are increasing the profitability of economic activities; second, disposable income per family is increasing over time; third, communes in small municipalities expect fast increase of revenues from property taxation to new low-density out-of-town urbanisations, and most important of all, the scarce building area available in the city increases the price of area in the inner city compared to the unprotected out-of-town sites.

The current planning legislation and tax system can both, encourage more sustainable ways of using our land resources, and still the public and the private sector obtain more economic, environmental and social benefits from development.

6.2 Reversing urban sprawl

> *"As long ago as 1966, the economist Kenneth Boulding argued that we must cease to behave as if we lived in a cowboy economy with unlimited new territory to be conquered and resources to be consumed. Instead we must begin to think of our planet as a spaceship, a close system with finite resources."*
>
> Richard Rogers (1997: *32)*

Higher density developments require less land and less maintenance expenditure per capita. With it there is an increase in the accessibility and use of public transport. In addition, public transport reduces the amount of land and materials required for roads (Barton 2002: 42). Higher density development has greater potential to use energy more efficiently municipal and private services, such as street lighting, sanitation, drainage system, sewerage system and management of municipal waste.

Furthermore, there is a range of different benefits for the city of increasing the brownfield's building potential. The number of dwellings increase, the number of area for activities, and employment relocation in the city with it. With this we can increase the urban green area, the revenues from new property taxes and activity taxes. The quality of life may increase if public transport is improved, and if there are restrictions to access of the private cars in the streets of Barcelona.

The municipality of Barcelona has planned to develop the majority of the current brownfields with only one-use activity districts, such as industrial, logistics and retail zones –8 sites from the 13 existing brownfields. The building potential of all the brownfield is as low as 0.79 m2 of building

area per m2 of land, because industrial plants are demanding one or two-storey buildings. Yet, prices of land are too high to allow this kind of inefficient uses of land in the municipality of Barcelona.

Instead, it is possible to increase the *complexity* -mix of land-uses- together with the density – the building potential- of these sites, and reduce the price of the building area. Multifunctional complex districts, with dwellings, industry, offices, commercial area and facilities demand higher building potentials of the brownfield sites, which, at least can increase up to 3 m2/m2 of land. This is the same potential of the redeveloped district of Poblenou.

The authorities have increased the building potential of Poblenou to 3 m2/m2 of land, and in some parts of the area this rate is increased to 3.2 m2/m2. This is a brownfield redevelopment that will represent 2.7 million new m2 of economic activities –the municipality estimates that 58 per cent of this area will be developed by 2010- and 400,000 new m2 of dwellings. According to the municipal estimations, there will be 3,500 new dwellings and 60,000 new employments in the city. In addition, the city will increase the green area with 80,000 new m2 and 260,000 m2 of facilities and municipal services.

The strategic plan for the entire city only allows 1.2 million m2 of housing in the next 20 years, thus, approximately 5,000 dwelling units per year. There is an estimated increase of the metropolitan areas population and demands, which does not feat with this amount –in 2000, the number of persons per dwelling has decreased from 3 to 2.5 in 10 years. Therefore, the prices for housing are estimated to continue increasing.

Furthermore, the current planning scheme is programming 4.6 million m2 of activity area for the next 19 years, in order to obtain a big amount of activity tax revenues. Yet, the current demand is an average of 235,000 m2 per year (Districte 22, 2000), so price of the area for tertiary activities might be rather stabilised, while the price of area for dwellings might increase.

As have seen – *see figure 7-1, p. 40* - most of brownfield sites are planned to be re-developed without dwellings in Barcelona: *Zona Franca*, *Fira de Mostres*, *Llobregat*, *Hospitalet, Pedrosa*, *Gran Via Sud*, *El Prat,* and *Barcelona harbour*. The municipality expects different companies and institutions to build single-storey buildings in these new districts for different uses, such as warehouses, shopping malls, clean-industry storing, exhibition area and parking. Yet, authorities can increase the building potential of these non-residential districts and still increase the quality of the built environment. If more storeys are added to one-storey building used for shopping, parking, storing or exhibiting, it is possible to increase the underused potential volume without producing overshadowing in the street. The winter sun still reaches the ground floor windows, and developers can consider buildings being vertically mix-used. This new built area can be used for dwellings, business and offices. As a result, residents and employees have a good choice of facilities within an easy walking distance, and they have less need for outer commuting. In addition, developers consume less energy because they need less building materials, and they can introduce district-heating schemes (Barton, 2002; Rogers, 1999).

Barcelona has good historic examples of districts with the highest urban potentials, together with high standards of life quality. For example, *El Gotic* is the most attractive and demanded district in the city –with one of the highest prices of land (Districte 22, 2000). The nearby areas concentrate most of employment locations, and residents prefer to live within a walking distance to their

employment locations and facilities. El Gotic is the most visited district in the city by tourists and citizens, and commercial activities have the highest profits. Buildings with commercial activities are vertically mix-used together with dwellings, offices, parking areas, warehouses and municipal facilities. The density in the Gothic and other nearby districts is very high - 210 inhabitants per hectare or 350 in *Santa Catarina* district (PTMB, 1999)- and yet skyscraper developments are not allowed. Access by car is very restricted and the quality of life is high. According to many authors, authorities should not allow more skyscrapers in Barcelona's brownfields, because these kind of developments are not suitable for creating new neighbouring communities (Barton, 2002).

If we increase the urban capacity until 3 built m2 per m2 of land, there will be an increase of 20 million m2 available within the same brownfield area of 930 hectares. This area can help to decrease the extremely high prices of dwellings in Barcelona, making available 200,000 new dwellings.

In addition, the current unprotected land must be reduced in order to increase the price of the undeveloped land in the remote periphery. The new Catalan Land Act 2/2002 has increased the possibility for the small municipalities to transform unprotected *non-urbanisable* land to *urbanisable* land. The aim of this law is to decrease the costs of land. This will deal with an increase in the consumption rate –depletion of virgin land- and a reduction in the efficiency of uses -thus increasing sprawl. The implementation of this law must come together with an increase of the area of the virgin land protected.

As a result, less undeveloped land will be urbanised in smaller municipalities in the periphery, and farmland and forest will not decrease at the present rates –and with it the biomass and the biodiversity. Smaller municipalities may look for a long-term rather than a short-term income from tax revenues. The current national property tax legislation is promoting sprawl. This tax scheme must be reversed into a fair pricing of the total costs of occupying the out-of-town virgin land sites and providing new services to these areas. Thus developers must pay the connection and the urbanisation costs. Small municipalities must encourage the re-use of currently un-used buildings, such as old farms, historic town centres, and un-used industrial plants. Today sprawl is subsidised by the small municipalities, the national government and the European Union. Small municipalities may also increase the building potential in the urbanisable land available for new developments approved in the planning schemes, thus increasing the mix-use complexity of the industrial and dwelling districts.

7. Discussions

7.1 Reversing the taxation system

The taxation system can be orientated to raise revenues and as a tool influencing corporate and individual behaviour. The *tax variation factor* is different between the small and the big municipalities, and this encourages greater land consumption and less land-use recycling. *See table 7-3*. Therefore, the tax variation factors might be reversed.

Annual taxes	**IBI**	**IAE**	**IVTM**
Municipalities over 100,000 inhabitants	1.075	1.5	2
Municipalities from 5,000 to 100,000 inhabitants	1.030	1.0	1.7
Municipalities with less than 5,000 inhabitants	1.020	0.5	1.4

Table 7-3 Current factors on Annual taxes in Barcelona, intermediate and small municipalities. IVTM: annual license car; IBI: annual tax to properties; IAE: annual tax to economic activities. Source: ATM (1999: 53)

7.2 Increasing building potential of brownfield

It is important to discuss city planning in a participatory way: how much new dwellings and offices should be allowed, what brownfield's regeneration plan is the best, what is the maximum building potential of the brownfield, or what transportation strategy should be adopted in the new redevelopments. As a result, citizens feel that they own the new district, and are responsible for its future.

The market trend in Barcelona is to create new districts with lots of office area and the current legislation encourages solely to market demand. S*ee table 7-1*. But brownfield developments also offer an opportunity for increasing mix of uses of tertiary activity with dwellings within the city.

Area	**Ha**	**m2**	**m2 / m2**	**Housing**	**Activities**
Harbour: active zone	197,1	920.982	0,47	-	920.982
Airport: active zone	208,0	797.000	0,38	-	797.000
Logistic Park: zone Franca	123,0	584.250	0,48	-	584.250
Fira de mostres/Montjuic 2	14,8	117.400	0,79	-	117.400
Pedrosa/Hospitalet	18,5	218.380	1,18	-	218.380
Gran Via Sud	31,3	470.000	1,50	-	470.000
Front litoral-Marge dret Besós	119,3	338.500	0,28	198.500	140.000
Forum Universal 2004	4,5	50.000	1,11	-	50.000
Sagrera-Sant Andreu/ Station TAV	54,3	743.105	1,37	539.243	203.862
Poblenou/Diagonal	46,1	626.956	1,36	290.329	336.627
Poblenou renovation 2000-2010	66,2	1.397.769	2,11	58.732	1.339.037
Poblenou after 2010	44,7	1.003.678	2,25	124.608	879.070

Hotels	4,7	118.557	2,50	-	118.557
Total Potential	**932,5**	**7.386.577**	**0,79**	**1.211.412**	**6.175.165**
Potential 2000 - 2010	**592,0**	**5.064.406**	**0,86**	**1.086.804**	**4.577.602**

Table 7-1 Current programme of brownfield redevelopment in Barcelona

As a result of the current planning in Barcelona there will be a lot of new office space for international firms operating in Barcelona, big commercial firms, and important business enterprises. The proportion of new dwellings and activity is 1/4. This is unsustainable without real life quality and no social benefit. Housing is one of the keys to consolidate new neighbourhoods built on old brownfield sites to bring the residents back to the city centre. Rogers illustrates this issue with a good example (1999: 109):

> *"The result of the market-led approach was most clearly illustrated by the fiasco in the redevelopment of the defunct docklands on the Isle of Dogs in London in 1980 and illustrated by the nature of the development that was encouraged to respond solely to market demand, and central government spent indirectly to encourage big business to develop the area."*

Poblenou district is one example of redeveloping brownfield, and increasing the building potential of the area, and land-use mix of industry, retail, commercial, offices, municipal services and dwellings. The same might be done in the rest of the brownfield available in the city. If the overall brownfield sites increase the building potential similarly to Poblenou, then the land available for new building area would increase from 8 to more than 20 millions of m2. *See table 7-2.*

Area	**Ha**	**m2**	**m2 / m2**	**m2 before**	**Increase of m2**
Harbour: active zone	197,1	5.913.000	3	920.982	4.992.018
Airport: active zone	208,0	6.240.000	3	797.000	5.443.000
Logistic Park: zona Franca	123,0	3.690.000	3	584.250	3.105.750
Fira de mostres/ Montjuic 2	14,8	444.000	3	117.400	326.600
Pedrosa/ Hospitalet	18,5	555.000	3	218.380	336.620
Gran Via Sud	31,3	939.000	3	470.000	469.000
Front litoral-Marge dret Besós	119,3	3.579.000	3	338.500	3.240.500
Forum Universal 2004	4,5	135.000	3	50.000	85.000
Sagrera-Sant Andreu/ Station TAV	54,3	1.629.000	3	743.105	885.895
Poblenou/Diagonal	46,1	1.383.000	3	626.956	756.044
Poblenou renovation 2000-2010	64,4	1.932.000	3	1.931.198	534.231
Poblenou after 2010	44,7	1.341.000	3	1.341.000	337.322
Hotels	4,7	141.000	3	118.557	22.443
Total Potential	**930,7**	**27.921.000**	**3**	**8.257.328**	**20.534.423**

Table 7-2 of brownfield and m2, m2/m2 increased, with uses, before and after

The commune allows as less as 1.2 million m2 of building area for new dwellings in the next 20 years, thus, approximately 5,000 dwelling units per year. This rate will make the prices for housing to continually increase compared to the disposable income per family.

Poblenou is orientated versus commercial activity area and offices. The direction of the strategic plan must be shifted to increase land use mix and density with workplaces, schools, shops and housing, with overflow from neighbouring communities, ensuring social coherence of the new brownfield developments, avoiding dividing the city into segregated zones and isolated communities or activities. As we can see in figure 7-1, the planning programme is still using zoning theories of the activities and segregated clusters of dwellings. Our suggested dense developments would reject the single-use districts and the dominance of the car, because it is too expensive for the city. This may bring a big amount of new area available for building dwellings and commercial area, and the prices may become equal to smaller municipalities, increasing the willingness to buy a dwelling in the city.

Dense cities can be designed to increase energy efficient, consume fewer resources, and produce less pollution and maintenance expenditures per capita. Complex mixed-use brownfield development has inherent social and environmental benefits, if it is planned to rely on public transport, and it is socially diverse, where different economic and social activities meet.

This concept differs radically from today's Barcelona urban model. Barcelona is transformed by policies designed to empower the market rather than the persons. Current price of the building area is increasing because there are no dwellings available, and there are no other uses than the economic activity from international corporations that can afford the price of land.

In Barcelona there is a lack of public will and consultation during the design process, and the officers are rather influenced by ill-informed committees. This leads to "*the taking of piecemeal decisions"* (Rogers, 1999) by the head at the planning office, Josep Anton Acebillo and the Major of Barcelona. Their attempting at aesthetic control has failed.

The hidden cost of the zoned model of Barcelona metropolitan area is causing an economic cost of traffic congestion, in terms of energy, lost of time, health, the environment, and the social cost of isolation of those citizens left isolated, or exclusive suburbs.

In addition, the municipality must procure good quality of the urban projects, with the use of the streets in favour of the pedestrian and the public transport. The network of pedestrian streets, cycle paths, market places and Ramblas must be expanded using the advantages of the high-density developments. Although, there is a limit to too high concentrations (Barton, 2002: 42)

7.3 Redevelopment of brownfields: integration versus demolition

> *"Traces of old buildings, stretches of Roman and medieval roads, archaeological relics of the industrial past, all these must form part of and contribute to the reconstruction of each area's unique appearance"*
>
> PTMB (1999: 302)

The recovery of some of the un-used industrial buildings in Barcelona –but also in the periphery- might contribute to the creation of a new set of urban monuments. And further, it might save some money, energy and material resources. This buildings could be re-used for relocating the new municipal facilities and services –such as libraries, museums, schools, etc- as well as for other developments from the private sector –housing, commercial area, etc.

For example, in 2001, two entire districts -*Poblenou* and *Forum 2004*- were entirely demolished, without respect to the existing unique features of industrial buildings from the beginning of last century. This might have played an identifying role to lend the character of these districts. Rabal is another example of demolition of an entire neighbourhood of medieval buildings, some of them protected by the same municipality.

There must be a guarantee of preservation of the existing valuable buildings (with historic, social, and ecological values). When increasing the building potential of Barcelona, the conservation of the very greatest buildings must be leaved aside, the preservation of the architectural heritage and the urban form raises fundamental questions in Barcelona.

In the best of the cases, the planning regulations in Barcelona preserve the façade and the developer construct an entirely new building behind. Instead, buildings can be changed to respond new needs without demolishing them and the historical urban form of districts is preserved, juxtaposing new and old, memory and innovation.

8. Conclusions

The planning of new developable land in the metropolitan area has been based on the "predict and provide" approach, where planning authorities do projections to provide urbanisable land for future demand. As a result of this approach, authorities are contributing to the dispersal of economic activities, services and inhabitants, with implications for increased travel distance and higher mobility between employment, residence and services. The commune increases revenues from taxes levied on new activities and inhabitants, so authorities use this approach to lower prices of land in the periphery compared to prices of land in the inner city, and thus increasing the attractiveness of households and companies to buy more land in the municipality. Developments in small municipalities are normally low-density urbanisations, and in the long term, maintenance expenditures per capita of these settlements are very high for the commune. In addition, the maintenance of the current un-used developed areas is very expensive for the commune. As a result, sprawl have resulted in settlements becoming less socially cohesive, less sustainable, and less economic efficient. In addition, the current agricultural land, public open space, ecological habitats, landscape and biodiversity are preserved in the metropolitan area of Barcelona.

If the planning authorities in small municipalities increase the density of the planned developable area, the commune will decrease the maintenance expenditures per capita, and will increase the revenues from taxation to more inhabitants and activities within the same developed area.

The current planning of re-developing brownfield land in the city of Barcelona has also been based on the "predict and provide" approach. The market trend in Barcelona is to create single-use districts with lots of office area, and the current planning encourages solely to market demand. The planned proportion between new dwellings and activity area in re-development of brownfields is 1/4. The commune allows developers to build too little amount of dwelling units per year. This rate will make the prices for housing to increase continually for the next 20 years, and the prices of area for activities to stabilise.

If the overall brownfield sites increase the building potential similarly to Poblenou re-development, then the area available for new building will increase from 8 to 20 millions of m2 within the same currently un-used area. This building area can be used to introduce more dwellings on brownfield sites to bring the residents back to the city centre. As we have seen, with complex mixed-use developments there will be inherent social and environmental benefits. If authorities re-develop dense brownfields, this will provide local employment, services, facilities and dwellings that may reduce the current travel distance and increase the proportion of short journeys capable of being travelled by non-motorized modes.

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