Characterising Transit Oriented Development in the Paris metropolitan region: what type of TOD are they?

Alain L'Hostis, Sébastien Darchen

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Abstract

Transit Oriented Development (TOD) is a planning model that was introduced by Calthorpe (1993) in the United States. However, it has been applied in different international contexts: in high density urban environments (Asia) but also in medium density urban environments like in Australian cities (Perth, Brisbane) and in Canadian cities (Vancouver). The TOD concept is understudied in Europe. In this paper we analyse TOD-like projects using TOD criteria measurement – like the density of the built environment, the quality of public spaces, accessibility to public transport, the mix of land-uses – to determine the kind of TODs they are. Those criteria have been selected according to the literature on the topic. For this analysis of TOD projects, we use geospatial data for the Paris metropolitan region. After the identification of typical Transit Oriented projects, the objective is to analyse recent TOD case studies (e.g., ZAC Pleyel project in St-Denis). The aim is to understand why some criteria are more challenging than others to implement in practice. The qualitative data has been collected through semi-structured interviews with urban stakeholders. The overall aim of the paper is to provide planning recommendations for best practices of TODs in a high density environment such as the Paris metropolitan region.

Introduction

Transit Oriented Development (TOD) is recognised worldwide as a planning concept suitable for urban development in the context of sustainability. We propose in this paper to use this concept in order to understand the situation and also to provide indications for the orientation of projects in the territory of Île-de-France.

It must be said that TOD has not been used as a concept to produce the current transport and land-use French situation. Yet TOD can be used to help building projects in the French context. In this aim two orientations of research are available: whether importing TOD concept and key findings from abroad with all the challenges , whether finding in the French situations the key elements of TOD in order to build contextualised recommendations. In this paper we want to develop the second type of orientation. Our first objective here is to characterize the TOD situations in Île-de-France in order to bridge the French situation with the international perspective of TOD. This will allow for a better knowledge from abroad of French experience in the TOD domain. This approach will also contribute to provide a new perspective on the French case studies by approaching them through framework that was not explicitly at the origin of these achievements. Our apporach is comparable to and borrows some ideas from the work of Galelo et al. who tried to identify an evolution towards TOD type organisation on a suburban train line in the Porto Area (Galelo, Ribeiro, et Martinez 2014).

What is TOD ?

(to be added by S Darchen)

A framework for characterising TOD in Île-de-France

TOD is essentially a concept for city development. It is based on empirical measures of existing cities (Cervero et Kockelman 1997) but the objective is mainly to develop new areas, or to redevelop the existing urban fabric (L'Hostis et al. 2009). In the TOD approaches it exists a tension between observed facts and situations and indications for future development. In terms of the classical disciplinary division, the rationale consists in using geography to produce indications for urban and spatial planning.

In the definition of TOD, one of the key methodological issue consists in determining the perimeter of the area surrounding the transit stops. For Bertolini, two approaches are broadly possible, whether by analysing the land-use dynamics, whether by analysing mobility (Bertolini et Spit 1998). The effect of a rail station on the prices of land and real estate is proven up to a distance of 700 meters for activities, while concerning housing the effect extends further in space (Debrezion, Pels, et Rietveld 2007).

An isochron of 12 minutes walking is used in a study of the densification of railway stations area in Hauts de Seine in Île-de-France (Louis et Grandin 2011), but the measure the most commonly admitted is the value of 10 minutes of a *walkable radius* (Bertolini et Spit 1998). The speed of walking as a transport mode in the literature is most of the time of 5 km/h (*Étude comparative des temps de déplacement selon les modes* 2007), sometimes slightly more[1]. Less frequently a speed of 4 km/h is used as in the pedestrians network of the city of Geneva (Lavadinho 2011, 433), or in a computation ex-post of distances in a mobility survey (Gascon et al. 2009, 24). If we consider the value of 4,3 used in the agglomeration of Lille in 1998 (Gascon et al. 2009, 23), the average value is between 4 and 5 km/h. All these considerations on the speed of walking lead to a figure of 800 meters for the radius around railway stations. In an analysis of regional rail and urban development in the Saint-Etienne region in France (L'Hostis et al. 2009) and in another study of the areas of stations of the Grand Paris (Pelloux et al. 2014), a perimeter of 800 meters was chosen.

The perimeters used in the observation, the assessment and the action around transit stops admits a strong link between the type of transit mode and the extent of the area of influence. In this rationale, we find the following values (CERTU 1997): 300 meters around bus stops, 500 meters around tramway stops and 700 meters around metro stations.

Île-de-France is a densely populated region that corresponds roughly to the functional space of the Paris agglomeration. All the range of public transport exist in the region with a century old metro network in the core of the agglomeration, with a diametralised railway network (RER and Francilien) serving the region introduced in the 1980's and more recently the re-introduction of light-rail (tramway) and bus rapid transit since the 1990's. It exists also an extended classical bus network. For this study on TOD in Île-de-France we have chosen to focus on the rail mode: we

1Vlastos considers a speed of 5,3 km/h on a wide side-walk, and 4,9 on a narrow side-walk in Athens (Vlastos 2014).

consider the regional rail, metro and tramway networks.

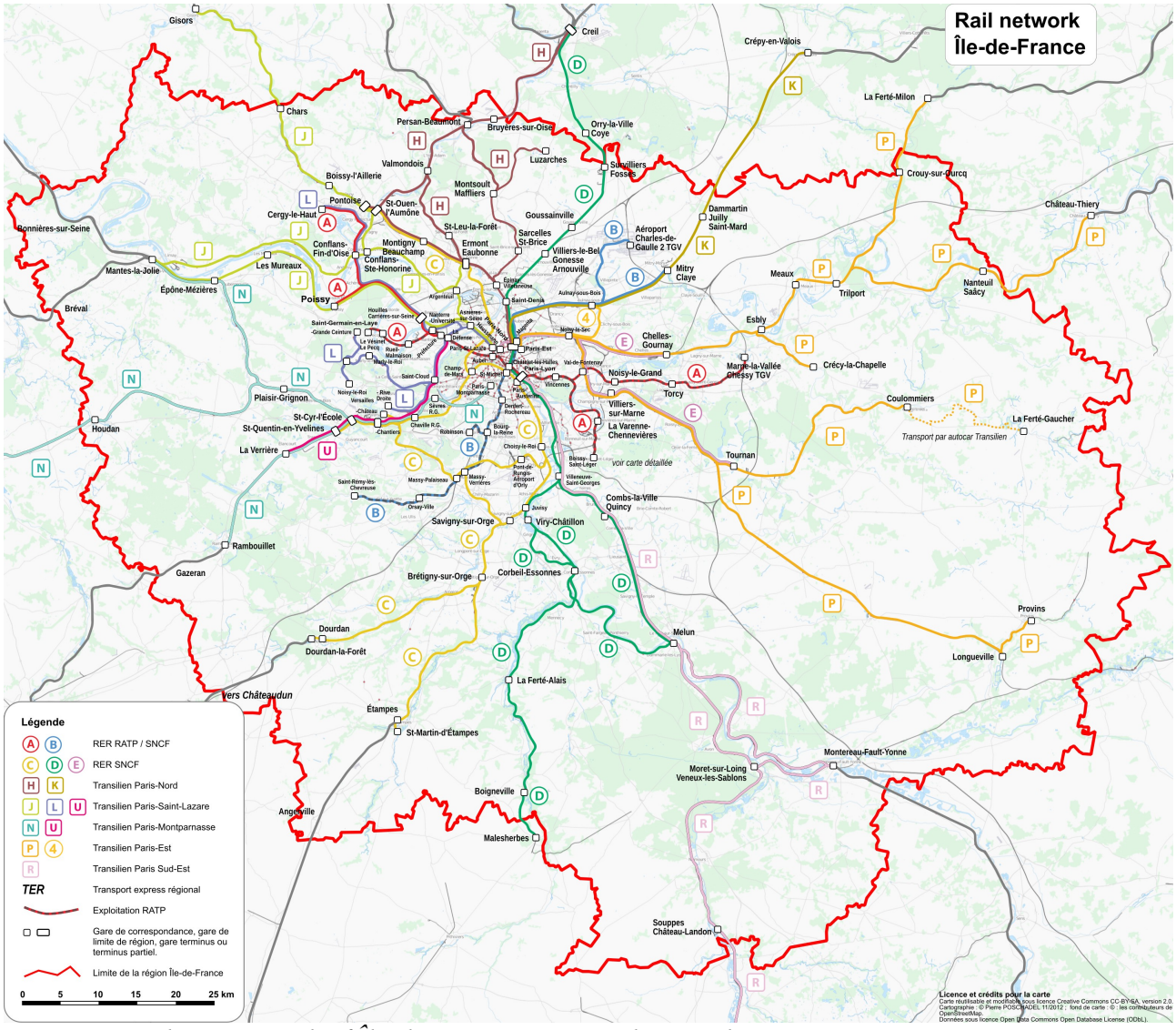


Figure 1 : railway network of Île-de-France, RER and Francilien

For the selection of the TOD areas we have identified all the regional rail served stations, all the metro stations and all the light-rail stations. By excluding metro stations already served by regional rail and light-rail stations already served by metro or regional rail, wee obtain a total of 883 focal points.

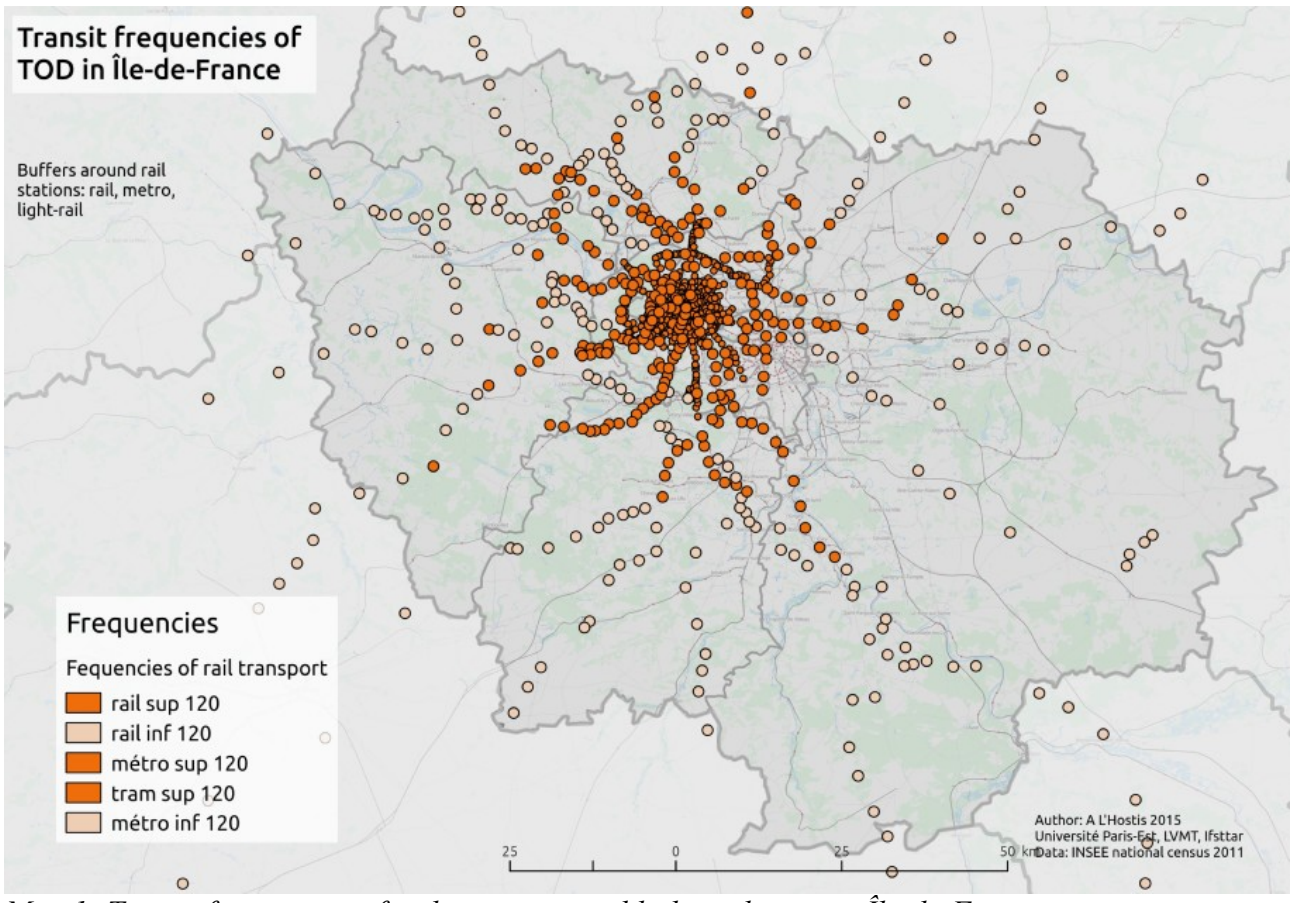
Referring to the previous discussion on perimeters, we have chosen buffers with 800 meters radius for rail station areas, and 500 meters radius for metro or tramway stations area. There is quite a lot of overlap between buffers. So we will consider in future steps a rule for removing from the analysis the buffers that are included in higher level buffers with thresholds to be fixed.

The buffers were calculated by means of geographic information system (QGIS) using straight-line distances and all-or-nothing function instead of other distance calculation procedures such as network distances and distance decay functions discussed in the literature (Gutiérrez, Cardozo, et García-Palomares 2011).

Findings for Île-de-France region

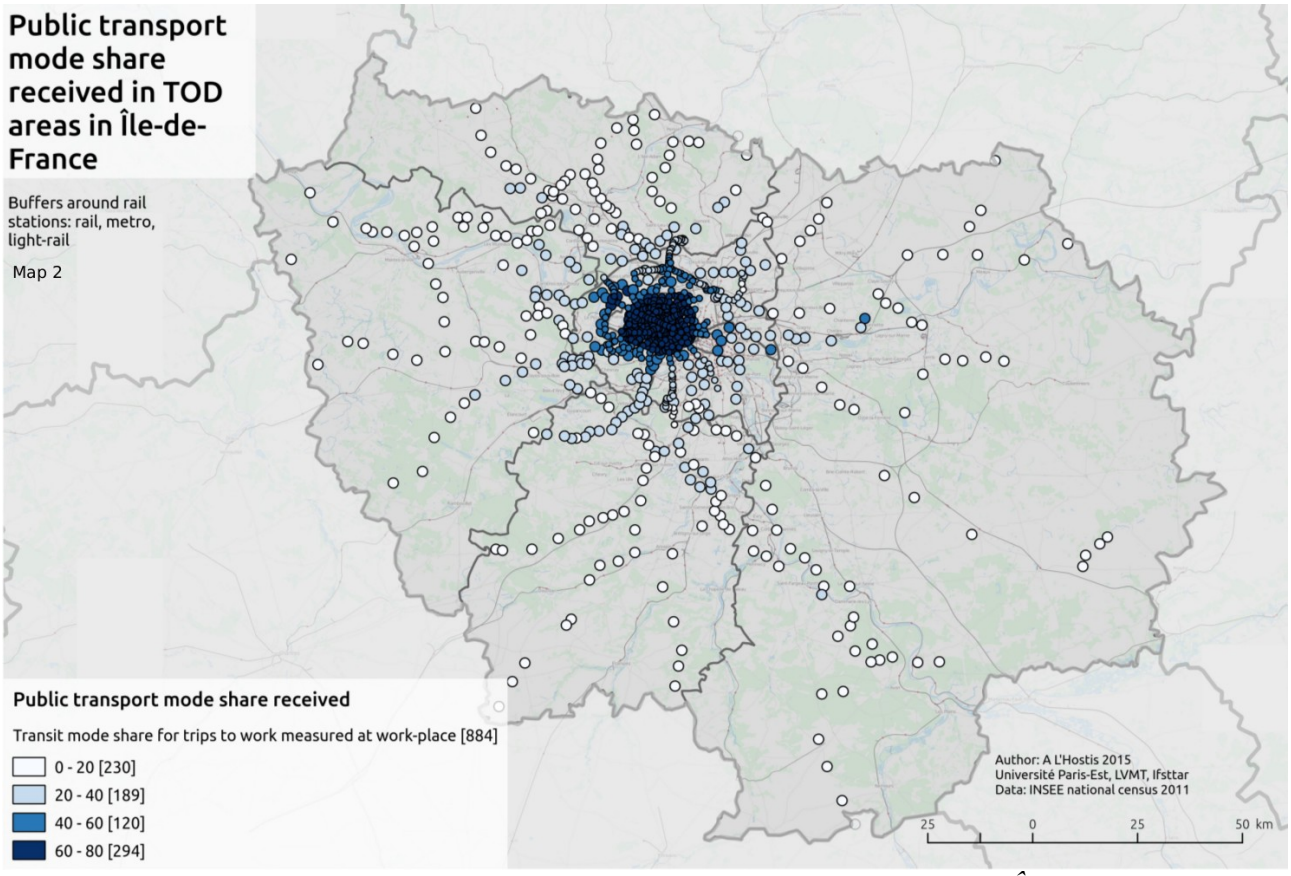
From now on we have identified and implemented a series of analysis on the various aspects of TOD following the indications of Renne and Wells (2005, 19).

The first dimension to be analysed is the transit service itself. The level of transit provision is an important element for a TOD. The literature admits the need for 8 to 10 minutes interval between services, while more than 15 minutes represent a disincentive (Evans et al. 2007, 17-62). In this study we have chosen a threshold of 10 minutes per direction. This leads to a threshold value of 120 services per day counting the two directions. A first map shows the stations with levels of service below and beyond this limit. As we can see on map 1, the services with a high level are concentrated in the core of the region. All metro and all light-rail stations are above the 10 minutes headway. It is only remote regional rail stations that have longer headways between services. Out of the 478 railway stations 242 have a level of service lower than 120 per day.



Map 1: Transit frequencies of railway metro and light-rail stops in Île-de-France

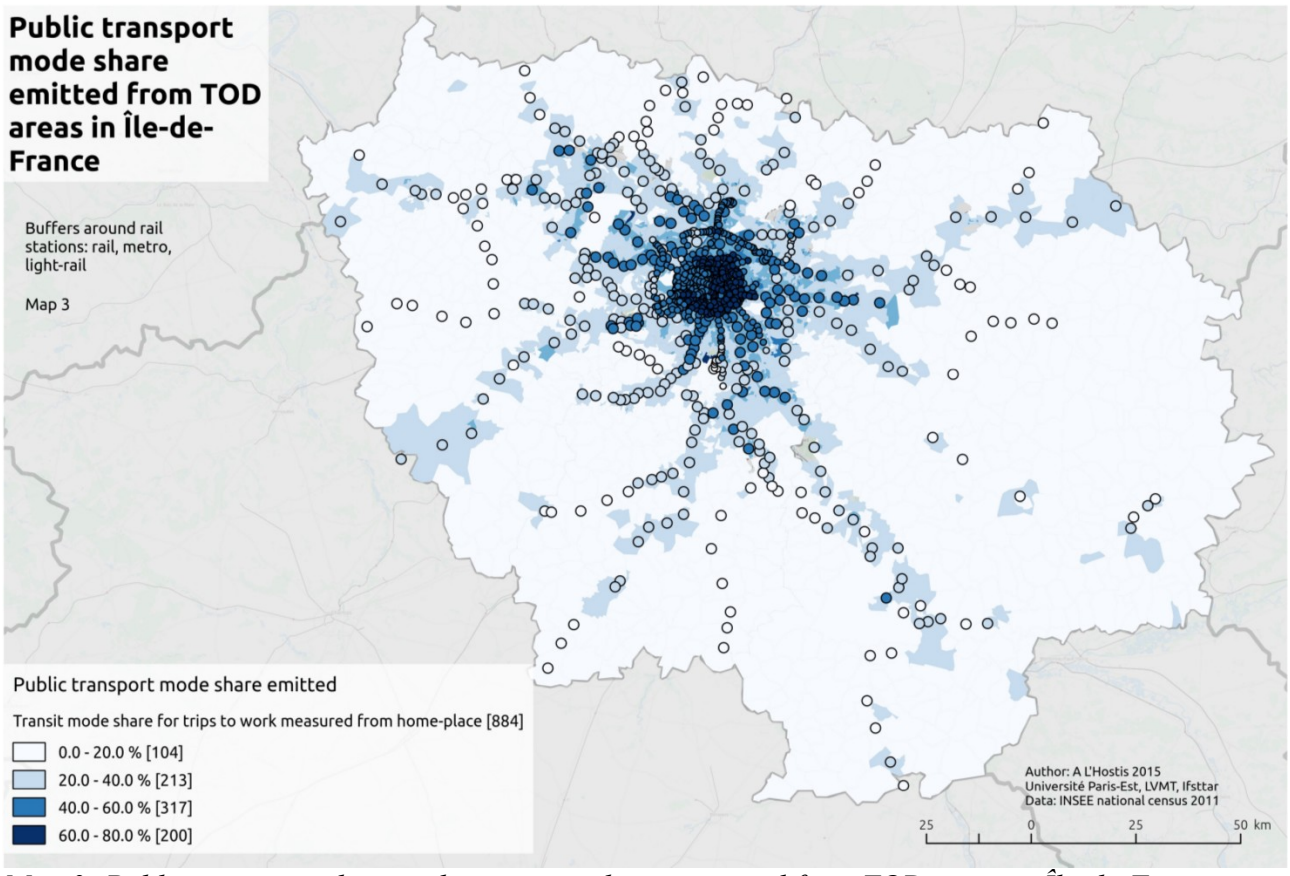
The second domain of analysis is the transit use. The analysis of the public transport share for travel to work purpose reveals a typology of TOD areas in Île-de-France, with a dominant of jobs and a dominant of housing both with a significant mode share.



Map 2: Public transport mode share in trips to work received in TOD areas in Île-de-France

As can be seen on map 2 areas where access to jobs with dominant public transport access (more than 60 %) are located in the Paris commune and in La Défense. Public transport remains significant for job access (40 to 60 %) in the first layer around the commune of Paris and noticeably in Hauts-de-Seine and in western Seine-St-Denis.

According to this measure, the spatial organisation of the regions appears strongly monocentric.



Map 3: Public transport share as home-to-work trips emitted from TOD areas in Île-de-France

TOD areas with residents significantly using public transport for access to jobs are much more dispersed in the region as can be seen on map 3. We have added to the cartographic representation the mode share in census blocks (IRIS) in the background. This allows visualising some clear corridors around transit axis.

If we consider together the emissions and the reception of public transport users we have an image of the region and its transport system as providing access to central jobs for residents of the periphery.

The average mode share of public transport for residents of the region is at 37 % from census data of 2010. If we consider TOD areas above regional average in public transport mode share and below the threshold in frequencies given by the literature we obtain a list of 7 locations shown in the following table.

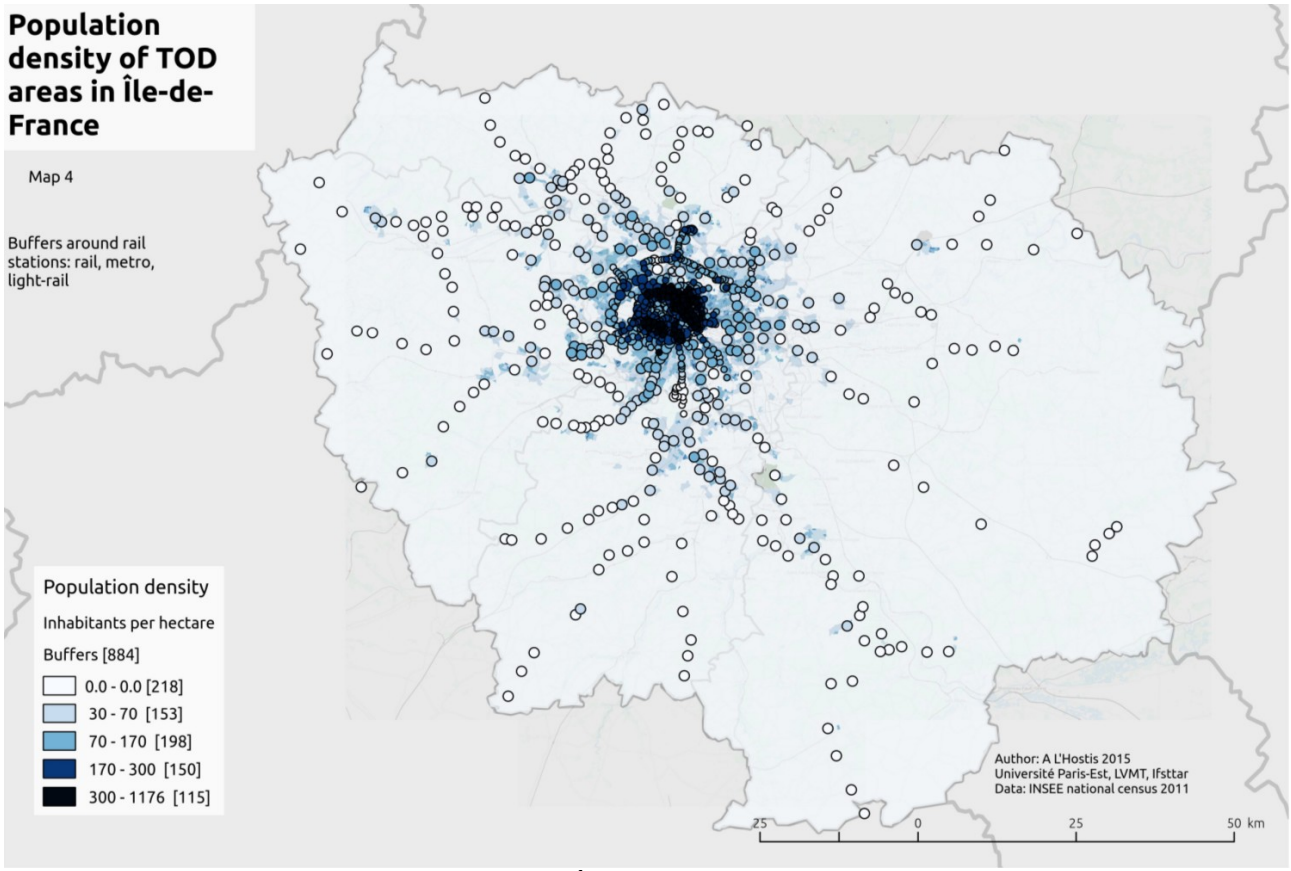
Table 1: TOD areas with low frequencies and high public transport mode share for trips to work measured at home-place

Stop name	Frequencies			Commune	Public transport
	rail	bus	total		mode share %
LES CLAIRIERES DE VERNEUIL	n.a.	78	78	Verneuil-sur-Seine	42
FONTAINEBLEAU AVON	83	0	83	Fontainebleau	42
GARE DE VAIRES - TORCY	92	158	250	Vaires-sur-Marne	39
Gare d'Herblay	95	51	146	Herblay	38
GARE DU VAL D'ARGENTEUIL	83	313	396	Argenteuil	45
ARGENTEUIL	86	303	389	Argenteuil	47
CONFLANS SAINTE-HONORINE	97	97	194	Conflans-Sainte-Honorine	43

This shows that the classical threshold of 10 minutes headway for public transport has to be dealt with caution since transit use for these areas can meet high values. In addition, the transit mode share we introduced, a regional mean, is not evenly present in the regional territory; its level decreases with distance to the centre. It is between 27 % and 21 % for external *départements*[2]. With this in mind the levels of transit use observed in these stations is even more remarkable: if we consider a threshold of 25 % of transit share, which is higher that the surroundings transit share, we find in our dataset 66 stations that have a frequency below 120 trains per day and yet a significant transit share. It would be interesting to measure the effect of TOD on transit use by comparing the transit use in TOD areas with transit use in surrounding areas.

Concerning densities the literature provides thresholds that are considered suitable to support transit use (Kuzmyak et al. 2003, 104; Evans et al. 2007, 101). The figures of 12 to 30 dwelling units per acre corresponds to 30 to 75 units per hectare. Taking into account of a mean of 2,33 persons per household one gets figures of 70 to 170 persons per hectare as density threshold.

2 The transit mode share are 27 % in Val-d'Oise (95), 25 % in Yvelines (78), 22 % in Essone (91) and 21 % in Seine-et-Marne (77) froms census data in 2010.



Map 4: Population density of TOD areas in Île-de-France

Map 4 shows the density levels in census blocks (IRIS) in 2010 and in the TOD buffers. Density analysis presents a less monocentric image that the indicator of transit share at work-place.

Density threshold	Number of TOD areas	Percentage of all TOD areas
70	463	52 %
170	265	30 %

We know from literature that density in the buffers of transit stops is a factor favouring transit use (Ewing et Cervero 2010). To test this trend in the Île-de-France context we have selected areas with high density and checked the minimum level of transit use observable. The lowest values are observed for metro stations and tram stops and do not fall under 40 %. This indicates a situation consistent with international literature.

Analysis in terms of urban design

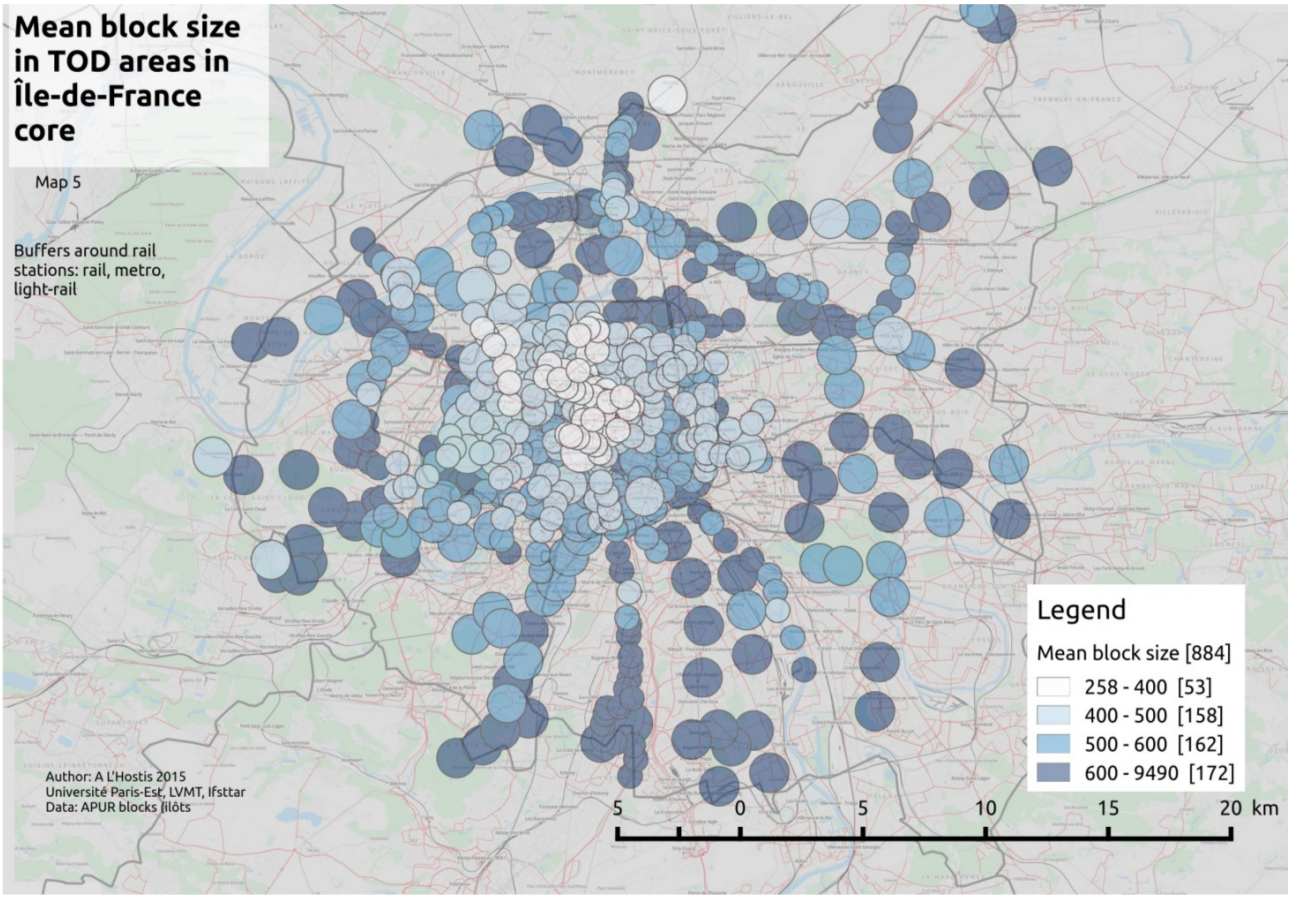
We have used data from the APUR of blocks for the central part of the region only. The blocks are only the urban blocks (N) and not the blocks linked to infrastructure or to green space. The literature provide figures of length of block perimeters that a compatible with walking with maximum values of 0,25 miles, so about 400 meters (Evans et al. 2007, 101).

On our sub-sample we observe the following figures.

Mean perimeter length of blocks in TOD areas	Number of TOD areas
258 – 400 m	52
400 – 500 m	164
500 – 600 m	155
600 – 9490 m	174
Total	545

Tableau 2: Mean perimeter length of blocks intersecting the TOD areas in the core of the region (Paris and petite couronne)

The only areas with block perimeters length under threshold are located in Paris intra-muros. This means that the proposed threshold is not suitable to characterise the Francilian cases of TOD and that a higher value should be considered.



Map 5: Mean block size in TOD areas

The cases with high values of the indicator are located in urban fabric where redevelopment should occur as in the St-Denis area.

Limits of the analysis

It is likely that most users of the rail transport system work in one of the TOD areas of 10 minutes walk around stations, but in the other way, many users live outside of the TOD areas using some egress mode to access the stations. Some empirical data of intermodality would be welcome here to further characterise the TOD in the region in a similar way as it has been described in the Den

Haag-Rotterdam region (*Leidraad Maak Plaats* 2013).

The case of St-Denis-Pleyel

(to be added by S Darchen)

Map 6: Saint-Denis area (north of Paris), stations and blocks in TOD areas

The area is marked by the presence of large blocks of infrastructures and economic activities (Pelloux et al. 2013, 18). This character is translated by high values of mean block length.

The values of the various indicators for the St-Denis-Pleyel area (we used the Stade-de-France -Saint-Denis station as a proxy of the future St-Denis Pleyel Grand Paris station) are the following:

stop_name	tram	metro	rail	bus	Total freq	type	PT mode share received	PT mode share emitted	Population density pers/hectare	mean block length
STADE DE FRANCE SAINT-DENIS	0	0	329	17	346	fer	53	53	36.52	793
La Plaine-Stade de France	0	0	936	1481	2417	fer	51	52	55.27	599
Carrefour-Pleyel	0	456	0	642	1098	metro	52	52	37.37	765

Table 3: Statistics for existing Saint-Denis TOD areas

Next steps

We have developed the measurement of a series of indicators. Namely frequencies, public transport share emitted from or received in TOD areas, and one aspect of urban design being the average length of the perimeters of blocks located inside the TOD buffers.

We have proposed a series of crossed analysis in order to get a better understanding of TOD in Île-de-France. TOD areas with low frequencies but significant public transport share can be observed in the second layer of the agglomeration. The data indicate that where density is high there is no low level of public transport use, which is consistent with TOD literature. Concerning block size, which is an important factor for pedestrian friendly urban design, the threshold indicated in the literature is not suitable for our analysis; a higher value should be fixed to approach the quality of the public space.

Three directions for further analysis are already identified in the domain of geospatial analysis:

-extend the range of indicators with mix of use, quality of public space for pedestrians, and other key parameters of TOD.

-improve the already built indicators with more accurate sources as in the case of population densities where a 400 meters grid exists and could be used rather that commune/IRIS statistics that are less accurate and have been used here

-develop some multivariate analysis to build a typology of TOD and allow identifying situations where the TOD principles applies and where some shortcomings can be observed.

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