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Abstract

A megacity is usually defined as a metropolitan area with a total population in excess of 10 million people. The number of megacities is increasing worldwide: in 1950 they were 4; in 1980 they were 28, in 2002 they were 39 and by 2015 they will be 59. In most agglomerations and megacities, urban planning and public infrastructure can guide the urban development in order to achieve a proper sustainable structure only partially. The extension of cities is in most cases in advance of urban development work and the provision of public facilities (Kotter, 2004).

In Europe it is rare to find megacities, apart from London and Paris, both of them megacities for reasons other then the existence of High Speed Rail (HSR). However, due to the general high density of population in Europe and the short distance between medium and large cities there is the possibility of HSR potentiate the emergence of groups of cities that will be linked together and thus reap the economic benefits associated with megacities, namely economies of scale, economies of agglomeration and bigger labour markets. This is important because adequate levels of planning might help to avoid the disbenefits of megacities in these European megacities.

However, in this contribution the authors argue that in some cases, specific facilities can foster the formation of megacities; in fact, this is the case of High Speed rail systems (see for example Europe). Specifically, High-Speed trains can be used to solve two different accessibility problems. In the first case, where a point-to-point link is dominant, each train is a potential substitute for an air connection between two cities, i.e. it connects cities (or rather CBDs) at long distance with a direct train connection (Blum *et al.*, 1997).The HSR links between Paris and Lyon, Paris and London and, Tokyo and Osaka, could be seen as examples of this first type of train connection. In this case the train trip

together with access and egress times should be compared with the competing solution which consists of the air trip plus the trip to the airport at the trip origin and the trip from the airport at the trip destination.

In the second case, where a HSR network is dominant, the rail system links together many cities and CBDs and, hence, creates a new type of region with a high intra-regional accessibility sharing a common labour market and a common market for household and business services. In this case the HSR binds together cities in a band, where each pair of cities is at a time distance of between 20minutes and 1 hour, i.e. a time distance that allows daily commuting. In, for example, Germany and Italy a number of cities are connected in exactly this manner by HS train.

In the U.S., HSR projects are very recent and they will have the role of connecting already formed megacities. An example is the state of California, which is planning an 800-mile HSR service connecting Los Angeles and San Francisco into a two and a half hour trip.

On the other hand, Europe, together with Asia, is the leader in HSR systems; in fact the development of HSR has been one of the central features of recent European Union transport infrastructure policy. The proposals for a European HSR network emerged in a report of the 1990 Community of European Railways and this was essentially adopted as the base for what became the European Community's proposed Trans-European Network for HSR (Vickerman, 1997).

In this paper the case studies of Portugal, where the HSR is a work in progress and of Italy, in which some lines have already been built, will be described in detail from the viewpoint of the various kinds of development described above.

Keywords: High Speed Rail, Megacities

Introduction

A megacity is usually defined as a metropolitan area with a total population in excess of 10 million people. They could also be defined as large core cities linked by an industrial belt or a continuum of cities (Mory, 1997). The number of megacities is increasing worldwide: in 1950 they were 4; in 1980 they were 28, in 2002 they were 39 and by 2015 they will be 59. In most agglomerations and megacities, urban planning and public infrastructure can only partially guide the urban development in order to achieve a proper sustainable structure. The extension of cities in most cases precedes urban development work and the provision of public facilities (Kotter, 2004). In addition to increasing global urbanization, a related but distinct phenomenon is also becoming more prominent: that of the megalopolis or megaregion. A megaregion is an economically integrated but still polycentric area, the formation of which is often induced by high-speed transportation, most notably High Speed Rail (HSR).

Hall (2009) defines a mega city region as a series of cities physically separated but functionally networked clustered around one or more larger central cities and are connected with dense flows of people and information using important transport infrastructures. It is a process of concentrated deconcentration.

Nowadays our cities are facing multiple crises, including economic recession, congestion, resource scarcity, social and public health concerns, and the consequences of climate change. At the same time, billions of dollars are about to be spent on repairing and building urban infrastructure. This convergence presents us with an historic opportunity to invest these funds differently. The future is represented by designing 21st century smart, green, integrated infrastructure, constructing new models that result in a better environment, improved public health, a stronger economy, and a safer society.

The challenges are immense. What is required is a significant realignment of resources and in fact, entire systems, to achieve the long-term outcomes of health, sustainability, and prosperity.

Many countries of the world are investing in HSR systems which have many advantages compared to other alternative transport modes, since they represent an optimal solution to meet challenges of increasing mobility demand while simultaneously addressing the greater attention of citizens to sustainability issues. HSR offers performance, safety, service, high energy efficiency and environmental friendliness. Moreover, it has the potential to induce megaregional formation and thereby promote economic development at a large scale. Nevertheless this issue is also contentious. Although it is recognized that increases in accessibility like the ones due to HSR could result in positive gains due to effects of agglomeration which could rise up to 20% of the conventional benefits (Graham, 2007), it could lead to space polarization (Gutierrez et al, 1996; Abalate and Bel, 2010) instead of inter-territorial cohesion (Abalate and Bel, 2010), meaning that it is usually the biggest urban agglomerations that benefit the most (Vickerman, 1997;de la Fuente et al, 2006; Abalate and Bel, 2010).

In the U.S., HSR projects are still nascent and they will have the role of both connecting already formed megacities and, hopefully, of furthering megaregional development. An example is the state of California, which is planning an 800-mile HSR service connecting Los Angeles and San Francisco into a two and a half hour trip. The Northeast Corridor connecting Boston, New York, Philadelphia, Baltimore, and Washington, D.C. is also under much discussion. Together these megaregions account for about a third of the US economy.

On the other hand, Europe, together with Asia, is already the leader in HSR systems; in fact the development of HSR systems has been one of the central features of recent European Union transport infrastructure policy. The proposals for a European HSR network emerged in a report of the Community of European Railways of the year 1990 and this was adopted as the base for what became the European Community's proposed Trans-European Network for HSR (Vickerman, 1997). This "network" is essentially the linking together of a series of national plans for promoting HSR improvements that emerged during the 1970s and 1980s.

In Europe three different *models* of rail systems can be identified (Campos and de Rus, 2009):

- the French HSR system, conceived only for passengers, set on new lines with peaks of speed equal to 300km/h and non-stop connections between metropolitan areas;

- the German HSR system, conceived for both passengers and freight, serving also intermediate cities with a system of trains with different speed not superior to 250 km/h, developed on the basis of existing renewed lines;
- the Swiss-English HSR system, consisting in speeding up the Intercity service to 200-225 km/h, combined with a train every hour for any other destination on the network and coincidences in all the stations, at the same time, with all the passengers' trains.

HS trains can be used to solve two different accessibility problems. In the first case, where a point-to-point link is dominant, each train is a potential substitute for an air connection between two cities, i.e. it connects cities (or rather CBD's) at long distance with a direct train connection (Blum et al., 1997).The HSR links between Paris and Lyon, Paris and London and, Tokyo and Osaka, could be seen as examples of this first type of train connection. In this case the train trip together with access and egress times should be compared with the competing solution, which consists of the air trip plus the trip to the airport at the trip origin and the trip from the airport at the trip destination.

In the second case, where a HS network is dominant, the train system links together many cities and CBD's (Blum et al., 1997) and, hence, creates a new type of region with a high intra-regional accessibility sharing a common labor market and a common market for household and business services. In this case the HS train binds together cities in a band, where each pair of cities is at a time distance of between 20-55 minutes, i.e. a time distance that allows daily commuting. In, for example, Germany and Italy a number of cities are connected in exactly this manner by HS train. It is precisely this option that could contribute to the creation of a megalopolis, by strongly increasing the intra-regional accessibility, creating competitive advantages and even making possible the existence of long distance commuting relations.

In this contribution the authors argue that in some cases, HSR systems can foster the formation of megacities and/or megaregions. In fact in Europe megacity regions tend to be smaller and some of them are still in an incipient state; additionally some of them appeared more spontaneously while others are the result of planning policy e.g. South East England (Hall, 2009). However, due to the general high density of population in Europe and the short distance between medium and large cities there is the possibility of HSR enabling the emergence of groups of cities that will be linked together and thus reap the economic benefits associated with megacities, namely economies of scale, economies of agglomeration and bigger labour markets. This is important because adequate levels of planning might help to avoid the disbenefits of megacities e.g. socioeconomic disparities and lack of efficient infrastructure (Kotter, 2004) in these European megacities.

This paper is organized as follows. Section 2 deals with the formation of megacities and proposed HSR systems in the US. In section 3 the case study of Europe is reported highlighting two countries, Italy and Portugal.

The case of Italy, reported in section 3.1, will focus on the Napoli-Roma HSR link and the formation of the megacity RONA. The case of Portugal is described in section 3.2. Section 4 presents conclusions and final remarks.

2. Megacities and HSR in US

At present, there is no High Speed Rail in the United States and with the exception of some portions of the northeastern part of the country known as the Northeast Corridor (NEC) and California; even the conventional rail network significantly lags the European systems. Nevertheless, HSR is a topic of considerable debate and discussion at present within the US. Proponents see HSR as a way of moving from the auto- and aviation-oriented 20th century models of mobility towards a more sustainable model for economic growth. As connectivity becomes more important in a globalized service economy and with the continued strain on existing transportation infrastructure caused by growth, rail is seen as a way to transform transportation within the US.

Nevertheless, to successfully implement HSR in the US context means addressing a particular set of challenges. First, a history of underinvestment in rail must be overcome. Over the past fifty years, federal funding for transportation has disproportionately favored highways and aviation (Todorovich et al., 2011). Not only does this mean that HSR would be a considerable jump in rail provision in contrast to the more incremental progression from conventional to high-speed rail in Europe, it also leaves a legacy of inadequate institutional and financial structures to support HSR. The Federal Railway Administration's current responsibility for grant administration extends far beyond its traditional duties of rail regulation (Todorovich et al., 2011). No stable funding exists for rail in the US. Amtrak, the national rail corporation, relies on annual and unstable congressional appropriations, unlike highways and transit, which receive dedicated revenue from the national gasoline tax. Since the first appropriation of funds for HSR in 2009-2010, 39 states, the District of Columbia, and Amtrak have applied for the $10 billion made available (Federal Railroad Administration, 2011). In 2011 following the economic crisis, however, congress voted to strip the program of funding and at present the California project is the only one set to move forward (Todorovich et al., 2011).

Second, implementing high-speed rail in a country the size of the US poses considerable political challenges. The federal system means that individual states have significant political influence and this, unless more strategic planning occurs, will result in the spreading of federal funds rather than focusing on corridors with the greatest potential for megaregion formation. California and the Northeast Corridor (covering Boston, New York, Philadelphia, Baltimore, and Washington, D.C.) are the two most promising corridors (see Figure 1). Each serves both existing megacities (i.e. Los Angeles and New York) and would likely advance the emergence of a new type of region in which labor markets and economies benefit from increased regional accessibility. These corridors would aim to solve both types of accessibility problems introduced in Section 1, capturing both short-haul air travel and competing with the automobile for commuter-distance trips.

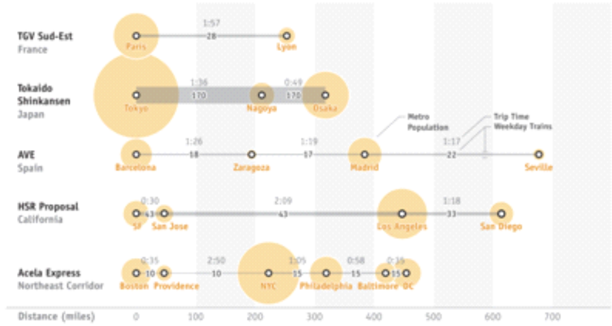

Figure 1 – Comparison of existing HSR and the US Proposals in California and the NEC (Todorovich et al., 2011)

Finally, an urban form that co-evolved with automobile dependency means that rail in the United States faces the challenge of a dispersed spatial pattern of existing development. This is, however, part of the reason why California and in particular the NEC have high potential for megaregion formation as supported by HSR. Both corridors have the existing population density, transport network congestion—particularly at airports and on highways, and projected growth to support high-quality rail. The NEC represents 20% of the nation's total GDP on just two percent of the land area with a population density approximately twelve times the national average (Amtrak 2010). Its existing rail market comprises 45% of all Amtrak demand, with many more passengers carried by commuter rail services along portions of the same routes (Amtrak Sept. 2010 and 2010). California's economy accounts for 13% of national GDP (Bureau of Economic Analysis, 2010) and its rail demand accounts for at least one fifth of national Amtrak usage (Federal Railroad Administration, 2011).

It remains to be seen whether High Speed Rail will be able to overcome the significant political and financial challenges to succeed in the United States. Questions remain about whether a more incremental approach to upgrade conventional rail would be significant enough to achieve the desired economic benefits or whether true international quality HSR is necessary to foster the formation of a new type of megaregion. The NEC and California have an existing level of density and economic interconnectivity that make these corridors the most likely location of HSR enabled megaregional formation. However a natural political bias at the federal level toward spreading the resources over many projects across the country rather than focusing on a few substantial projects makes investment problematic.

3 Megacities and HSR in Europe

The development of HSR has been one of the central features of recent European Union transport infrastructure policy (Vickerman, 1997). The first HS line in Europe, designed at the beginning of the 1960s, was the Direttissima Roma–Firenze. The first HS link in France was the Paris–Lyon and it was opened in 1981. In the second half of the 1980s, the Hannover– Würzburg HSR line was opened in Germany; while in Spain the section Madrid–Cordoba–Seville of 470 km long was inaugurated in 1992.

In 2000 Italy had 248 km of HSR line, i.e. around half of those of Germany and Spain and even 1/5 of that of France. In 2006 there were 562 km of new lines with the opening of the Roma–Napoli (to

Gricignano) and of the Turino–Novara HSR sections. However, in the same period, Spain increased its HSR kilometres from 470 to 1225. In the following subsections the case of Italy and Portugal will be analysed in detail.

3.1 Megacities and HSR in Italy

The development of the HS/HC network in Italy is embedded in the wider context of the Trans European corridors. Specifically, the big Trans European projects in which Italy is involved, apart from the Water Highways, are (see Fig.2):

- Priority Project n. 1: rail section Berlin – Verona – Milan – Bologna – Naples – Palermo;
- Priority Project n.6 which, by linking Lisbon to Kiev, goes trhough the Po Valley; it corresponds to the V TenEuropean Corridor;
- Pan-European Corridor VIII: intermodal section Varna-Sofia-Bari;
- Priority Project n.24: rail link between the port of Genoa and that of Rotterdam through the Gottardo tunnel.

Figure 2 - The Trans-European corridors passing through Italy

The “Direttissima” (HSR line) between Roma and Firenze was opened in 1981 and it represents the first example of a HS rail link in Italy. This was a specific response to the poor quality of the conventional rail route between these cities, which was also the main link between Roma and Northern Italy. However, Italy is currently undertaking a major expansion of HS rail (Cascetta et al., 2009). Once it is completed in 2014, most major cities will be connected to the network. The key objective for the construction that is currently underway is to raise the Italian rail network to the best European standards and to improve its capacity. After the completion of the HS rail system there will be a reduction in travel time between the major cities connected in the order of 40-50% (see Table 1).

In addition to HS rail, High Capacity (HC) rail lines consist in speeding up and increasing the capacity of the existing rail lines. In this case, the new rail lines have lower speed values, but at the same time they allow a better service. In fact it is on these rail lines that the regional service for travellers and freight is made. An example of this type is the Regional Metro System (RMS) project of Napoli and Campania region in Italy (Cascetta and Pagliara, 2008).

Link	Travel time on old rail lines	Travel time on new rail lines	% Reduction of travel time due to the new HS/HC rail lines
Torino-Milano	1h-30'	50'	-44%
Milano-Venezia	2h-43'	1h-25'	-48%
Milano-Bologna	1h-42'	60'	-41%
Milano-Roma	4h-30'	3h	-33%
Torino-Napoli	8h-30'	5h	-41%
Bologna-Firenze	59'	30'	-49%
Roma-Napoli	1h-45'	1h-05'	-38%
Roma-Bari	4h-30'	3h	-33%
Napoli-Bari	3h-40'	2h	-45%

Table 1: Reduction of travel times due to the new HS/HC rail lines

The national Italian network and operations are all owned by FS (State Railway) Holdings, a fully government owned company. It has three key operating subsidiaries: Trenitalia operates all freight and passenger trains, including the high-speed trains, RFI (Rete Ferroviaria Italiana) manages the infrastructure, and TAV (Treno Alta Velocità SpA) is responsible for the planning and construction of the new HS infrastructure.

The rail link of 195 km from Roma till Gricignano was opened in December 2005. The line is not completed yet as the rail link of 18 km from Gricignano of Aversa to Napoli Afragola and the link penetrating the node of Napoli are still under construction (see Fig. 3). The completion of this stretch will bring a reduction of travel time from the current 87 minutes to a travel time between 60 and 65 minutes.

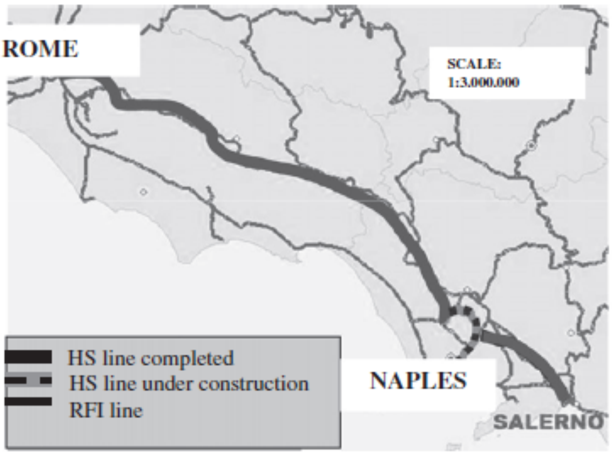

Figure 3 - The HSR link between Napoli and Roma

The new rail link connects two of the largest Italian metropolitan areas. The metropolitan area of Roma with a number of residents equal to 4,145,822 and with a residential density of 473.19 inh/km^2 and the metropolitan area of Napoli with a number of residents equal to 3,582,900 and with the highest residential density in Italy equal to 1900.27 inh/km^2. The two metropolitan areas are very different from each other. In a study of the 14 Italian metropolitan areas (de Luca *et al.*, 2007), an analysis of the intensity of total systematic relationships was carried out and the results indicate an urban polarised growth, i.e. a non-disperse growth which gives rise to new central places. The latter were identified through some indicators, such as the total systematic relationship among municipalities and the intensity of total relationship indicators. The first one is given by:

$$Tot\_syst\_rel\_mun_i = \sum_{j=1}^{n} Gen_{ij} + \sum_{j=1}^{n} Dest_{ij} \quad i \neq j \qquad (1)$$

where:

n is the number of municipalities of the region to which municipality j belongs;

Gen_{ij} are the generated systematic relationships from municipality i to municipality j;

$Dest_{ij}$ are the destinated systematic relationships to municipality j from municipality i.

The intensity of total systematic relationships indicator is given by.

$$Intensity\_Tot\_syst\_rel\_mun_i = \frac{\sum_{j=1}^{n} Gen_{ij} + \sum_{j=1}^{n} Dest_{ij}}{Residents_j} \cdot 1000 \quad i \neq j \qquad (2)$$

The latter has been considered fundamental for the identification of the polarisation phenomenon in large urbanised areas. Under the same number of systematic relationships, this ratio is more intense for the municipality with less demographic weight; while a municipality which falls into the attractive orbit of two municipalities is considered strictly linked to the municipality with which the intensity of total systematic relationships is greater.

The polarisation phenomenon within these 14 urban areas creates Second Level Urban Systems (SLUS), i.e. sets of neighbouring municipalities with a reference pole, all reciprocally integrated into a first level urban system. Specifically, three different urban forms can be identified: monocentric, when it is possible to identify just one prevailing pole (like the case of Roma, see Fig. 4); polycentric, when there is a main pole and SLUS with some towns exceeding 100000 inhabitants (this is the case of the urban area of Napoli, see Fig.5); multipole, when the system is a set of poles of the same level (Veneto urban area).

According to the classification reported in section 1 the Roma-Napoli HSR link is similar to the French one and it solves the second problem of accessibility.

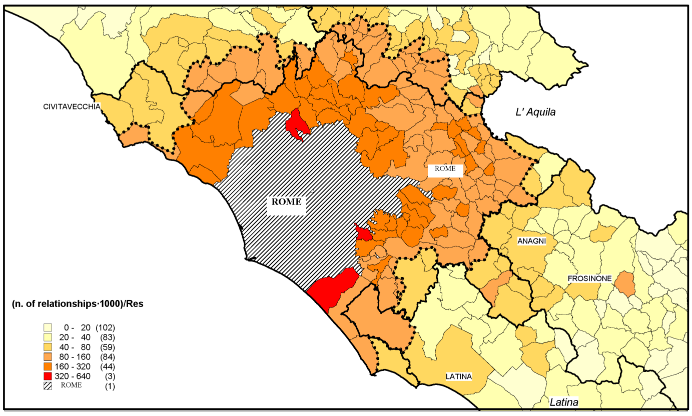

Fig.4 – The monocentric area of Roma

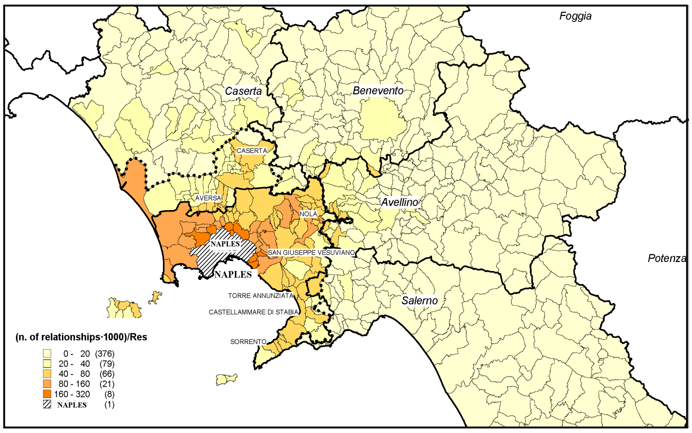

Fig. 5 – The polarized area of Napoli

In March 2008 a Revealed Preference survey was carried out on the multimodal connection Roma-Napoli and vice versa. The reference universe is made up of all the users who travel on the connection under study with HS trains, but also with the alternative modes/services of Eurostar (ES) trains, Intercity trains (IC) and by car on the motorway. The main outcome of the survey is that the use of car and of Intercity trains have almost remained unchanged during the few years of operation of the HS service, while the use of HS services have significantly increased. It follows that a generated demand is derived from the use of this HSR link and the modal share is increased as well in favour of train. This result is very interesting since the introduction of the new service increases also the level of interaction between the two cities. Specifically, from 2005 to 2007 the share between train and car has passed from 49% and 51% to 55% and 45% respectively (Cascetta et al., 2011).

Concerning access/egress to/from station, the most used means of transport are metro and taxi in Roma and taxi and private car in Napoli (see Table 2). Analysing the origin and destination of both train and car users (see Table 3) shows that, because of the impact of access/ egress times, train users are more likely to travel on the origin– destination (OD) pair Roma/Napoli. Moreover, this effect is larger when Roma is the final destination of the trip, as a consequence of the already mentioned monocentric structure of its metropolitan area (values circled in Table 3). .

	Roma Napoli				Napoli Roma			
Access/egress mean	access (nr. of user)	%	egress (nr. of user)	%	access (nr. of user)	%	egress (nr. of user)	%
walking/bycicle	146	16.7	104	11.9	143	18.7	111	14.5
car/motorbike	142	16.2	216	24.7	184	24.0	118	15.4
taxi	206	23.6	177	20.3	239	31.2	173	22.6
bus/tram	134	15.3	113	12.9	79	10.3	103	13.4
metro/funicular	237	27.1	145	16.6	116	15.1	210	27.4
train	5	0.6	111	12.7	2	0.3	50	6.5

Table 2 – Access/egress means of transport for HS users

CAR	ORIG \ DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
	NAPLES	0	0	86	10	3	*Weekday*
	ROME	53	33	0	0	14	
	NAPLES	0	0	91	8	1	*Saturday*
	ROME	55	38	0	0	7	
	NAPLES	0	0	81	10	9	*Sunday*
	ROME	61	26	0	0	13	
	NAPLES	0	0	85	10	5	*Total*
	ROME	57	32	0	0	11	

IC	DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
	NAPLES	0	0	88	7	5	*Weekday*
	ROME	62	32	0	0	6	
	NAPLES	0	0	86	7	8	*Saturday*
	ROME	70	28	0	0	2	
	NAPLES	0	0	87	4	9	*Sunday*
	ROME	70	25	0	0	5	
	NAPLES	0	0	87	6	7	*Total*
	ROME	68	28	0	0	4	

HS	ORIG \ DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
	NAPLES	0	0	96	2	2	*Weekday*
	ROME	68	24	0	0	8	
	NAPLES	0	0	91	1	8	*Saturday*
	ROME	62	29	0	0	9	
	NAPLES	0	0	82	6	12	*Sunday*
	ROME	66	27	0	0	6	
	NAPLES	0	0	92	2	5	*Total*
	ROME	66	26	0	0	8	

ES	DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
	NAPLES	0	0	92	3	5	*Weekday*
	ROME	85	15	0	0	0	
	NAPLES	0	0	91	2	7	*Saturday*
	ROME	73	22	0	0	5	
	NAPLES	0	0	88	3	9	*Sunday*
	ROME	80	20	0	0	0	
	NAPLES	0	0	90	3	7	*Total*
	ROME	78	19	0	0	3	

Table 3: Trips from Napoli and Roma

3.2 The HSR project in Portugal as a tool to help the creation of a Megacity

The Portuguese HSR project includes three priority links - Lisbon-Madrid, Lisbon-Oporto, and Oporto-Vigo corridors - with a total length of about 650 km and an investment of around € 8 billion. It also includes some significant and costly civil structures such as the Tagus Crossing in Lisbon (see Fig. 6). The corridor Lisbon – Madrid had at its main objective to link these two capital cities with no intention of creating a Megapolis.

The other two main corridors were planned with the objective of reinforcing intra and interregional links either betwen the two main Portuguese cities (Lisbon and Oporto) and between the north of Portugal and the Galiza region in Spain.

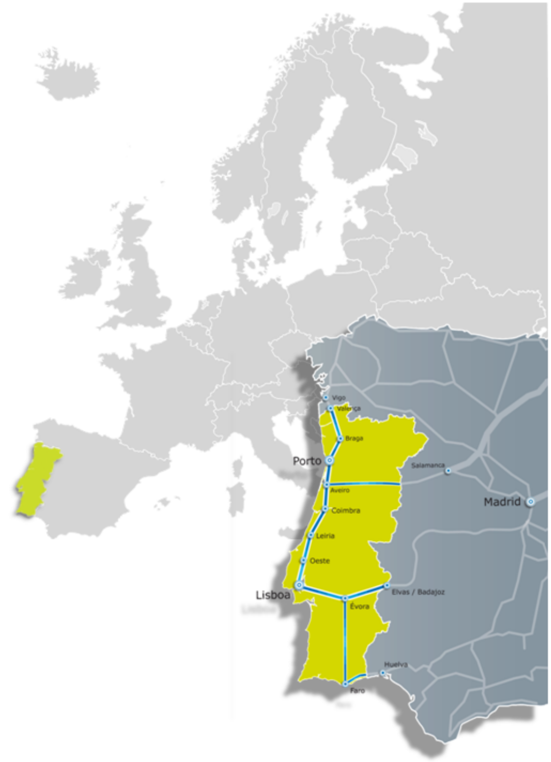

Fig. 6 – The Portuguese HSR network (RAVE)

A quite significant proportion of the Portuguese population lives in the stretch between Braga (around 50 km north of Oporto) and Setubal (in the Lisbon Metropolitan Area, around 30 km south of Lisbon). Between Lisbon and Porto cities like, Leiria, Coimbra and Aveiro are ranked in the higher positions of the Portuguese urban hierarchy. Although the population density of Portugal is relatively high around 115-120 inhab./km2(higher than France), in general its cities tend to be of small dimension.

The rationale behind this project is included in several policy documents published by the Portuguese Government, namely the PNPOT, the National Program for the Policy of Territorial Planning. The document focussed on all aspects related with planning and spatial development, several of them focussing on issues directly linked to the orgnization of the urban structure and the transportation sector. The main lines of this diagnosis are the following (MAOTDR, 2007):

- The more dynamic and polarizing areas in the country are located along the coast between the metropolitan areas of Lisbon and Oporto;
- Both metropolitan areas (Lisbon and Oporto) are quite strong when considering the national population but are still fragile in its international functional projection. Between them exists a large area with diffuse urbanization and several polynucleated urban areas puntuacted by some cities of regional importance. These major cities although they are considered as large medium cities in the Portuguese context, don´t have the demographic dimension to be considered as medium cities in the European context.
- Two main tendencies appeared in the last decades. The first one is the depopulation of the rural areas and the urbanization of the country´s population. In the decade of 1990 there was a stabilization of the demographic weight of the two metropolitan areas (Lisbon and Oporto), as well as the reinforcement of several medium cities, particularly in the coastal areas. This was achieved with a more diffuse urbanization resulting in an increase in sprawling; This pattern is also associated with the rise in car ownership and motorization rates, which also helped an increase in the intensity of interurban relations contributing to the rise of regional and subregional urban systems;
- In the last decades there was a strong investment in road

infrastructures that were mainly concentrated in the littoral and linking the two metropolitan areas as well as some important medium cities in the interior. As a result the road density is quite high. The rail sector also experienced also important changes with the investment being concentrated in more important rail corridors and with several low demand lines being deactivated. Nevertheless this rationalization was not enough to sustain the decline of rail market share in interurban trips

Thus as a result of these dynamics the PNPOT indicates that the main problems are associated with:

A strongly carbon-energy intensive transportation sector due to the heavy reliance on road based transportation, leading to a strong dependency on external energy sources;

A strong geographical dispersion in the economic infrastructures and facilities leading to their weak international presence which leads to losses of scale and atrophy of the more developed economic functions.

An insuficient international presence of the urban functions in the main urban agglomerations, which creates difficulties in the country's participation in the international investment and economic flows

Thus the introduction of HSR in Portugal was seen in this document as a strategic tool to help reshape the regions served by this mode. Therefore it would contribute to organize the cities in the northwest of the Iberian Peninsula (Line between Porto and Vigo), to reinforce the urban centers of Leiria, Coimbra and Aveiro (Line between Lisbon and Porto), since these are served by the HSR, and to insert Lisbon in the HSR transeuropean networks and thus increase its role in the context of the great european regions (Line between Lisbon and Madrid). Besides these objectives the line between Lisbon and Porto would help the creation of a Megalopolis, since travel time between both cities would be around 1h15m (SDG/VTM, 2009). This corridor encompasses 63% of the total number of companies, 70% of the total GDP, 61% of the total population, and 37% of the total number of tourists (AtKearney, 2003).

Several studies undertaken since 2000 stressed the potential benefits of the HSR in Portugal and its capability to help the formation of a Megalopolis in the region between Lisbon and Porto (with a population of around 6 million inhabitants):

- HSR could be though of as both an instrument of economic policy by reducing regional asymmetries and territorial management (SOCINOVA, 2003),
- The Lisbon Porto line considered the existence o both direct services and others with intermediate stops thus contributing to the existence of a bundle of services that contribute to the internal cohesion in the corridor and reinforcing connections between all of the cities located inside of it.At the same time one of the objectives of the project was to reinforce the competitiveness of those intermediate cities by increasing their accessibility in order to transcend their dimension

(SDG/VTM, 2009).

- The indirect economic benefits envisaged for the project encompassed economies of agglomeration (due to the increase in accessibility and reduction of travel times), and impacts in the labor market. The benefits due to the economies of agglomeration were estimated at 64 million euros. The impacts for the labor market was significantly inferior, only 350 thousand euros. This was due to the low number of commuting trips, since the demand studies didn´t consider explicitly the possible induced traffic due to the effects of super commuting. The impact on imperfect competion is again on the magnitude of the agglomeration economies, around 26.5 million euros (SDG/VTM, 2009).

As a result, and although the HSR project in Portugal has lost its momentum due to the international crisis of 2008 and subsequent sovereign debt crisis of 2011, it results at least partly from a voluntary approach from the Portuguese authorities to create a mega region between Lisbon and Oporto that could transcend the small demographic dimension of Portuguese cities and put them in a paradigm of networked cities in order to dissociate the relations between dimension and urban functions (Capelllo and Camagni, 2000).

4 Conclusions

In this paper, the authors elaborated on the phenomenon of HSR-induced creation of megacities or megaregions. The detailed investigation of the Roma-Napoli case reveals generated demand as a result of the HS service. Similarly, HSR in Portugal was planned in order to explicitly contribute to a creation of a megacity region between Lisbon and Oporto by strongly increasing the intra-regional accessibility, creating competitive advantages and even making possible the existence of long distance commuting relations. In general, indicators of HSR-induced megaregion formation include: an increase in one-day round trips; high levels of induced demand, particularly for business trips; an increase in the number of daily commuters; and a decrease in overnight stays (Melibaeva, 2010).

HSR investment is usually promoted not only as a means to increase capacity, improve service, and reduce greenhouse gas emissions, but also to promote regional economic development. The formation of new types of regions, aided by the provision of both air- and auto-competitive accessibility, is a key piece of the economic development argument. Less easy to predict, however, is whether induced growth is truly new. That is, does HSR play a catalytic role by enabling travel that would not occur otherwise, or are HSR’s regional effects more redistributive, resulting in zero-sum growth with “winners” and “losers”? In studies of the Tokyo-Osaka line in Japan, the Paris-Lyon link in France, and the Cologne-Frankfurt connection in Germany, Melibaeva (2010) finds no evidence for *net* growth caused by HSR at the national scale. However in these cases and others such as the NEC in the U.S., an argument can be made that improving mobility in regions that are the “economic engines” of various nations are good strategic investments over the long run. And the environmental advantages should not be overlooked.

From this we see that HSR *alone* is not enough to achieve the economic benefits of megaregional formation, but instead requires concerted policy efforts. Available policy tools to maximize economic benefits and regional growth while minimizing negative distributional effects include: providing adequate frequency of service to smaller intermediate cities, and providing intermodal linkages (both to the conventional rail and urban transit networks) to extend the benefits of HSR to areas not directly served. Coordinating such policies requires planning at a new spatial scale. For example, the trade-off between dominant O-D pair travel times (and thus HSR competitiveness) and adequate frequency to smaller cities, necessitates optimization at the regional level, which in turn implies governance at that level. This type of institutional challenge is one of the primary barriers at present to HSR in the US. In the NEC of the U.S., numerous US states are involved along with the Federal government and regional organizations such as the I-95 Coalition. The institutional constraints are indeed daunting. Also, on a national scale in the U.S., political imperatives to spread HSR investments around the nation are counter to the need for focused funding on corridors in which HSR makes sense. In Italy, on the other hand, regional coordination was more readily achieved due to the existence of one unified rail company.

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