The density dilemma.
A proposal for introducing Smart Growth principles in a sprawl settlement within Catania Metropolitan Area

Introductory remarks

"Urban Sprawl" is known worldwide as the uncontrolled expansion of low-density, single-use suburban development scattered around the countryside.

Sprawl seems to encompass all the new trends of urban development such as regional scale, speed, mass production and distribution, and the merger of city and countryside (Saunders, 2005). At the very beginning the fragmented environment of low density cities had more or less the same structure. The difference was in the dimension of houses, the wildness of gardens surrounding them the invasiveness of roads and parking areas. Nowadays the suburbs can provide the full range of urbanity traditionally belonging to compact cities. At their edges, at the overlap with the edges of other suburbs within the emerging metropolitan regions, we can find office parks, shopping centres, spacious, well equipped and gleaming commercial activities that tend to improve their look in order to successfully compete with the traditional shops of the urban centres (La Greca, 2009).

If we try to delve a little deeper into the phenomenon we rapidly recognize it as a peculiar aspect of the impressive growth of the contemporary town, even if one of the most evident and dimensionally relevant.

"Sprawl" and "suburbia" are the most recurring form of urban expansion in many Anglo-Saxon countries, primarily the United Kingdom, North America and Australia. A. Corboz has pointed out that anti-urban reaction is at the root of its ideological development. Its model is the village and its scientific stand is the garden cities of Ruskin, Owen, Howard and later Perry, Stein and Mumford. Urban sprawl is now rightly regarded as one of the major common challenges facing urban Europe (EEA, 2006) and the most significant and urgent issue in American land use around the turn of the century (Saunders, 2005).

Not only in the USA but all over the world, in the age of the global economy, the impact of urban ways of living increasingly have repercussions well beyond our city boundaries, reaching out across the planet. Cities are the defining ecological phenomenon of the new millennium for they have become the principal engines of economic growth and the places where the greatest part of humanity dwells. (Newman, Jennings, 2005).

The small city of Mascalucia, is one of the cities within the Catania Metropolitan Area. It is a pertinent case study to focus on the relevant phenomenon of a continues urbanization which are constantly eroding the countryside jeopardizing the boundary between city and open country. Here the sprawl seems to be a sort of urbanization laying down without any planning control. It is an example of low density scattered urbanization which is overwhelming the beauty of landscape, the natural resources, the identity of the places covered by a random disposition of anonymous and often trivial buildings.

The ever-increasing demands of urban and economic development besieged the natural landscape. The only barricade to refrain such a development seems to be the periurban areas. These are shards of country sides within the metropolitan urban fabric. The barriers between urban boundaries and open country side should be re-defined through a new landscape urbanism applied to the interpretation of urban voids, a sort of "periurbanscape" in order to make the agricultural areas surviving within a new urban culture (Kipar, 2009).

The present sensitivity to the issue of climate change determines the need to re-consider urban development in the face of the cultural challenge of new models of settlement. The contemporary city is changing, grows on itself without expanding: the densification strategy is establishing itself as an innovative and high quality approach.

The case study is quite interesting also in order to deal with the theme of sprawl and how it was encouraged by automobile traffic and how allocation of space could be improved. It emerges the key role of a creative public transport approach as the central issue in coping with sprawl.
The work we are carrying on is mainly based on the J. Kenworthy (2009) thesis that the most sustainable transport will largely be determined by the strength and reliability of both land use and transport policy interventions that minimize sprawl, increase the centralization of jobs, and generally favour public transport, walking and cycling over cars.
A mix of solutions has to be detected in order to achieve a relevant reduction in CO2 emissions being the latter an imperative facing adaptation to climate change.
The planning approach for Mascalucia aims to highlight the potential role that transport oriented development policy can play to positively influence sound development in cities, for many of the key sustainability characteristics of cities are linked together in a synergistic or interdependent way.

The Metropolitan Context
The city of Mascalucia is one of 27 municipalities within the Catania Metropolitan area. It well exemplifies an highly urbanized settlement with an high percentage of urban sprawl. In the period of 1961-2001, the total population of the metropolitan area grew more than 27%, with the main city of Catania loosing 16% and the other 26 municipalities increasing of 107%. In 2001, about 57% of total population lived outside the main city (60% today).
If we consider only the 18 municipalities surrounding the main city and more intertwined with the latter, these ones totalled a 46% of whole population in 2001. This percentage increased to 49% in 2008. In the same period the main city lost another 4.5% of its population (Tab 1).
Almost 70% of total built up areas, characterised by prevailing detached or semidetached housing, were built between 1964 and 1985 (Tab. 2). Encouraged by the diffusion of private cars and low real estate prices, this low density urbanization has heavily affected the fragile Mount Etna traditional rural landscape and generated, dramatic congestion phenomena.
The general Master Plan of the main city, shaped in 1964 and final endorsed in 1969, severely diminished the opportunity for new developments by privileging areas for new urban facilities. On the other way round in the smaller municipalities surrounding the northern boundaries of the city of Catania the lack of rigid zoning regulations in engendered the rise of the sprawl.
The frenetic approximate building activity shaped a clumsy settlement model where suburbia areas mixed with urban sprawl in periurban areas have seriously jeopardize the feature of rural landscape in an rambling sub-urban melting pot. Thousands of building permits have been endorsed on the basis of inadequate urban plans without any sustainable approach or sounding town planning principles.
Despite of many attempts (since 1969) the Catania Metropolitan area has never approved either a Master Plan or a Strategic Plan. As a consequence, each municipality has its own master plan based on self-directed alternatives and without any harmonization on urban form development or any agreement on population density, urban growth boundaries or even metropolitan open land shared vision. As we have pointed out this increasingly but steady approach has caused a notable erosion of the residual agricultural land gradually substituted by new developments (Tab. 6)

The urban context
The small town of Mascalucia was an agricultural one (about 3000 inhabitants in the late 19th century) on the volcano Etna low slopes, approximately 500 meters above sea level. Its 1600 hectares are nowadays entirely absorbed into the expanding conurbation of Catania. Its agriculture oriented economy, originally based on wine production, has completely swiped out by holiday houses developments since mid sixties, transformed into stable dwellings in the following 20 years. In 2008 population reached 27.482.

Tab. 3 and Tab. 3 give a clear picture of the dynamics of its urbanization over the last 80 years. The original urban growth along the main existing street axis, connecting the different municipalities among them and with the main city, has progressively evolved into an urban tissue arranged around main cross roads and then towards a single detached house “la villetta” (the small villa), representing nowadays the prevailing urban feature. It was the answer of a middle and upper low class, asking for status symbol of wealthy people who used to build their holiday houses on the hills around Etna (Dato 1995). The period 1964-1985 shows the higher growth rate, with more than 60% of the whole built urban fabric. An ever growing social demand aiming towards individualistic lifestyles, has expressed through the acquisition of accessory private spaces (garage, vegetable garden, etc.) hard to find in the compact city.
These socio-economics trends have produced a low density urban system, quite similar and spread all over near municipalities, giving place to an urbanized continuum, where the detached housing shares the 80% of all buildings in Mascalucia, while residential land use covers 45% of all the municipal territorial area (Tab. 7). During the two decades characterized by the highest level of development, average land consumption per residential use is 250 m^2, reaching peaks of 650 m^2 per day..
Low density settlements and homogenous residential land use are strongly correlated, and contribute to lowering the degree of urbanity of the overall city of Mascalucia. The few existing urban facilities are less than 8% of the built environment and they are concentrated in the downtown. The open land, still with agricultural potential, has a remarkable extension (45% of municipal territory), but most of them is abandoned or even spoiled, probably because the excessive fragmentation of the land is not compatible with an efficient productive use. As a consequence, the irremediably compromised agricultural landscape, has progressively transformed into a “leopard-spotted” urban landscape, where empty spaces are filled up with different land use, from agricultural to uncultivated, from open retail to waste dumping, indefinite spaces following one another and making counterpoint to urban sprawl (Dato, Martinico 1991).

Mobility
The prevalent residential land use of Mascalucia and the absence of significant productive and commercial activities, creates a strong dependence of Mascalucia from the main city of Catania. This is reflected in the mobility commuter patterns with most of the traffic flows directed towards Catania where the most important functions (hospitals, university, secondary schools, leisure) of metropolitan level are located. More than 65% of all systematic trips during the peak period has destinations external to Mascalucia and 62% of these latter are inside Catania. More than 87% of travels to Catania are made by car along the main road (SP. 10), less than 13% is by low frequency and low performing bus transit services. Negligible traffic volumes are directed towards neighbouring municipalities, mainly S. G. La Punta, Nicolosi, Misterbianco, Gravina, through a narrow, irregular and congested roads (still based on the ancient rural network design).
The urban sprawl phenomenon has encouraged the construction of new links to the main rural and provincial network, that serves Mascalucia and the nearby municipalities, thus creating a grid of local streets, often interrupted in correspondence of settlement disconnection. (tab. 5)
As already remarked during the drafting of the City Master Plan at the high amount of roads (Tab. 4) do not correspond equal benefits in terms of mobility and accessibility (Dato 1995).
A comparison between the length of the road network in 1928 and in 2008, shows that the network has grown from 46 km to a current share of 182 km, corresponding to 15 meters for each resident in 1928 in front of 6 meters in 2008.
Then, while the road infrastructure standard has decreased, rate of trips significantly has grown, both for the exponential escalation of car ownership and for the metropolitanization of

high proportion of population and territory, resulting in daily commuting traffic flows mainly towards the main city.
This car oriented town pattern has given origin to high social and environmental costs, has led to the waste of high valued resources, such as land, energy and time, not taking into proper account their intrinsic lack nor the external costs of car based mobility, such as noise, air pollution, accidents and climate change (Viale, 2007).

Planning
Three land use master plans of Mascalucia has been built since 1960s. The second, approved in the early 80's, has been the main cause for sprawl since it allowed a building area of 10% of the plot almost everywhere outside the built up area. Landowners began subdividing their properties in plats of about 500-1000 sqm, selling them mainly to middle class people from main city, eager to have an holiday house in a place close to the mount Etna.
The third one, approved in 2000 was an attempt to rationalise the resulting settlement system by restricting further developments and introducing services and infrastructures that were lagging behind. It was a sort of emergency plan, based on precise target of urban growth reduction, and on regeneration actions implemented by an homogenous distribution of urban facilities and services throughout the territory, by minimal infill to rationalize low density urban fabrics and to link the edge ones. The master plan allowed urbanization for 3000 new inhabitants, during the period 2000 – 2020, in addition at the inhabitants that could be located in the holiday houses, recently transformed into stable dwellings

Land use and transport system interaction and integration
It is well recognized that a proper integration of land use and transportation planning is effective in reducing car dependency of our cities.
The land distribution of householders and economic activities generates the need for using different urban functions and then the demand for travel. All mobility dimensions are, to different extent, affected by the characteristics of the transport service (travel time, costs, reliability, comfort) available in the different O/D pairs. The interaction between transport demand and supply determines the traffic flows on the different modal networks and the consequent territorial accessibility. Accessibility affects the location choices of householders and economic activities, producing the circular land use and transport relationship.(fig. 7)
As it can be seen by the flow chart (fig. 7), the veh-km travelled depends on the size mobile population, on trip frequency, trip length (including path choice) and mode choice. The last three are largely affected by land use. For instance, accessible retail opportunities increase trip frequency, while close retail opportunities reduce trip lengths and very close retail opportunities might result in shifting to walk mode and the presence of an attractive land use and urban design might influence the choice of travel path.
Transport planners need to forecast how future travel demand is affected by land use and similarly they have to be able to estimate how new transport investments modify land use. It is basically a predictive task. On the other way round the point of view of the urban planner should be prescriptive: how to address changes in land use in order to get a better performance of the transportation systems and how to change the latter in order to produce desired changes in land use.

Feasibility of a BRT line as transit system for TOD
Land use density - mix of land uses, urban form, urban design, activity scale, and contiguousness of development - plays a crucial role in reducing car travel, by reducing car trip frequency and trip lengths, and shifting to alternative mode of transport, including walking and cycling. This has originated the concept of Transit-Oriented Development, based on "*locating new constructions and redevelopment in and around transit nodes is viewed by many as a promising tool for curbing sprawl and the automobile dependence it spawns.*"

(TCRP Report, 2004 p.3). Calthorpe defines TOD as "*mixed-use districts within a comfortable walking distance of a transit stop and core commercial area (about 2000 feet). A walkable environment makes it attractive for residents, visitors, and employees to travel on foot to transit and convenience*". (Calthorpe, 1993 p.41)
It occurs within 0.5 km of a transit stop, when it is linked to a walkable and bikeable street network, with mix of land use and compact density.
Favouring urban development around transit facilities has proved to be effective in improving accessibility, quality of life and transit financial sustainability.
The basic idea of TOD is that a proper combination of transit accessibility, service performance and well connected network to access walking or biking or leaving the car on a park-and-ride facility, can induce a smart urban growth toward a liveable community. But, actually, while the land use - transport (cause – effect) relationship is quite spontaneous, the transport – land use relationship need public support and guide.
Anyhow, TOD is primarily based on rail mass transit as the faster and most effective transport mode to compete with car, produce significant mode shift, reduce car dependency and urban sprawl. Actually, it is not rail transit per se that is technologically superior to rubber tired highway transit, but the so called right-of-way (ROW), that is the most critical element to the system performance. A bus transit system with a high percentage of protected running way has performances closer to a Light Rail Transit as it runs in its own way most of the time, separated from cars and possibly with grade separated to avoid intersections. Such a transport system is called Bus Rapid Transit (BRT). Largely used in many parts of the world, BRT is proofing to offer a potentially cost-effective transportation mode that bridges a capital cost gap between regular bus service and light rail transit, and can deliver services with features that normally are found only with rail service. (Gray 2006)
According to Vuchic (2007), BRT is an integrated system of distinct buses and a separate infrastructure with considerable independence from other traffic, allowing higher speed, reliability and safety than a conventional bus transit system. Its lines provides frequent, reliable service and regular headways during all daily hours. The stations are equipped with good passenger protection, information and fare-collection facilities and they are spaced at least 300 to 600 m apart close to central city and greater distances in suburban areas. Bus vehicles have a distinctive design and receive a preferential treatment at all major intersections. Eventually Intelligent Transportation Systems (ITS) technology is used for monitoring vehicle location and movements, passenger information and fare collection.
BRT can be considered a new and creative way of providing high quality and high performance transit, which suit better than fixed rail transit systems in low density urban areas.
A remarkable question is now if a BRT system can be a practical alternative to rail transit to catalyst a TOD, promoting walkable, compact and mixed-use development around its stations in cities with low density auto development patterns and very high growth rates.
Moreover we think that the real success of a TOD pattern can be measured only by the actual increase in transit ridership and consequent reduction of car travels. So a key factor will be the implementation of an integrated transport policy at the metropolitan area scale, ranging from location/alignment of the busway and stations based on a proper knowledge of travel demand desire lines, to the interconnectedness of public transit services (network, fares, scheduling), to park-and-ride facility providing, from proper park and road pricing policies to the effectiveness of walking and bicycling facilities and promotion, etc.

Relation between TOD and CCA

The impact of Climate Change on towns and cities and their inhabitants will be significant in next years, through uncomfortably high temperatures, greater incidences of flooding, strain on water resources and quality, and less stable ground conditions.
Tackling Climate Change challenges is an essential component of truly urban sustainable development.

Regional spatial planning and urban design can provide solutions that make our communities less vulnerable to these risks. Green infrastructure including gardens, parks, productive landscapes, green corridors, green roofs and walls and blue infrastructure such as water bodies, rivers, streams, floodplains and sustainable drainage systems, play a vital role in creating climate resilient development – a role, which is currently not sufficiently recognised and utilised and lacks integration in mainstream planning.
This is the main objective of the GRaBS project (Green and Blue Space Adaptation for Urban Areas and Eco Towns), carried out by a network of leading organisations established across Europe, including the University of Catania, involved in integrating climate change adaptation into regional planning and development.
The concentration of buildings and paved surfaces in urban areas creates a specific urban climate with higher temperatures, particularly at night, plus restriction of wind, in turn restricting the dispersal of pollutants, and causing increased run-off of rainfall. The increased temperatures lead to the so-called 'heat island effect'. Urban green space is therefore very important because of its effects in ameliorating these climatic effects. It can create local microclimates that are more comfortable for people and it can help to reduce temperatures and promote airflow and movement. Cooling results from shade effects and from the extra humidity produced by vegetation, which together produce a more comfortable environment.
The problem is that green spaces are a potential for shifting towards low density cities. So it looks as Transit Oriented Development land use policies aiming towards urban density to promote transit use and Climate Change Adaptation land use policies aiming towards low density conflict together.
Then the case study of Mascalucia may be a good field to experiment how to find a trade-off between these two conflicting needs of urban sustainability and development.
The proposal is twofold:

1. TOD reduce the need of car travels and this should be reflected in the reduction of paved surfaces that, if transformed in green spaces, could counterbalance the increase in urban density close to the transit stations. The right approach is to focus on separated medium size green spaces well connected by a well structure network of green corridors that provide accessibility by sustainable transport to green spaces and to other urban activities as well.
2. So the aim will be the "greening of urban mobility" both in the sense of favouring the shift towards green (sustainable) modes of transport for climate change mitigation and in the sense of supporting the development and fruition of green spaces for climate change adaptation.

A new planning approach to cope with climate change
The case study helps us to understand the main feature of urban sprawl, its main spatial characteristic and the basic strategies of present policy based on densification, mixed use planning and reduction of private car dependence by concentrating new services and transit access in pedestrian oriented areas. The challenge of the proposal presented is to define a set of specific rules that can limit the uncontrolled sprawl by contextualizing general and widely accepted principles to local conditions such as de-concentrated bundling of developments along public transport nodes, the protection of open space, nature protection, urban development through urban strategic projects and the concentration of business areas in main nodes.
According to the concept of Transit-Oriented Development, planning criteria will focus on promoting new urban development around the nodes of the main transit corridor, as alternative to the car oriented development. (Facchinetti, 2007).
The full awareness of the centrality of the land use and transport system approach, leads to the implementation of a BRT line, running along the main south-north highway linking

Catania, Gravina, Mascalucia, Nicolosi, Pedara, providing an high accessibility to the district town. (fig 8)
The location of the transit stations and stops is based on transit node accessibility criteria, on the transformability of the areas around the nodes, and on a radius of 500 m of the transit catchments area.
The analysis of the catchments area shows that more than 40% of the built area of Mascalucia is within a walkbale distance of the proposed transit stations.
The challenge is to enlarge the accessibility of the transit stations through a dense network of cycling and pedestrian protected paths connecting also the residence with other contiguous mixed land uses which contribute to offer a smart and liveable community.
Close to the transit station an increase of the housing density shall be allowed in order to enhance the location of economic activities, collective spaces, park-and-ride facilities, all complying within the general framework of urban planning integrating land use and transport systems at the different territorial scales. In fact, while the BRT itinerary has to comply and integrate the transport choices already part of the transport plan at the metropolitan scale, the new development based on the TOD approach around the transit stations has to be a key element of the municipal land use planning tools with a high level of details. It means that a special attention has to be paid to the identification of the suitable building areas or the one to be provided with public facilities, and also to impact on the values of land and properties, determined by the increased accessibility, urban and environmental quality.
The last is a critical element for the success of a sustainable development project. Indeed, the accessibility of land is generally not properly priced, because the cost of building and maintaining transport infrastructures used to access land are sustained by the community and not by the landowner. A proper taxation levied on the value of land - land value and not on property, would lead to an internalisation of external costs imposed by the development of land, and would discourage urban sprawl. Moreover, earmarking the tax receipts for the funding of the transport infrastructure would lead to an increase in the land value in a specific area ("land value capture") thus contributing to solving the problem of funding infrastructure.
With these premises, the implementation of a reliable and performing BRT transit system can contribute to improve the accessibility of low density suburban areas, to give the opportunity for urban enhancement, through the restoring of the existing real estate, the settlement of new urban functions other than residence, the aggregation of dispersed and detached residential areas around new urban central places, where is easier walk, live, have social interaction and access transit. In the meantime BRT can contribute to improve social, economic and environmental dimensions towards a sustainable development, including the challenges deriving from climate change.

Bibliography

Bevilaqua P. (2008) *Miseria dello sviluppo*, Laterza, Bari
Calthorpe P. (1993) *The next American Metropolis*, Princeton Architectural Press, New York
City of Ottawa, Planning, Transit and the Environment Department (2007) Land Use and Design Guidelines for Transit Oriented Development
Dato G., Martinico F. (1991) "Metamorfosi dello spazio urbano nell'area metropolitana di Catania", in Sanfilippo E. D. Catania, *Città metropolitana*, Maimone Editore, Catania
Dato G. (1995) Comune di Mascalucia, Relazione del PRG
EEA (2006) *Urban sprawl in Europe: The ignored challenge*, EEA, Copenhagen. European Environment Agency, Copenhagen.
Facchinetti M. (2007) *Intorno al nodo*, Pitagora Editrice, Bologna
Gray G. et al. (2006) *Bus Rapid Transit: a handbook for partners* - Mineta Transportation Institute, College of Business, San José State University
Kenworthy J. (2009) *An International Comparative Perspective on Fast Rising Motorisation and Automobile Dependence in Developing Cities,* In Transport Policy Making and Planning for Cities of the Developing World, eds H. Dimitriou and R. Gackenheimer, 1-36. London: Edward Elgar.

Kipar A. (2009) *New Landscape Territories in Urban Design*, in "IsocarpReview" n. 4, Isocarp, Then Haag.
Martinico F. (2005) "The Clumsy Metropolis Urban Dynamics and Globalization in a Metropolitan Area of the Southern Italy" in La Greca P. (ed), *Planning in More Globalized and Competitive World*, ISoCaRP – Gangemi, The Hague-Roma, 2005
La Greca P. (2009) *Urban Growth without Sprawl. An Introduction*, in "IsocarpReview" n. 4, Isocarp, Then Haag.
Newman P., Jennings I (2008) *Cities as Sustainable Ecosystems. Principles and Practices*, Island Press, Washington, D.C.
Ryan L. R. (2002) *Preserving rural character in New England: local residents' perceptions of alternative residential development,* "Landscape and Urban Planning", 61
Saunders S. W.(editor) (2005) *Sprawl and Suburbia*, University of Minnesota Press.
Schiller L. P. (2002) *Taking the High Road, Protecting Open Space Along America's Highways, The Trust for Public Land*, Washington, D.C.
TCRP Report 102 (2004) - Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects – TRB, Washington
Transportation Cooperative Research Program (TCRP), Report 90, Bus Rapid Transit, Vol. I, 2003
Viale G. (2007) *Vita e morte dell'automobile*, Bollati Boringhieri. Bologna
Vuchic V. R. (2007) *Urban Transit Systems and Technology,* John Wiley & Sons, Hoboken

Tab1 - Recent population dynamics in Catania Metropolitan Area

Municipality	Total 2001	Total 2008	2001 -2008	%split in 2008
Aci bonaccorsi	2 549	2927	14,8%	0,50%
Aci castello	18 272	18107	-0,9%	3,08%
Aci catena	27 058	28434	5,1%	4,83%
Aci sant'antonio	15 389	17188	11,7%	2,92%
Camporotondo etneo	3 007	3805	26,5%	0,65%
Gravina di catania	27 343	27808	1,7%	4,73%
Mascalucia	**24 483**	**27482**	**12,2%**	**4,67%**
Misterbianco	43 995	47912	8,9%	8,14%
Nicolosi	6 197	6959	12,3%	1,18%
Pedara	10 062	12283	22,1%	2,09%
San Giovanni la Punta	20 850	22136	6,2%	3,76%
San Gregorio di CT	10 366	11307	9,1%	1,92%
San Pietro Clarenza	5 863	6670	13,8%	1,13%
Sant'Agata li Battiati	10 378	9690	-6,6%	1,65%
Trecastagni	8 212	9769	19,0%	1,66%
Tremestieri Etneo	20 442	21520	5,3%	3,66%
Valverde	7 246	7588	4,7%	1,29%
Viagrande	6 591	7707	16,9%	1,31%
Catania	**313 110**	**298957**	**-4,5%**	**50,82%**
Total outside Catania	**268 303**	**289 282**	**7,8%**	**49.18**
Total 19 municipalities	**581 413**	**588 249**	**1,2%**	**100,00%**

Tab. 2 – Urban growth in the Catania Metropolitan Area

Built up areas	Sum_AREA	%	% cumulated
Before 1936	3353327,3	6,2%	6,2%
From 1936 to 1964	2867105,2	5,3%	11,5%
From 1964 to 1985	37249790,0	69,0%	80,5%
From 1985 to 2000	10550606,2	19,5%	100,0%
Total	**54020828,7**	**100,0%**	

Tab.3 – Urban growth in Mascalucia

Built up areas	(mq)	(ha)	%
before 1928	357.481	35,7	4,74%
from 1928 to 1964	476.947	47,7	6,32%
from 1964 to 1985	4.543.156	454,3	60,24%
from 1985 to 2000	1.737.788	173,8	23,04%
from 2000 to 2008	425.903	42,6	5,65%
Total	**7.115.372**	**754**	**100,00%**

Tab.4 – Road network growth in Mascalucia

Roads lenght	(m)	%
before 1928	46.871	25,65 %
from 1928 to 1964	8.663	4,74 %
from 1964 to 1985	100.146	54,80 %
from 1985 to 2000	1.219	0,66 %
from 2000 to 2008	23.374	12,80 %
Total	**182.715**	**100,00%**

Tab.5 – Road classification in Mascalucia

Roads calssification	(m)	%
Main roads	18.745	10,25 %
Collector roads	25.589	14,02 %
Local roads	137.100	75,03 %
Total	**182.715**	**100 %**

Tab.6 – Land use in Mascalucia

Land use types	Area (ha)	%
Abbandoned farmland	215,0	13,20%
Farmland	135,70	8,30%
Woods and shurbs	333,4	20,50%
Private gardens	19,8	1,20%
Parks and public garden	24,5	1,30%
Retail (shopping)	8,7	0,5%
Manufacturing	1,8	0,10%
ParKing	3,4	0,22%
Services and utilities	38,0	2,30%
Country side houses	13,5	0,80%
Residential	687,5	45,19%
Roads	150,0	9,30%
TOT	**1521**	**100,00%**

Tab.7 – Urban Morphology in Mascalucia

Morpholgy categories	Area (ha)	%
Historical compact urban settlements	32,7	4,30%
Linear historical rural settlements	8,4	1,10%
New multi-storey apartment residences	63,9	8,40%
Detached houses	636,8	83,75%
Country side houses	18,2	2,40%
Other settlements	18,6	2,45%
TOT	**760**	**100,00%**

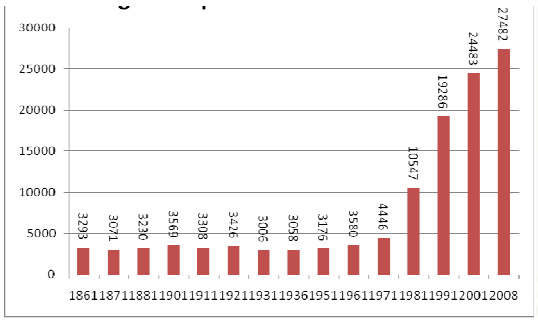

Fig. 1 – Population in Mascalucia

Fig. 2 – City of Mascalucia - Road Classification

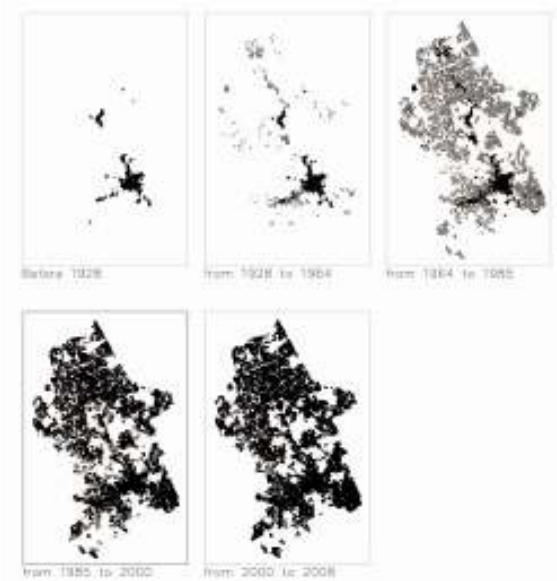

Fig. 3 – City of Mascalucia - Urban Growth

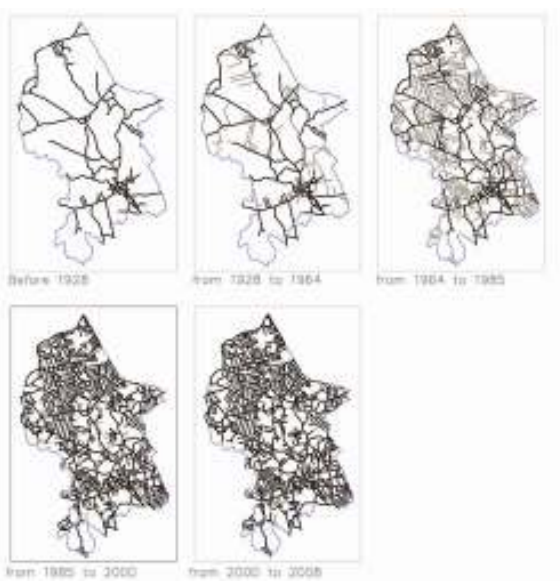

Fig. 4 – City of Mascalucia - Road Network Growth

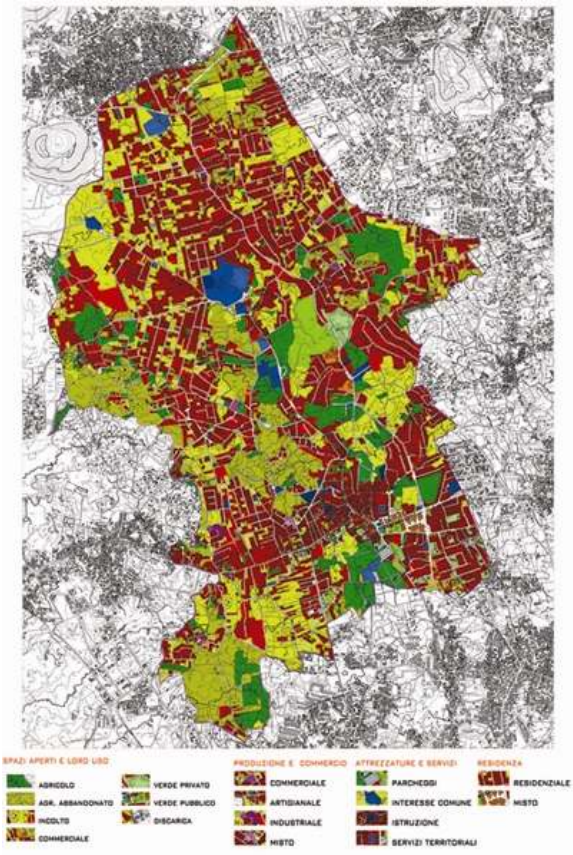

Fig. 5 – City of Mascalucia – Land Use

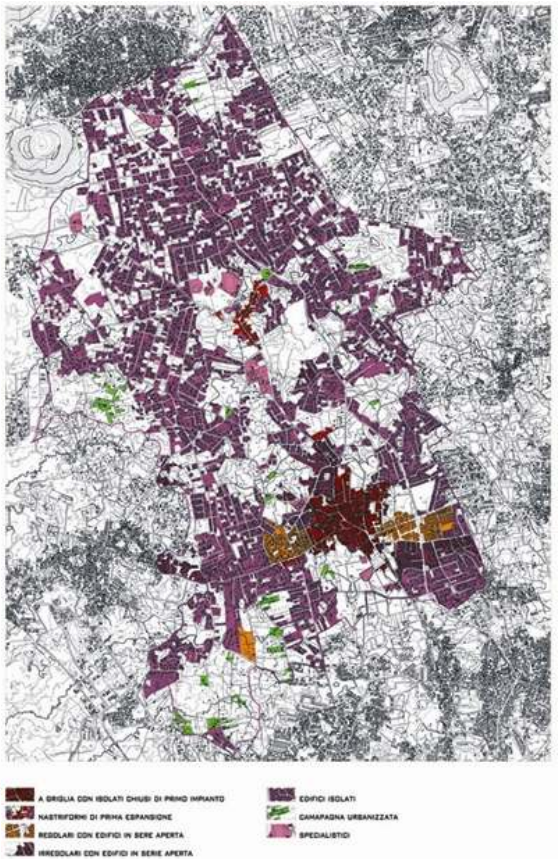

Fig. 6 – City of Mascalucia – Urban Morphology

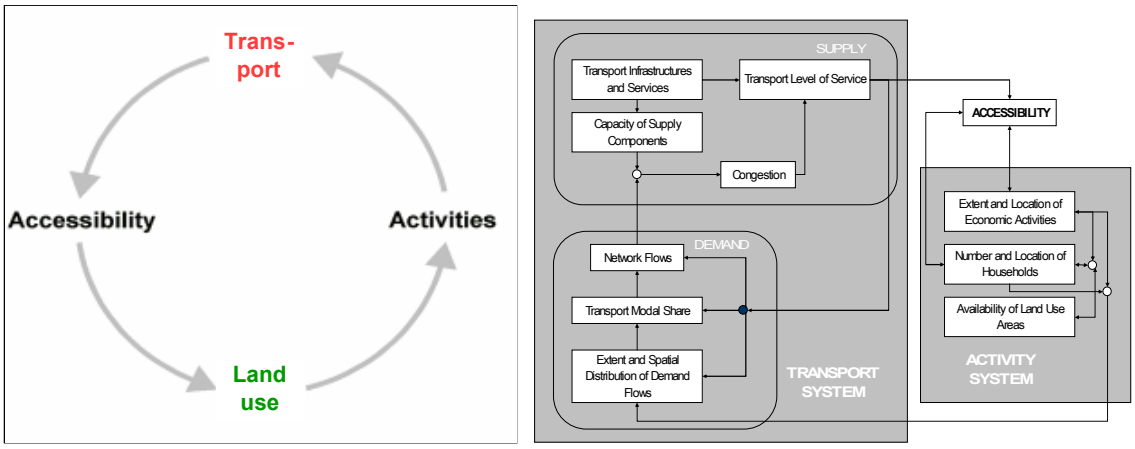

Fig. 7 - Land use – transport interaction

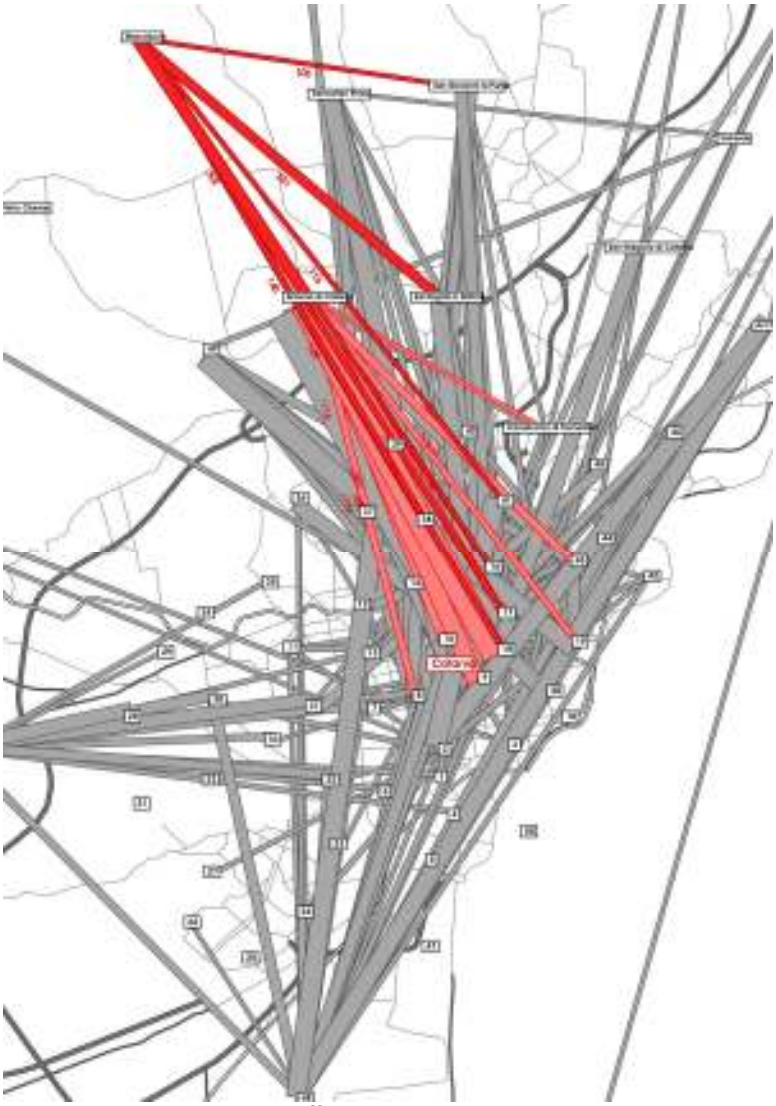

Fig. 8 - Desire lines peak-time commuter traffic (work and study) 6.30-9.00

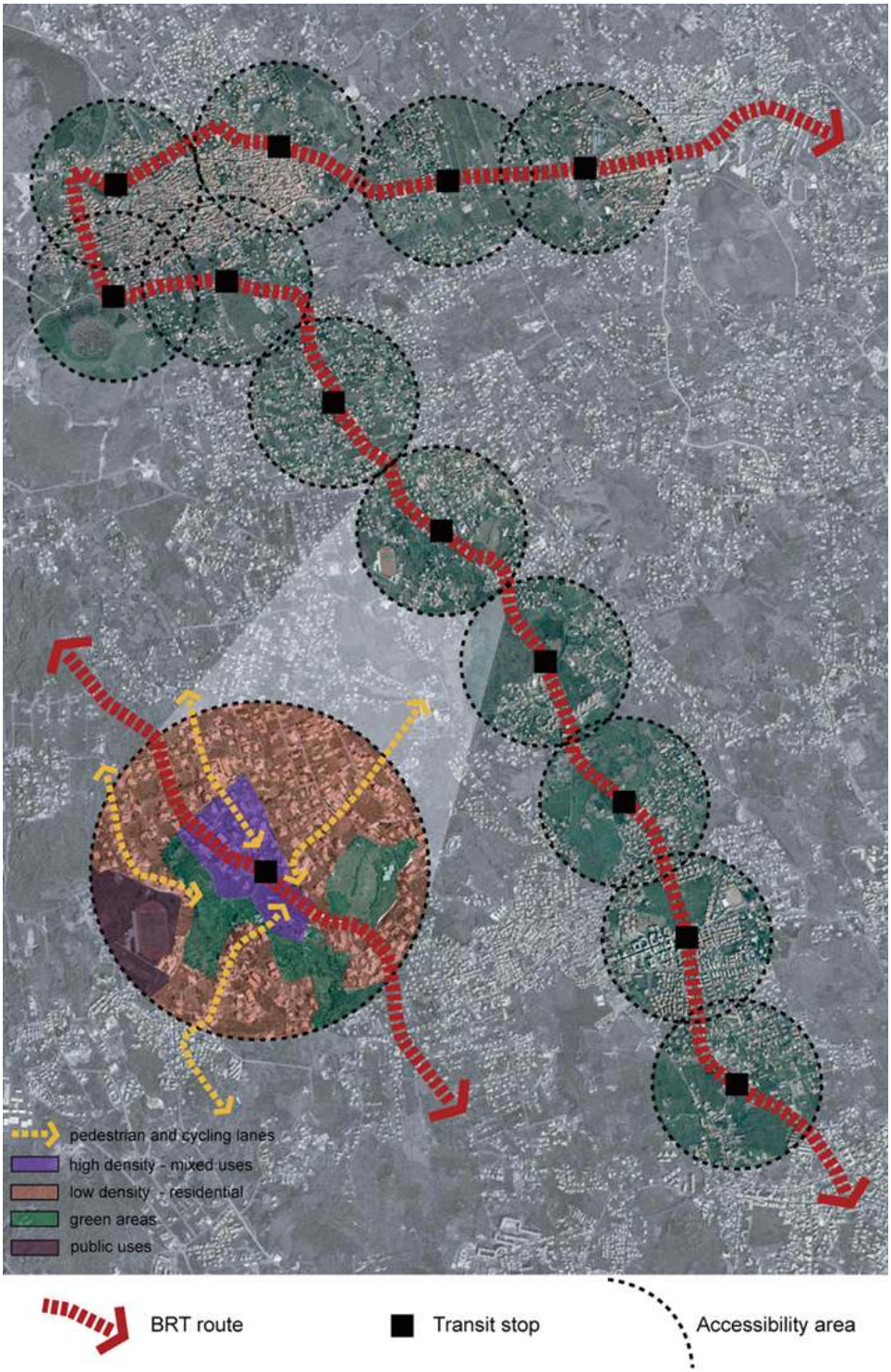

Fig. 9 – Mascalucia BRT route

Paolo La Greca, Giuseppe Inturri and Luca Barbarossa
University of Catania, Italy