Société du Grand Paris

Grand Paris Express
Evaluation of the long-term impacts
with a TRANUS integrated land-use/transport model

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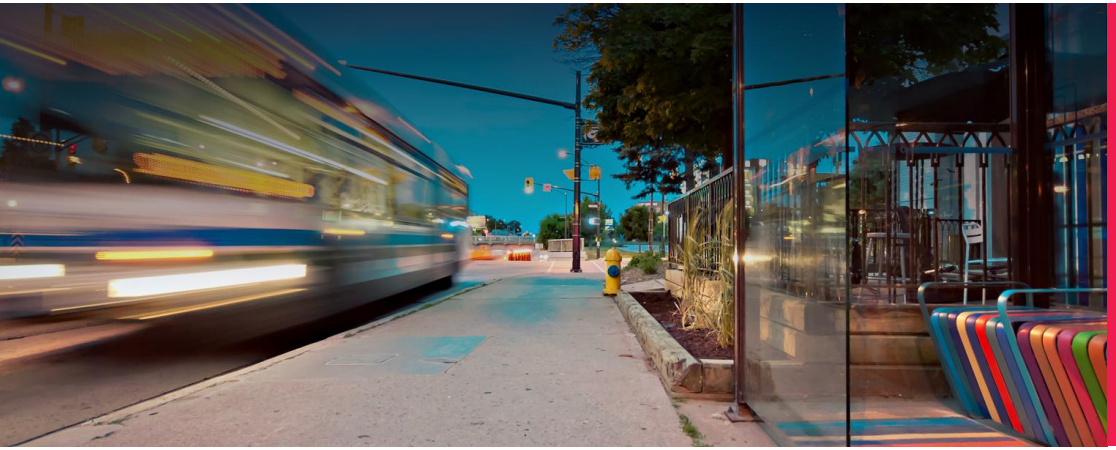
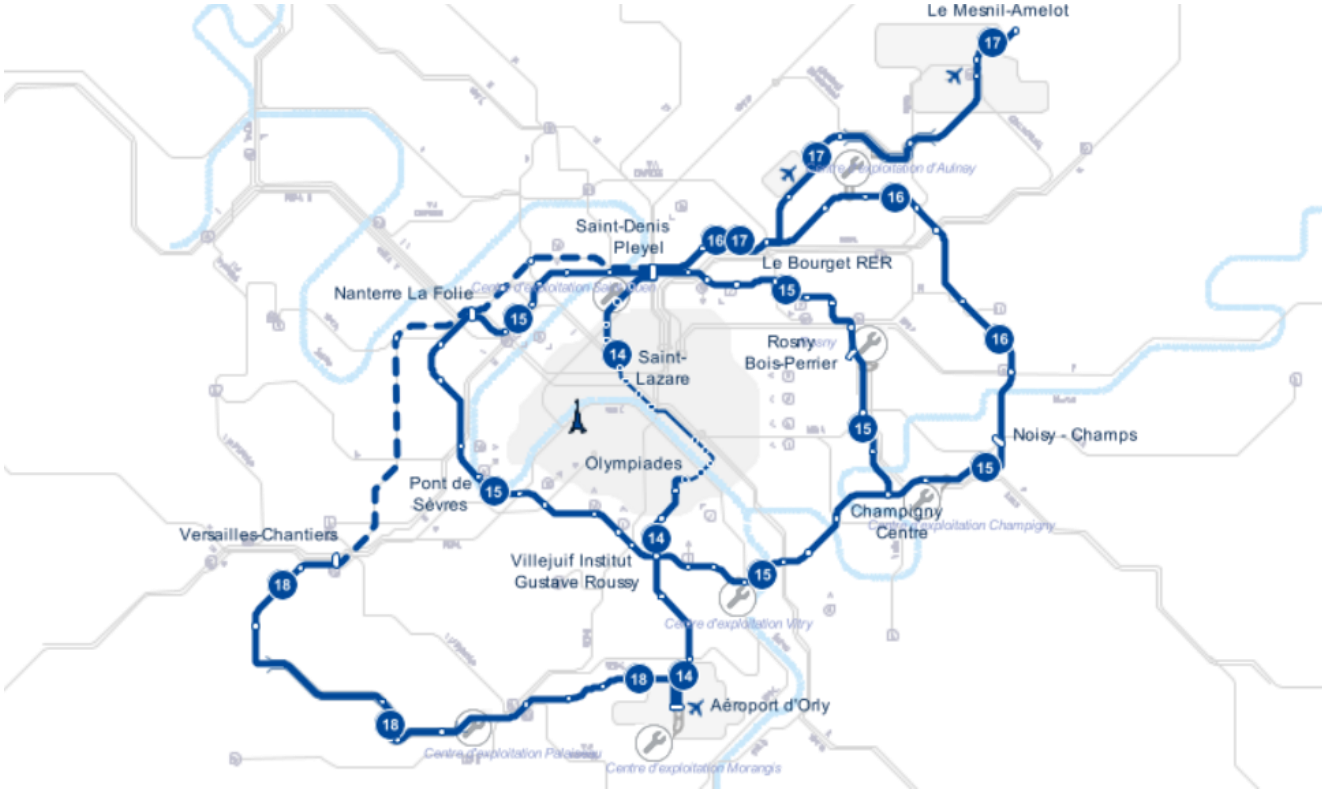
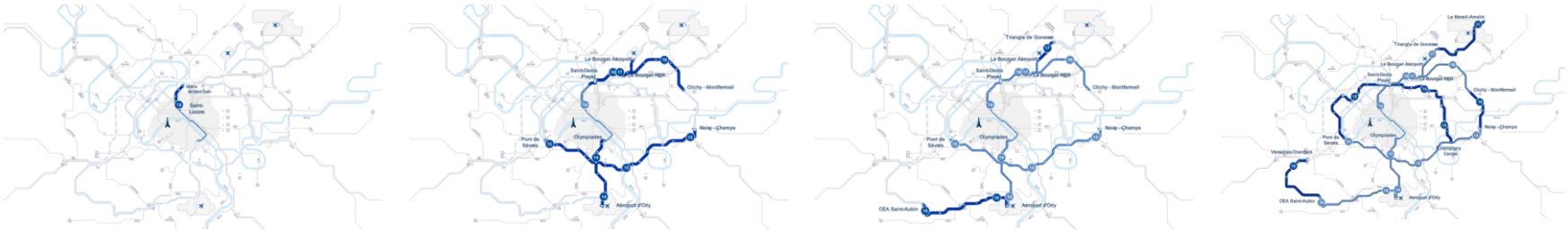


Introduction

THE GRAND PARIS EXPRESS PROJECT



- Large-scale public transport project (automatic metro) in and around Paris
- Objective to better serve the second suburban ring around Paris → opportunity for relocation and development of new poles
- 200 km of automated lines : 4 new lines and line 14 extended toward South and North
- 68 new stations
- 7 technical centres
- Frequency: every 2 to 3 minutes
- Investment cost: 36 billions €



Source (maps): www.societedugrandparis.fr

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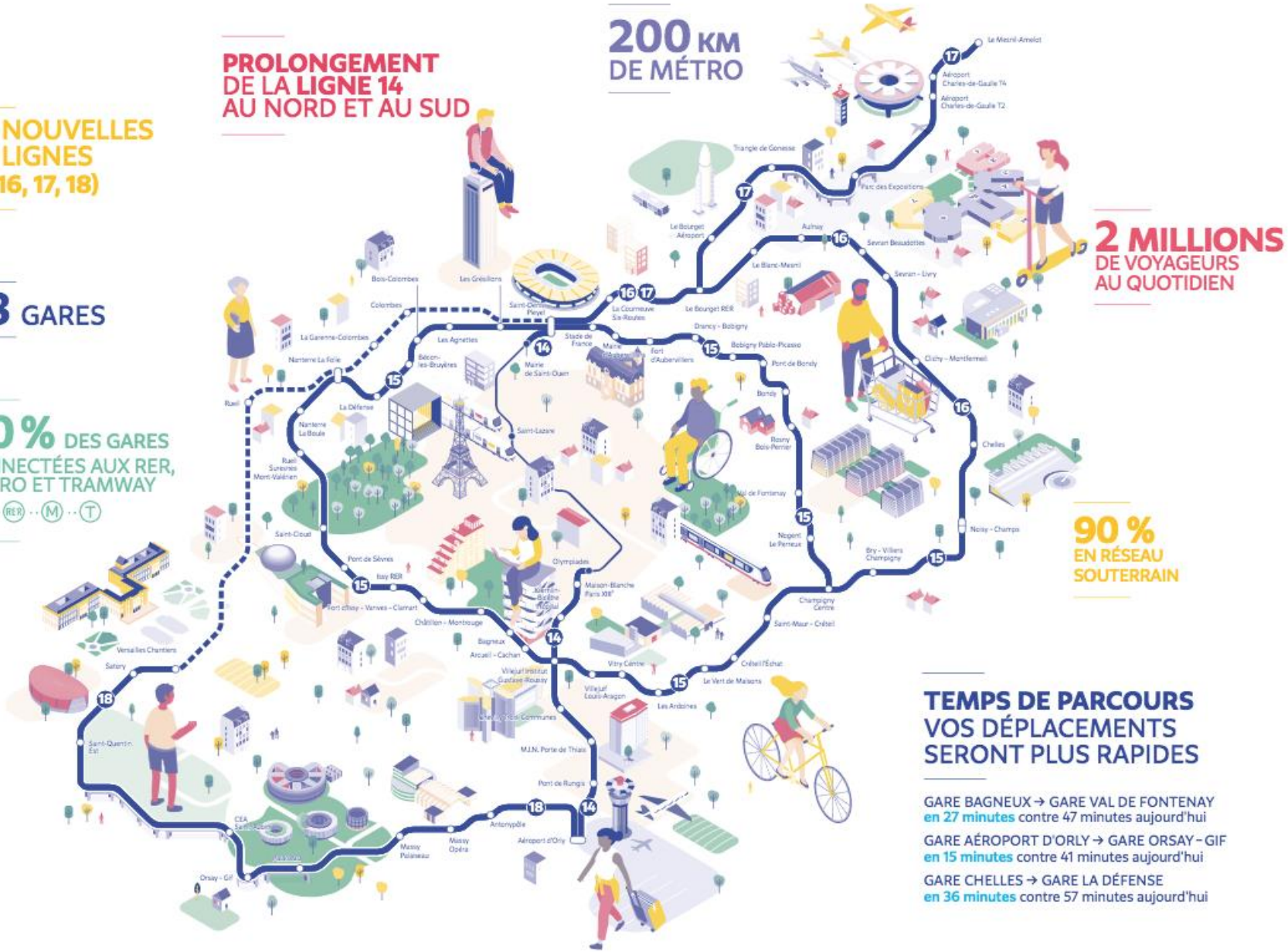


Source: www.societedugrandparis.fr

LES QUARTIERS DE GARE, DES LIEUX D'INSPIRATION

Lieux faciles d'accès, pôles d'échanges et d'activités, les quartiers de gare du Grand Paris Express incarnent la ville de demain.

Projet immobilier du futur quartier de la gare Bagneux

NOYAUX D'UN NOUVEAU DÉVELOPPEMENT URBAIN

L'arrivée du métro et la construction des gares suscitent et accélèrent de nombreuses opérations d'aménagement qui amélioreront la qualité de vie des Franciliens. Ces projets limitent l'étalement urbain qui consomme les espaces naturels. En mêlant à de justes proportions logements sociaux, appartements en accession à la propriété, services, commerces, bureaux et espaces verts, ces programmes contribuent à la mixité que requiert une ville équitable.

Le Grand Paris Express contribuera à la création de **250 000 à 400 000 logements** dans les communes desservies.

+ de 95% des habitants de la métropole vivront à moins de 2 km d'une gare, après la mise en service du Grand Paris Express.

Perspective extérieure de la gare Saint-Denis Pleyel

AIR DE FAMILLE

Les 68 gares du Grand Paris Express signalent le métro dans la ville. Leur architecture s'intègre à l'environnement urbain. Toutes différentes, elles partagent néanmoins une ambition commune pour le confort des voyageurs : sols résistants, matériaux nobles, lumière naturelle, signalétique claire, mobiliers ergonomiques.

LIEU DE VIE

La gare offre bien plus qu'un accès au métro. Elle pourra aussi abriter des commerces, des services et des espaces collaboratifs ouverts sur la ville, ce qui en fera un lieu de rencontres entre voyageurs et habitants.

Perspective intérieure du hall d'accueil de la gare Les Ardoines

NOUVEAUTÉS DURABLES

Quatre principes majeurs guident les aménagements aux abords des gares. Pour la cohérence visuelle, on veille à la « continuité », en utilisant par exemple un même matériau pour différentes réalisations. On s'assure de la possible « évolutivité » des aménagements : élaborés des années avant leur mise en service, les espaces publics s'adapteront dans le temps en fonction des usages. Des espaces sont même réservés à des fonctions qui restent à inventer, c'est le principe de « progressivité ». Enfin, conception et réalisation sont guidées par une volonté de « pérennité » des équipements.

Perspective extérieure de la gare Saint-Maur – Créteil

Source: www.societedugrandparis.fr

With a depth of 50 m, the future Villejuif Institut Gustave-Roussy station is one of the emblematic stations of the project. After removing 300,000 m³ of earth, the teams are now preparing the construction of the tunnels that will allow connections between lines 14 and 15.

Source: www.societedugrandparis.fr

By autumn 2019, 9 tunnelling machines (“*tunneliers*”) had been launched on the Grand Paris Express site, and 6 were being assembled. At the height of the work, some twenty TMs will be needed to build the new metro lines. These extraordinary machines work tirelessly and at great depth.

Source: www.societedugrandparis.fr

GRAND PARIS EXPRESS – PREVIOUS STUDIES

- The « Société du Grand Paris » (SGP) is a public company created in 2010 by the French Government with the aim of managing the project of the « Grand Paris Express »
- The project mid-term impacts (horizon 2030) have previously been estimated with three LUTI models:
  - UrbanSimE (Paul Wadell and André De Palma)
  - Pirandello model (Delons and Piron)
  - RELU-TRAN (Alex Anas)
- The SGP decided to keep the UrbanSimE model as its official model for further work and to keep the results of UrbanSimE as the official results
- The objective of the current study is to model the longer-term effects

ISSUES

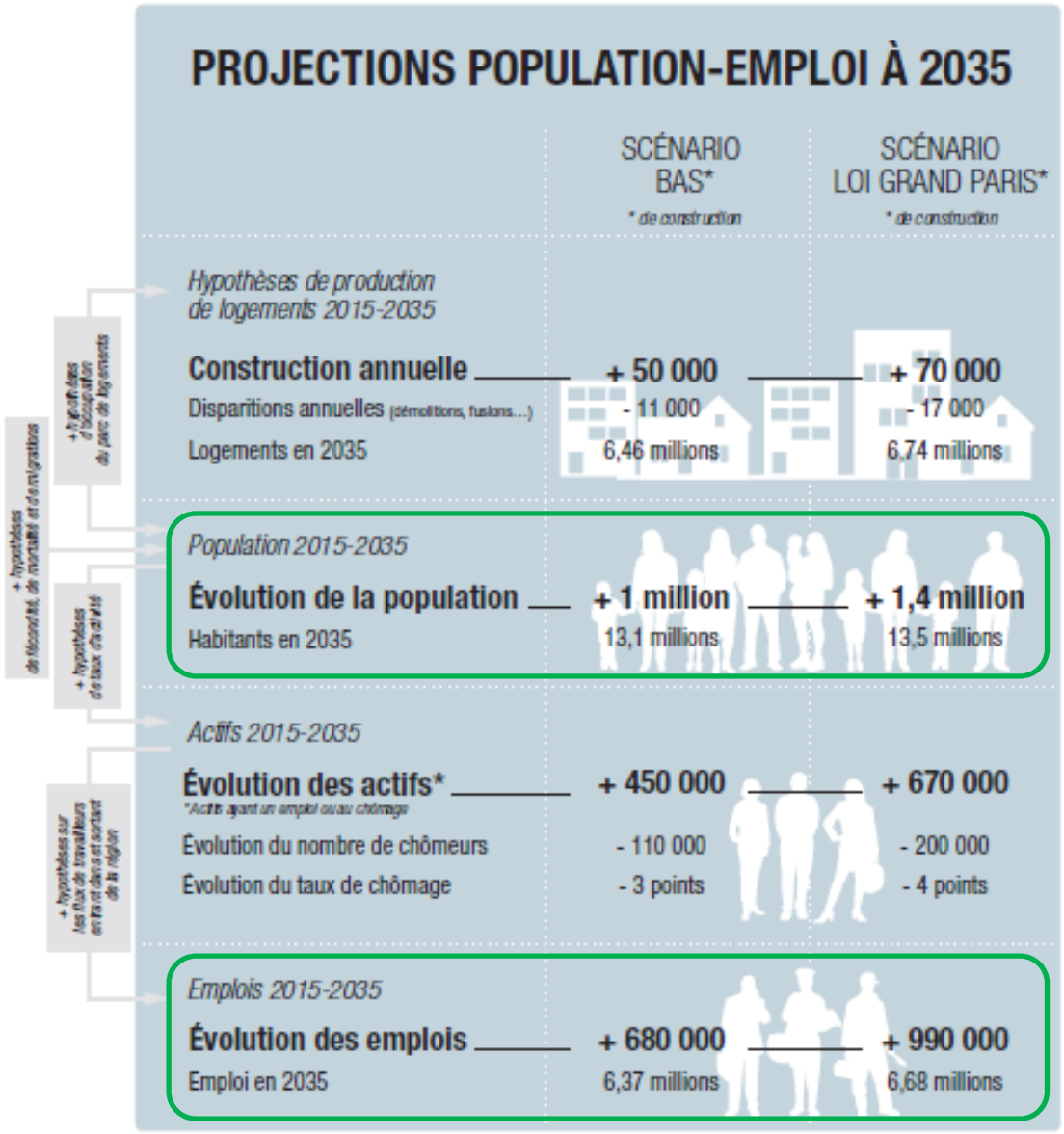
- The impacts of the « Grand Paris » have been evaluated for a mid term situation (10 to 15 years), close from what we are currently experiencing
- However, the impacts of the « Grand Paris » will spread over time, over the lifetime of the infrastructure (>100 years)
- What will be the impacts of the « Grand Paris » in a situation much more far away from what we are currently experiencing with for example :
  - A population of 14, even 15 millions of inhabitants ;
  - Further developments in public transports (better bus feeder services, maybe an additional metro ring, …
  - Changes in mobility behaviour
  - Etc.

POPULATION AND EMPLOYMENT PROJECTIONS FOR ILE-DE-FRANCE

Base year of the model: 2016

IDF :
12,3 M habitants (01/01/2017)
5,7 M jobs (2016)

Study area :
15,3 M habitants (01/01/2017)
6,7 M jobs (2016)



(*) Loi Grand Paris: strengthened housing construction policy
Source: Institut Paris Région, juillet 2020

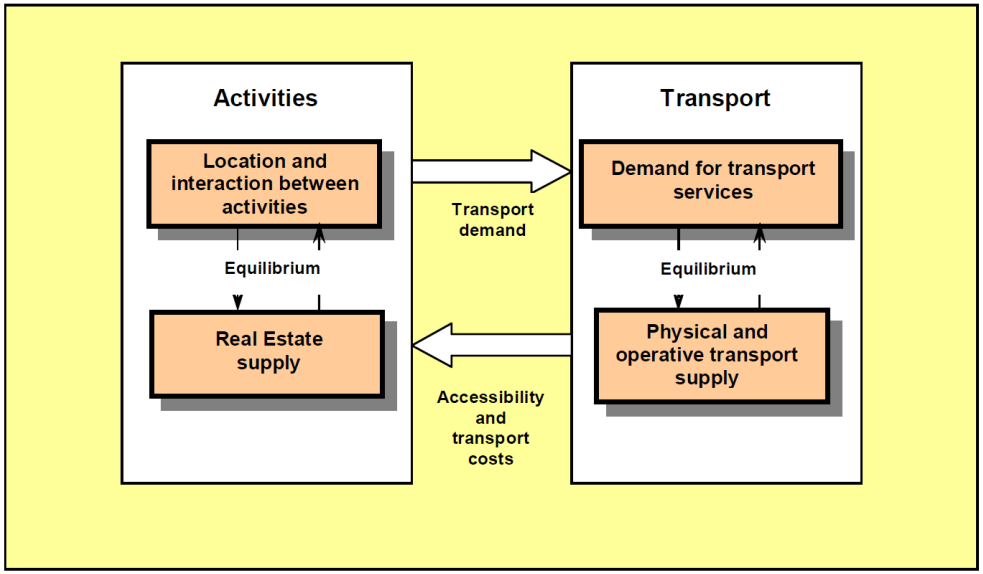
OBJECTIVES OF THE STUDY

- Analysing various scenarios:
  - Long-term development of population and employment
  - Development of public transports infrastructures
  - Mobility behaviour (development of soft transportation modes, transport on demand, which mobility evolution with the autonomous vehicles?, how will evolve the congestion?, etc.)

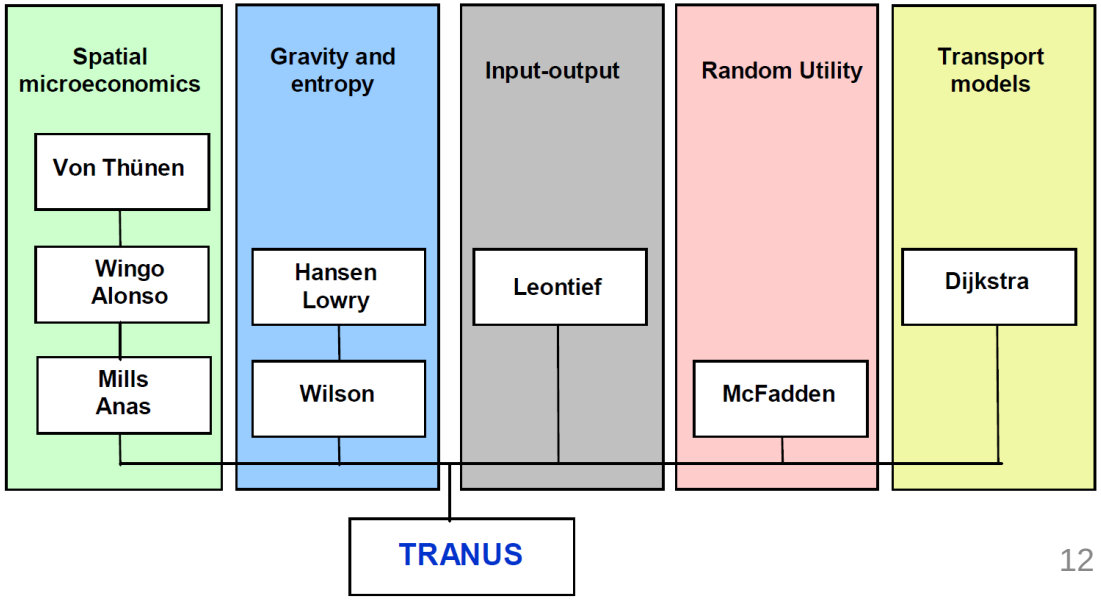
→ What will be the **contribution of the GPE** to the overall community objectives (environment, decarbonisation - SNBC, smoother mobility, better quality of life, equity, …) in the long term?

- Estimating the long-term impacts of the GPE in order to feed:
  - A cost-benefits analysis
  - A carbon audit
- Analysing (classically) the following impacts:
  - Location of population and employment
  - Average density, urban spread/concentration
  - Choice of transport mode and distances travelled

METHODOLOGICAL APPROACH: THE TRANUS FRAMEWORK



- Integrated land-use and transport modelling system - Tranus
  - Aggregated model
  - Equilibrium model
  - Economic base theory
  - Input-output matrix (consumption/production between sectors)
  - Simulation of the land/housing market (supply/demand equilibrium)
  - Random utility theory for localisation choice, modal choice and itinerary choice



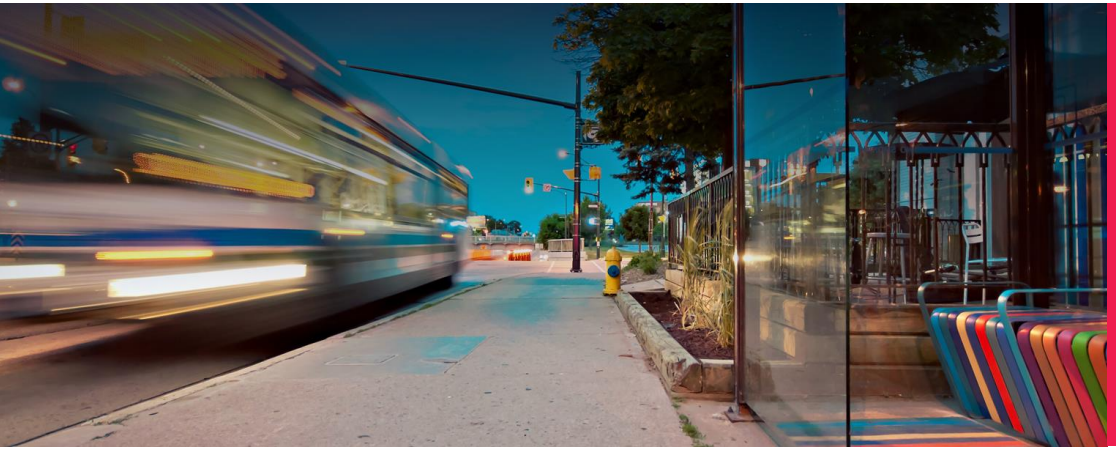
A SIMPLIFIED MODEL

- **Why ?** In order to meet the objectives of the study within the available resources:
  - (very) long term effects
  - no need for detailed forecasts
  - but it is critical to properly model the mechanisms, the interactions, to get the right **elasticities** and to get the right scale (order of magnitude) of the effects

- What means a **"simplified model"** here ?
  - The study area is large ; exchanges with the outside are minor and hence can be modelled in a nutshell
  - The zoning system is not much disaggregate (120 000 pers./zone)
  - The public transport network is modelled in a schematic way
  - The home-to-school trips are modelled exogenously
  - The entering commuter trips (from outside the study area) and outgoing commuter trips are modelled exogenously
  - No modelling of the freight transport
  - Parameters have to be robust but, to some extent, not necessarily specific (may be fixed by analogy, etc.)
  - It is no required to reconstitute precisely the base situation (2016) but well to get the right elasticities

A WORK IN PROGRESS

- Current status :
  - finalisation of the land-use submodel calibration and of the transport submodel calibration
- Next steps :
  - Calibration of the full LU-T-I model
  - Simulation of the reference situation at future horizons (on the basis of the existing official population and employment projections)
  - Simulation of the project situation



Model development

Study area, zoning system

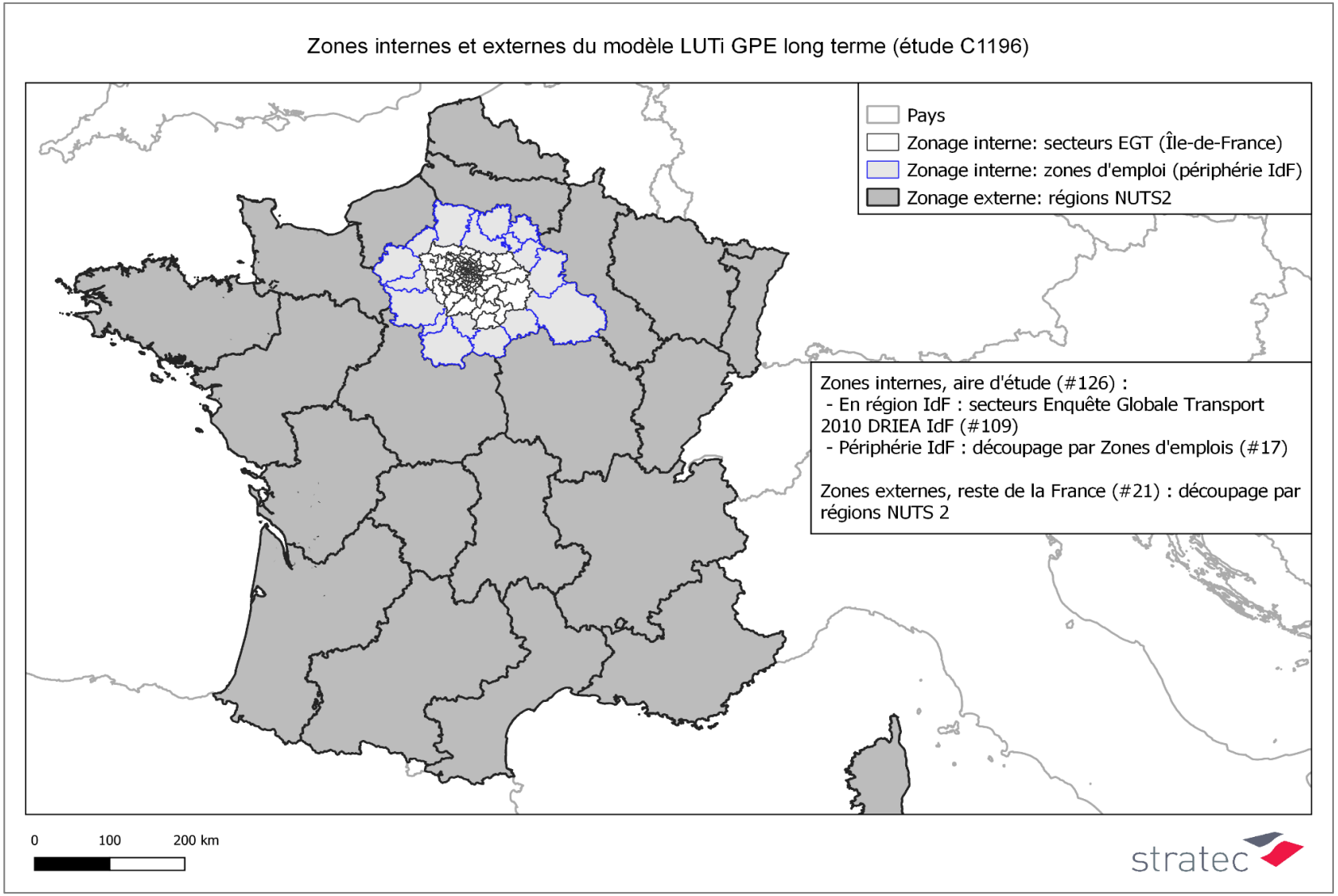
STUDY AREA AND ZONING SYSTEM

- The **study area**:
  - the Ile-de-France (IDF) Region (i.e. Paris + 7 other *départements*)
  - + some surrounding areas (located in the immediate periphery), which have a large number of commuters living in those areas and working in the IDF

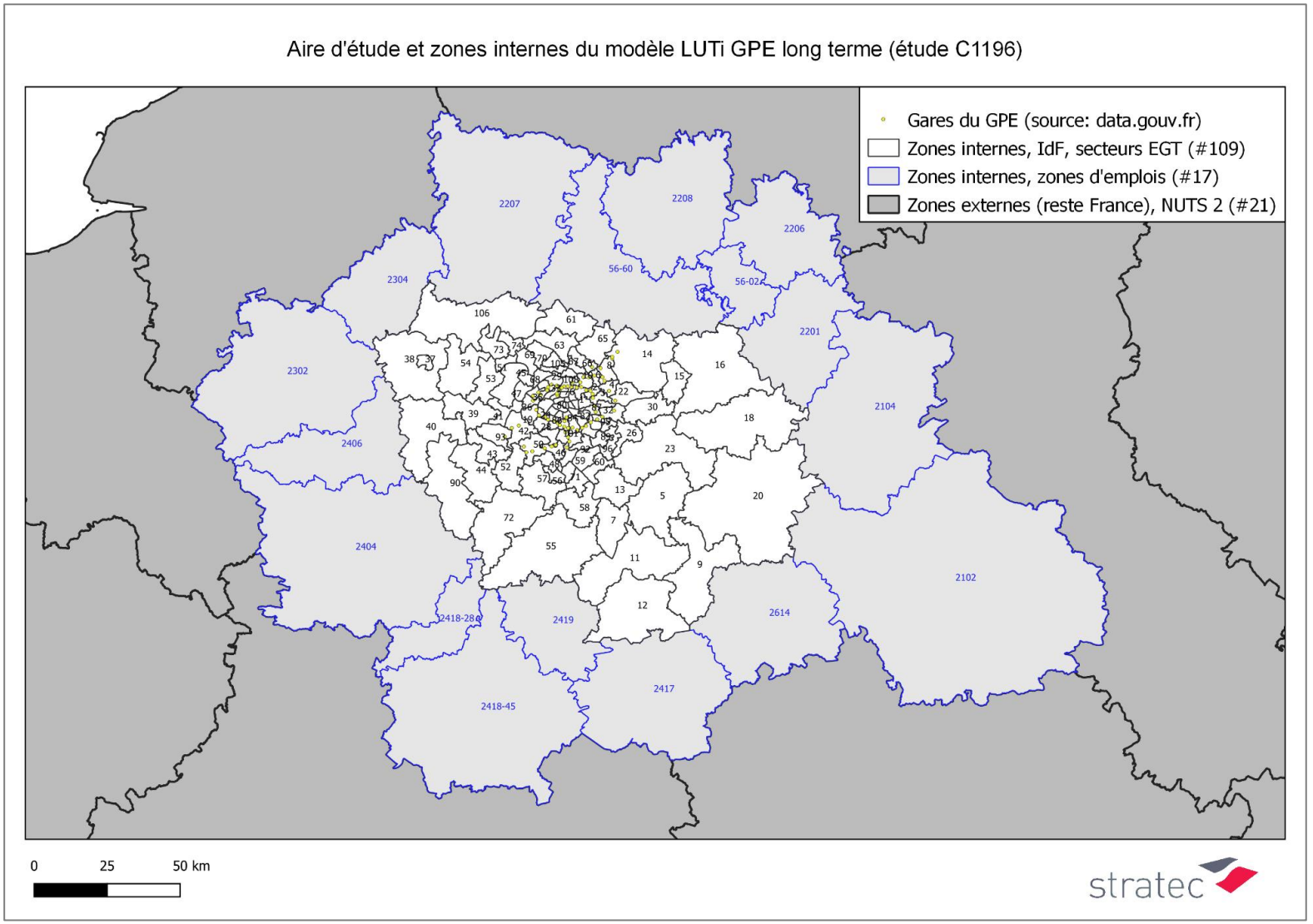
- The zoning system:
  - **Study area (126 zones)**:
    - the Region Ile de France is divided by EGT sector **(109 zones)**
    - the immediate periphery is divided by INSEE “employment basins” **(17 zones)**
  - Rest of France = **external zones (21 zones)**:
    - defined according to the European classification NUTS 2 level

(*) EGT : “*Enquête Globale Transport*”

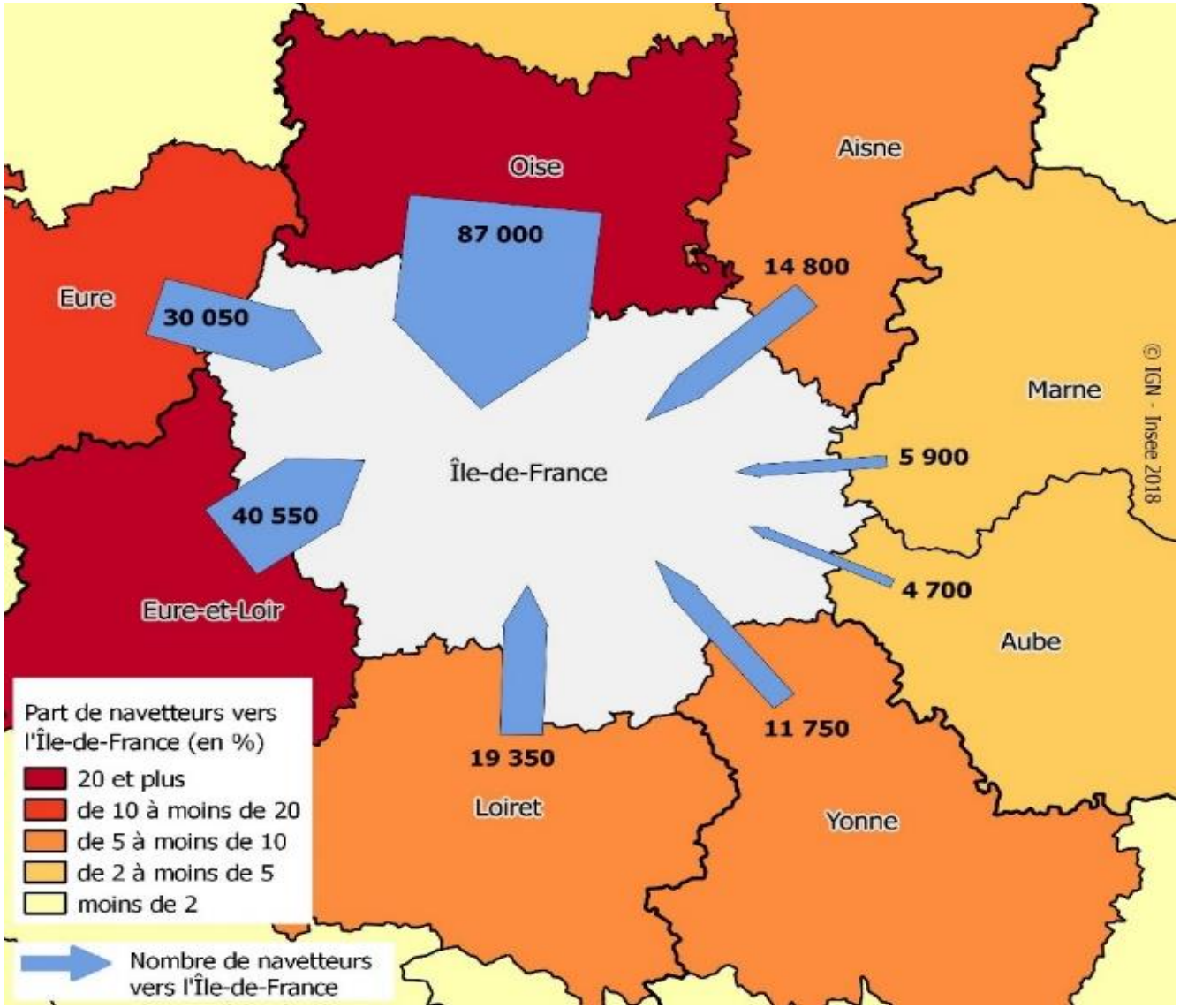
STUDY AREA AND ZONING SYSTEM (2)



STUDY AREA AND ZONING SYSTEM (3)

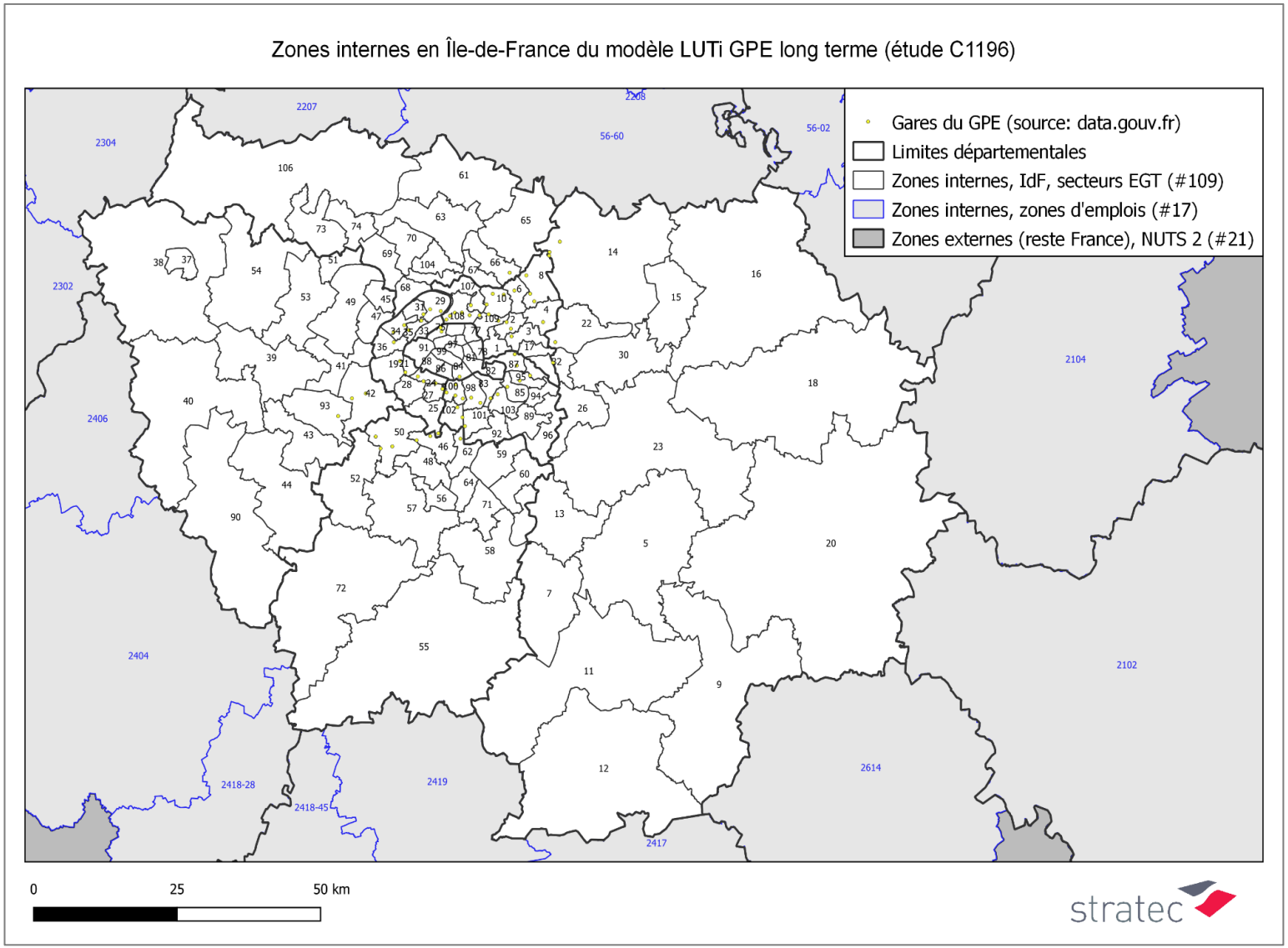


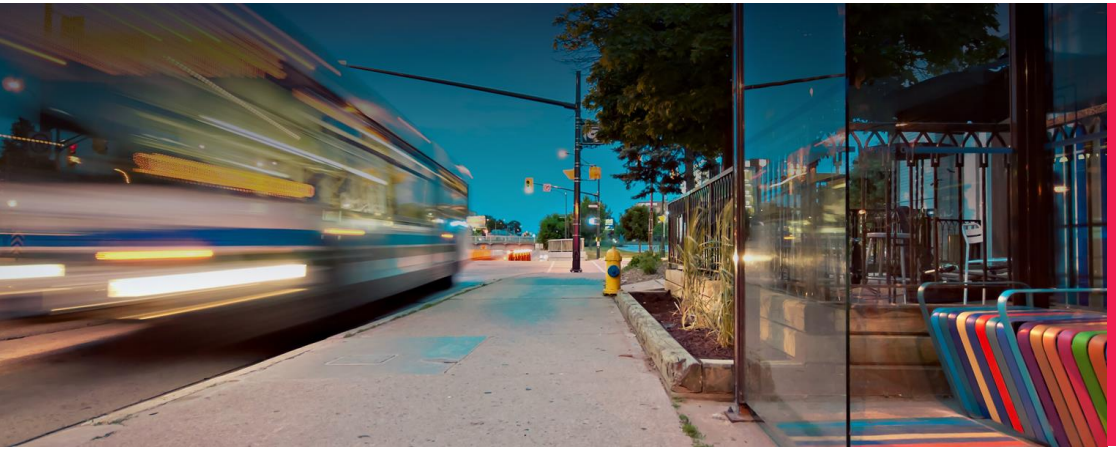
STUDY AREA AND ZONING SYSTEM (4)



Commuters torwards Ile de France from the surrounding areas in 2014 (INSEE, census, https://www.insee.fr/fr/statistiques/3573707)

STUDY AREA AND ZONING SYSTEM (5)





Model development

Land-use: segmentation of the sectors (stakeholders)

LAND-USE MODEL – SECTORS (STAKEHOLDERS)

- 3 types of sectors (stakeholders):

Sectors (stakeholders)		Units	Categorization variable
1	Economic activity sectors (9 activity sectors)	Number of jobs	Activity sector
2	Household categories (8 categories)	Number of households	Household size and composition and socio-professional category of the reference person of the household
3	Land types (4 types)	Hectares	Type of land use

LAND-USE MODEL – ACTIVITY SECTORS

Exogenous / Induced	Categorization	Number of jobs in 2016	Share in 2016 (%)
EXOGENOUS	Agriculture	49.718	0,7%
	Industry	392.773	5,9%
	Intensive industry	200.754	3,0%
	« heavy tertiary »	1.062.648	15,8%
	Public administration	638.528	9,5%
	Education	485.883	7,2%
TOTAL EXOGENOUS		2.830.304	42,2%
INDUCED	Corporate services	1.919.398	28,6%
	Services to the population	1.438.707	21,4%
	Retail trade	521.141	7,8%
TOTAL INDUCED		3.879.246	57,8%
TOTAL ALL CATEGORIZATION		**6.709.550**	**100%**

LAND-USE MODEL - EMPLOYMENT

- Categorization based on INSEE business sectors

Segments		Secteurs d'activités INSEE	
		Code	Intitulé
EXOGÈNES	-1- Agriculture	AZ	Agriculture, sylviculture et pêche
	-2- Industrie étendue	BZ	Industries extractives
		CA	Fabrication de denrées alimentaires, de boissons et de produits à base de tabac
		CC	Travail du bois, industries du papier et imprimerie
		CD	Cokéfaction et raffinage
		CG	Fabrication de produits en caoutchouc et en plastique ainsi que d'autres produits minéraux non métalliques
		CH	Métallurgie et fabrication de produits métalliques à l'exception des machines et des équipements
		CK	Fabrication de machines et équipements (non compris ailleurs)
		CL	Fabrication de matériels de transport
		CM	Autres industries manufacturières ; réparation et installation de machines et d'équipements
		EZ	Production et distribution d'eau ; assainissement, gestion des déchets et dépollution
	-3- Industrie intensive	CB	Fabrication de textiles, industries de l'habillement, industrie du cuir et de la chaussure
		CE	Industrie chimique
		CF	Industrie pharmaceutique
		CI	Fabrication de produits informatiques, électroniques et optiques
		CJ	Fabrication d'équipements électriques
		DZ	Production et distribution d'électricité, de gaz, de vapeur et d'air conditionné
	-4- Tertiaire lourd	FZ	Construction
		HZ	Transports et entreposage
		G46	Commerce de gros, à l'exclusion des automobiles et des motocycles
	-5- Administration publique	OZ	Administration publique
	-6- Enseignement	PZ	Enseignement
INDUITS	-7- Services aux entreprises	JA	Edition, audiovisuel et diffusion
		JB	Télécommunications
		JC	Activités informatiques et services d'information
		KZ	Activités financières et d'assurance
		LZ	Activités immobilières
		MA	Activités juridiques, comptables, de gestion, d'architecture, d'ingénierie, de contrôle et d'analyses techniques
		MB	Recherche-développement scientifique
		MC	Autres activités spécialisées, scientifiques et techniques
		NZ	Activités de services administratifs et de soutien
		UZ	Activités extra-territoriales
	-8- Services à la population	IZ	Hébergement et restauration
		QA	Activités pour la santé humaine
		QB	Hébergement médico-social et social et action sociale sans hébergement
		RZ	Arts, spectacles et activités récréatives
		SZ	Autres activités de services
		TZ	Activités des ménages en tant qu'employeurs ; activités indifférenciées des ménages en tant que producteurs de biens et services pour usage propre
	-9- Commerce de détail	G45	Commerce et réparation d'automobiles et de motocycles
		G47	Commerce de détail, à l'exception des automobiles et des motocycles

LAND-USE MODEL – HOUSEHOLD CATEGORIES

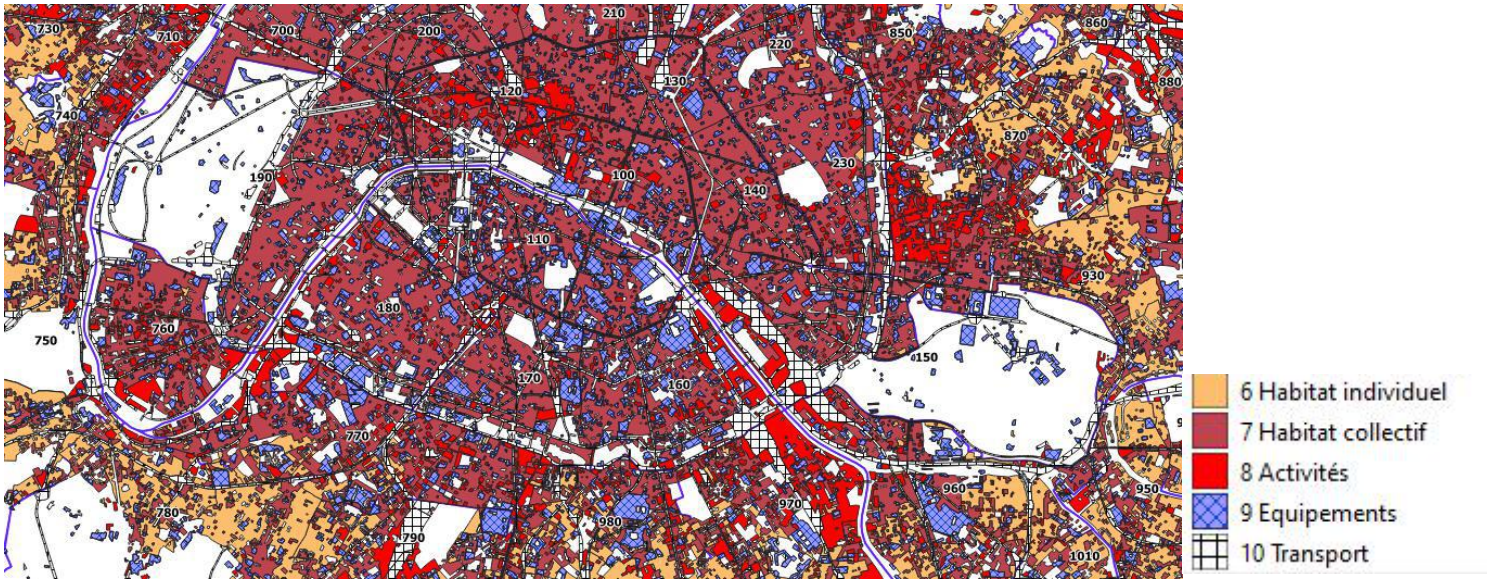
- Household segmentation :
  - 6 induced segments :
    - 1 person - active person with a high qualification job (executive or higher intellectual profession)
    - > 1 person - the reference person being an active person with a high qualification job (executive or higher intellectual profession)
    - 1 person – active person a medium qualification job (teacher, nurse, social worker)
    - > 1 person – the reference person being an active person with a medium qualification job
    - 1 person – active person who is self-employed (retailer, artisan, farmer), employee or worker
    - > 1 person – the reference person being an active person who is self-employed (retailer, artisan, farmer), employee or worker
  - 2 exogenous segments :
    - Households whose the reference person is retired or inactive
    - Students that live outside the parental home

LAND-USE MODEL – HOUSEHOLD CATEGORIES

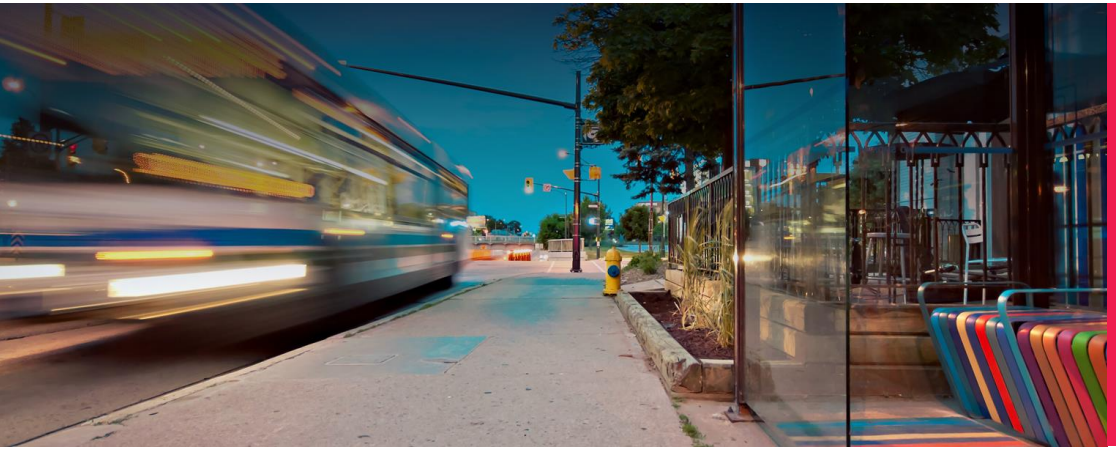
Exogenous/induced	Categorization	Number of household in 2016	Share in 2016 (%)
EXOGENOUS	Retired or inactive	1.644.535	24,5%
	Students that live outside the parental home	420.411	6,3%
TOTAL EXOGENOUS		2.064.946	30,8%
INDUCED	Employee, worker, self-employed (retailer, artisan, farmer) - 1 person	558.732	8,3%
	Medium qualification job - 1 person	352.251	5,2%
	High qualification job - 1 person	387.643	5,8%
	Employee, worker, self-employed (retailer, artisan, farmer) - > 1 person	1.672.553	24,9%
	Medium qualification job - > 1 person	804.638	12,0%
	High qualification job - > 1 person	871.025	13,0%
TOTAL INDUCED		4.646.842	69,2%
TOTAL ALL CATEGORIES		6.711.788	100%

LAND-USE MODEL – LAND DATA

- Data used to categorize are :
  - MOS 2017 for Ile-de-France area (Mode d'occupation du Sol, official data for land-use in IDF): we kept 4 categories among 11 categories defined:
    - individual housing / collective housing / (economic) activities / equipment
  - Corine Land Cover 2018 for areas outside Ile-de-France (44 categories based on satellite imagery)
  - Planning documents (PLU, PLUi, POS et CC)



Land-use in Paris (MOS 2017, IAU)



Model development

Land-use: input/output matrix

INPUT-OUTPUT MATRIX – EXAMPLES OF RELATIONSHIPS AND OF PARAMETERS

The input/output matrix represents the production/consumption relationships between city players (the households and the activity sectors) and their consumption of land or built-up area

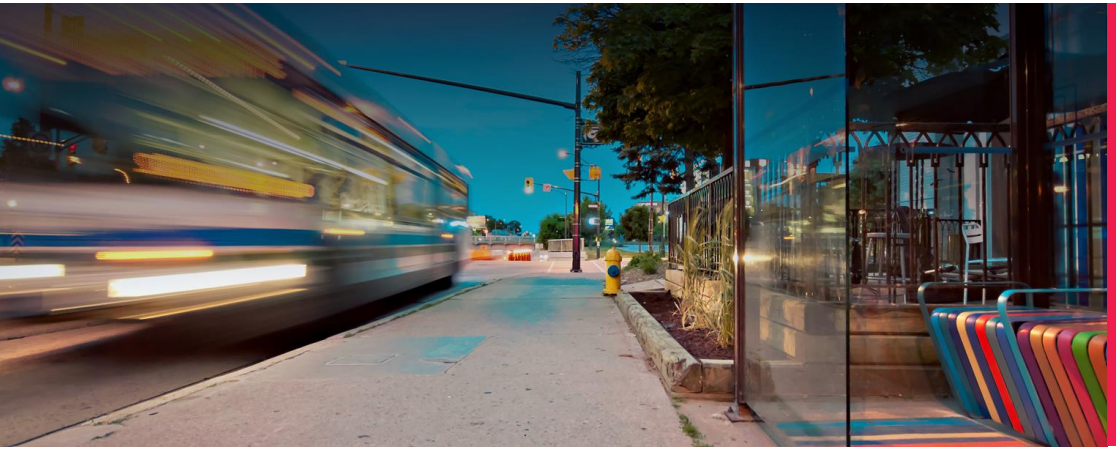
Consumers	Producers	
	Employment	Households
		Self-employed > 1 person
Employment		
……. Agriculture …….		0.644
Households		

Relation A : consumption of household labor force by activity sectors : household "produce" labour force and activity sectors consume it

Consumers	Producers	
	Employment	Households
	… Corporate services…	
Employment		
Households		
……. High qualification job - 1 person …….	0.0776	

Relation B : consumption of goods and services by households (consumers) ; these goods and services being produced by the activity sectors (producers)

Data sources: INSEE demographic and employment statistics, census, national survey on labour forces, national survey on household consumption, regional transport survey (EGT), official population and employment forecasts by the Institut Paris Région (regional planning office), land data from the MOS, …



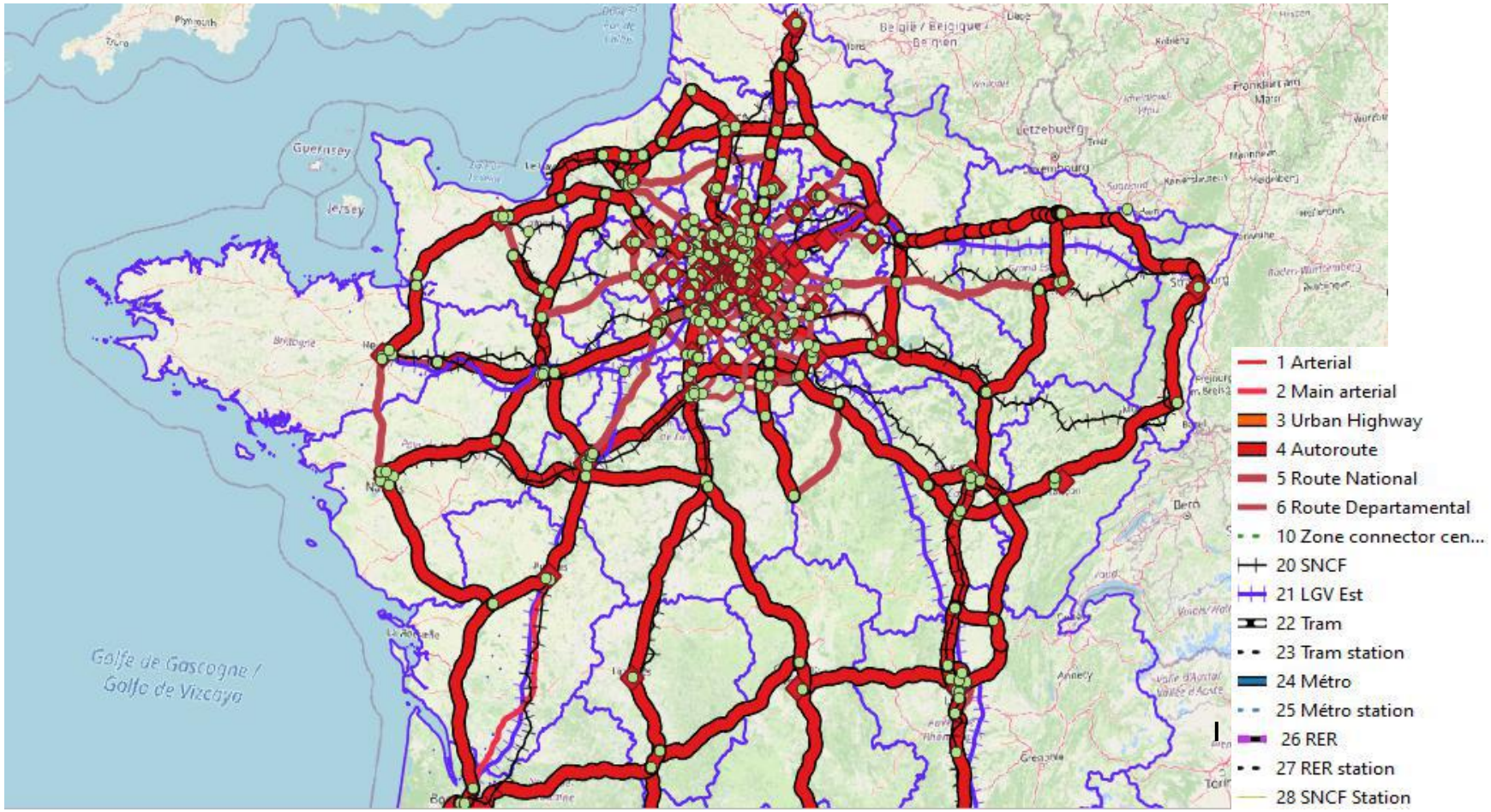
Model development

Transport model: network

TRANSPORT MODEL - NETWORKS

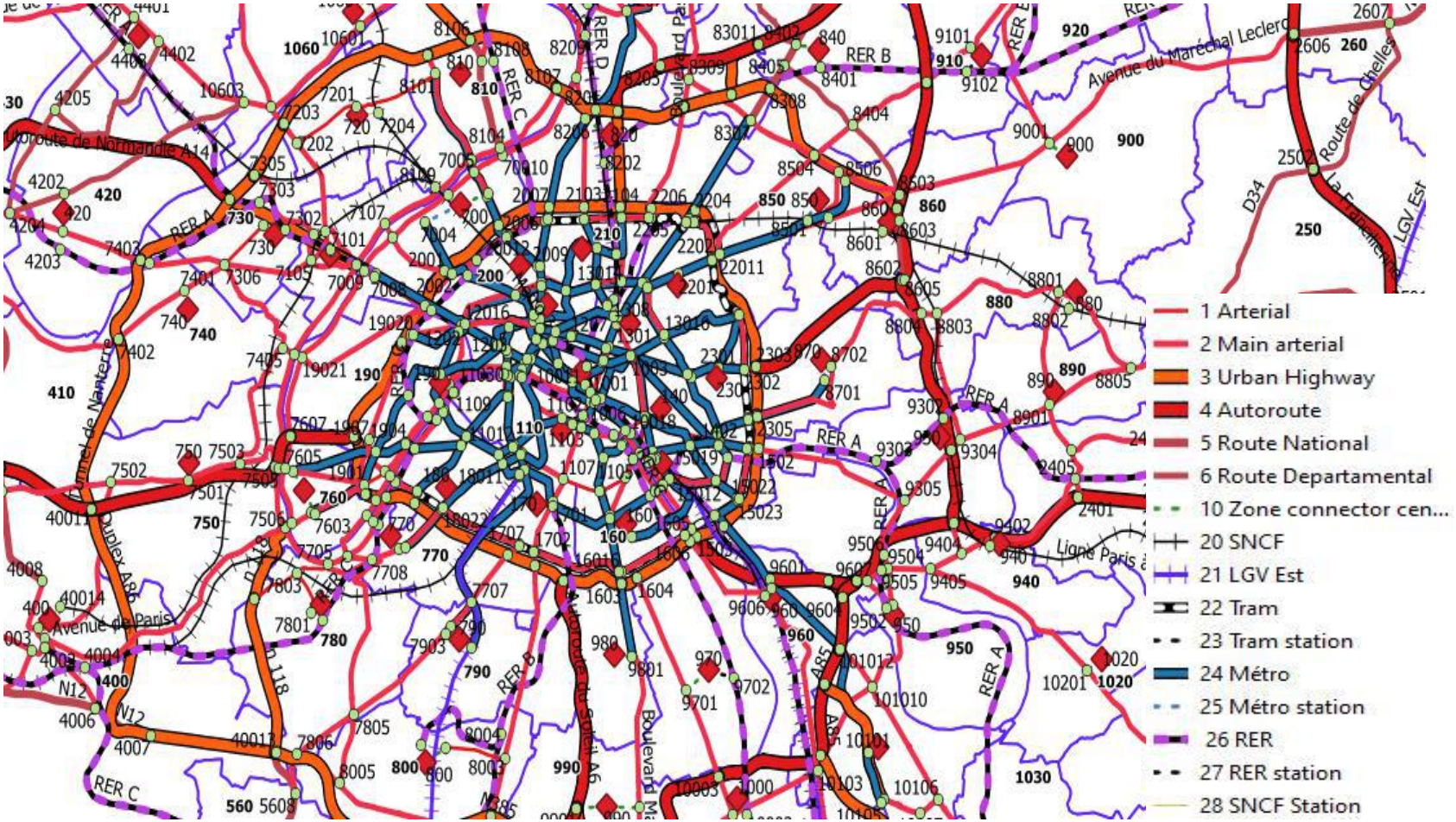
- The road network has been developed starting from OpenStreetMap (OSM)
  - It includes arteries, urban motorways, motorways, A-roads, B-roads, zonal connectors for roads
  - Easy to use in Tranus because integrated in Qgis
- The public transport network resumes the main components of the IDF public transport system, i.e.:
  - SNCF lines, LGV, tram lines, tram stations, metro lines, metro stations, RER lines, RER stations, SNCF stations
  - the bus lines are not modelled in detail but just as feeder of the rail network
- Network definition:
  - 1127 nodes
  - 955 bidirectional links road
  - 861 bidirectional links TC

TRANSPORT MODEL - NETWORK



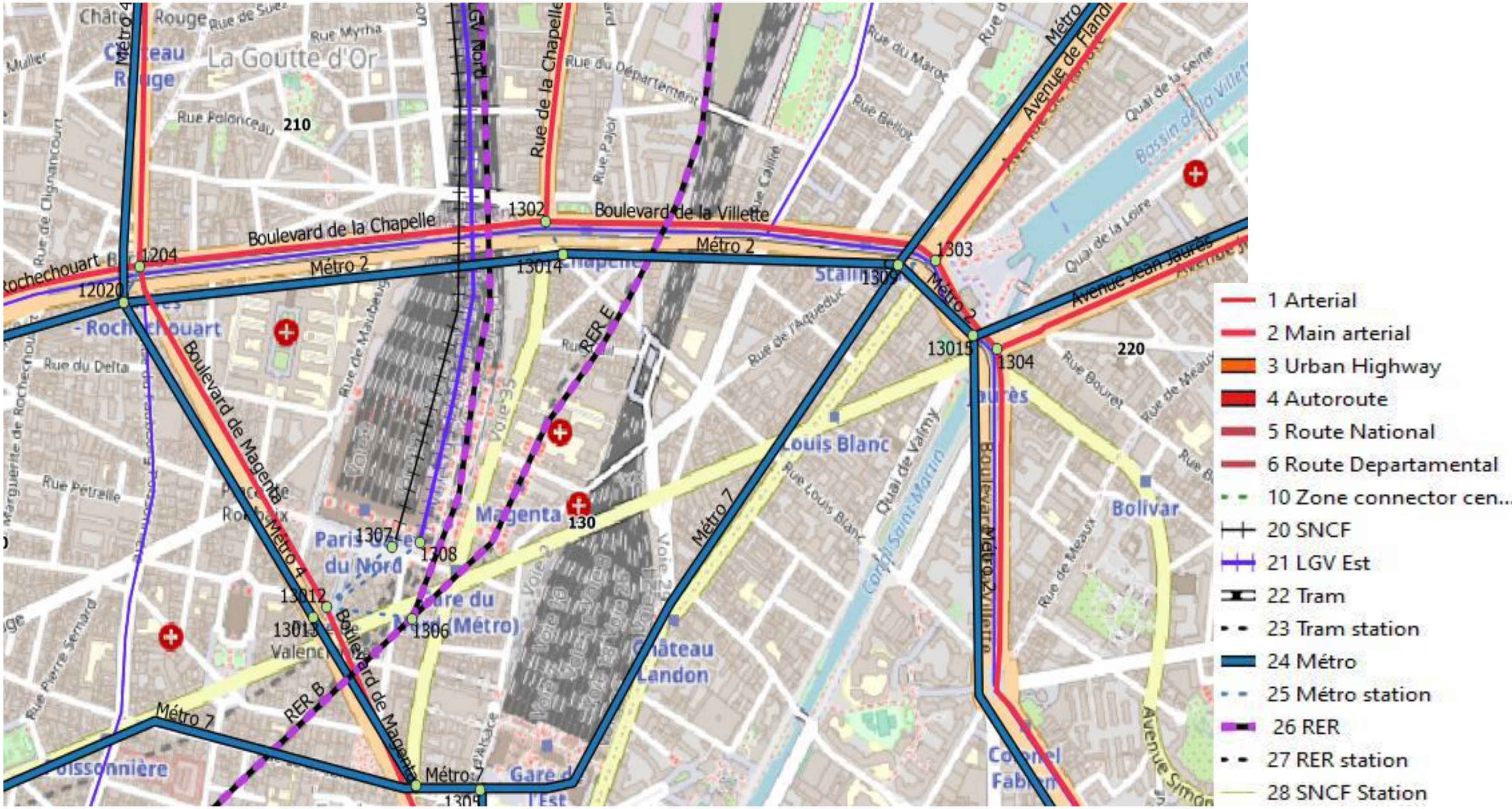
Transport network – large scale

TRANSPORT MODEL - NETWORK

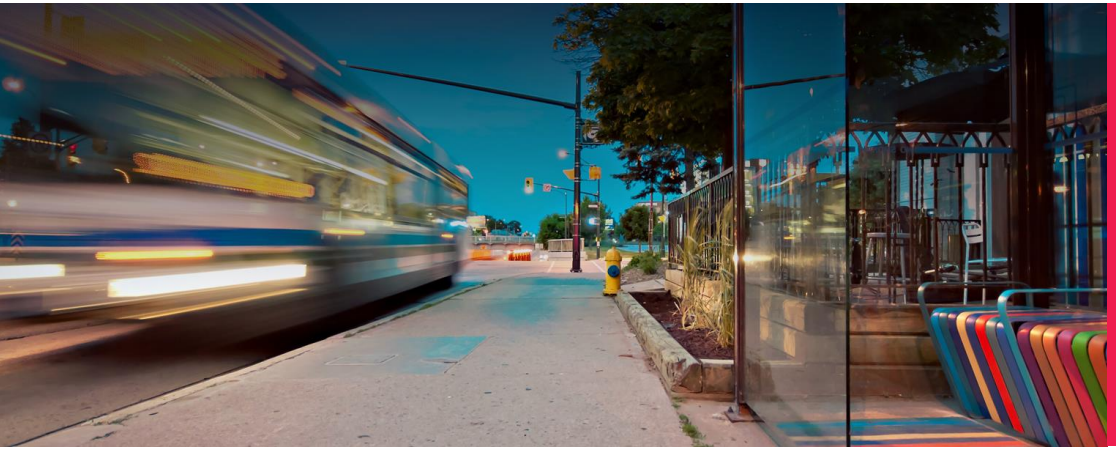


Transport network – Paris

TRANSPORT MODEL - NETWORK



Transport network – Gare du Nord



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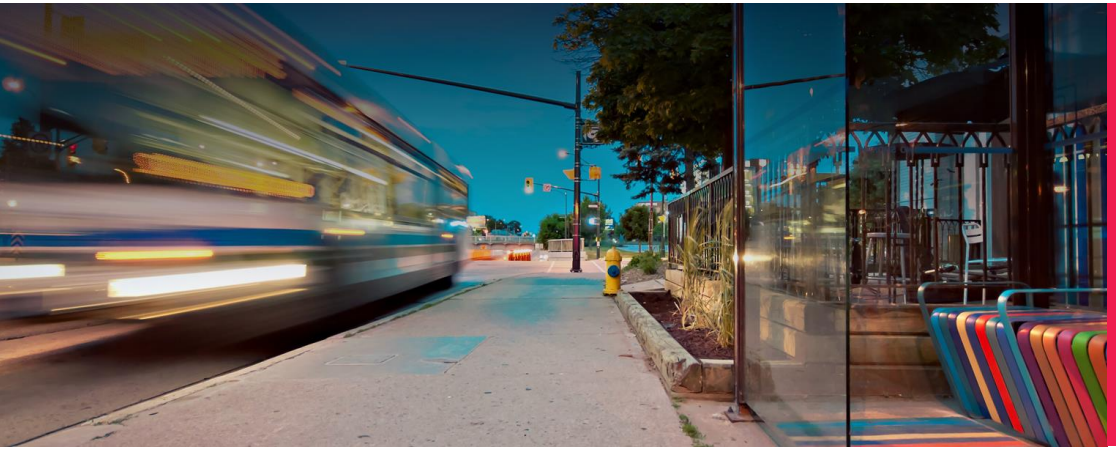
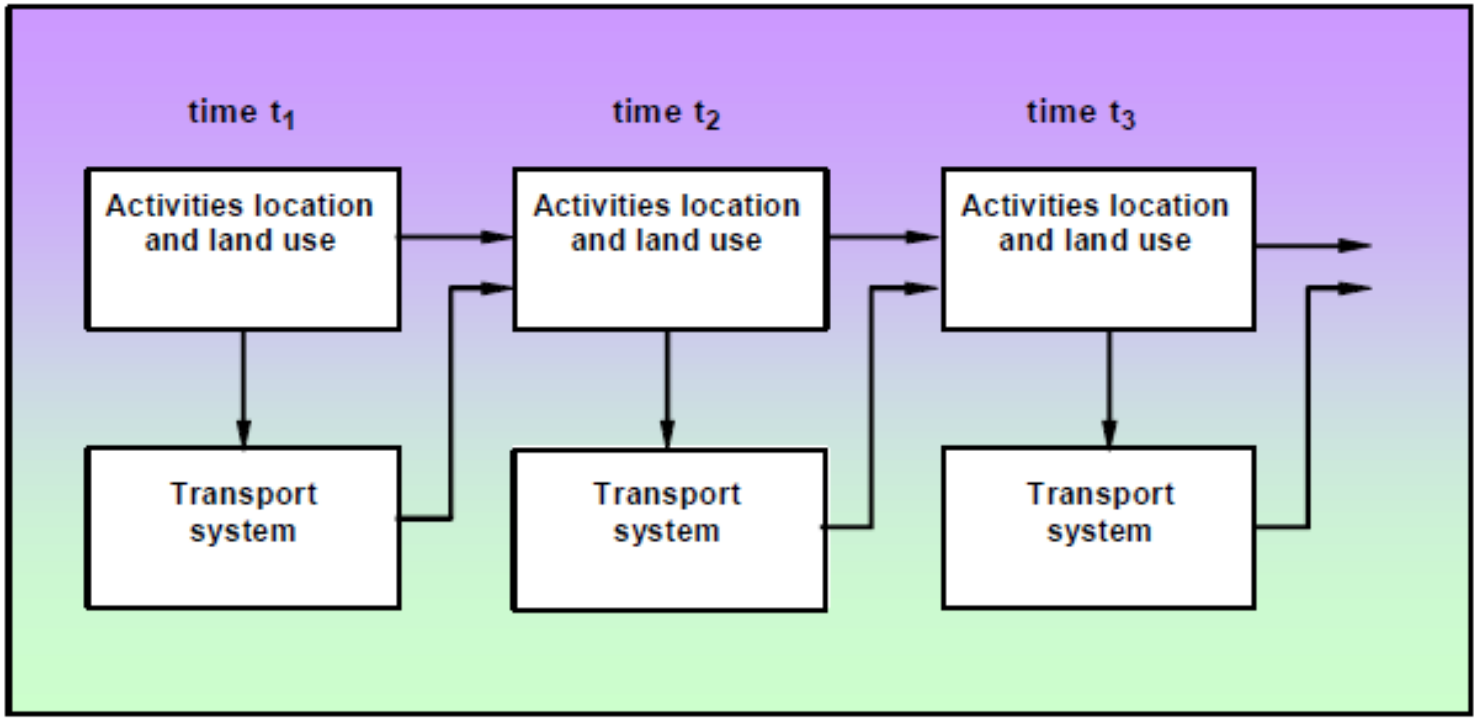


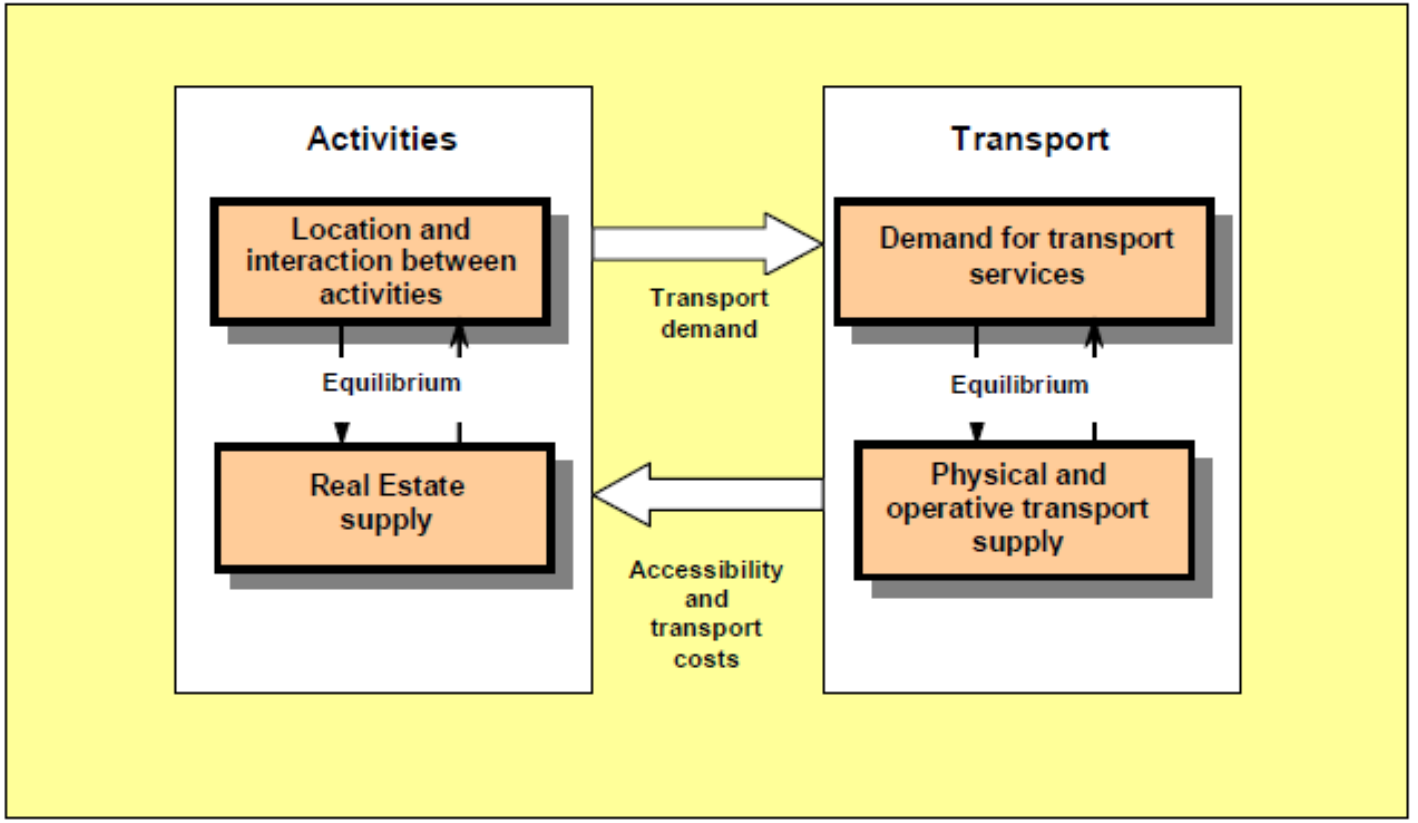
Annexes

Figure 3: Dynamic relationships between activities and transport



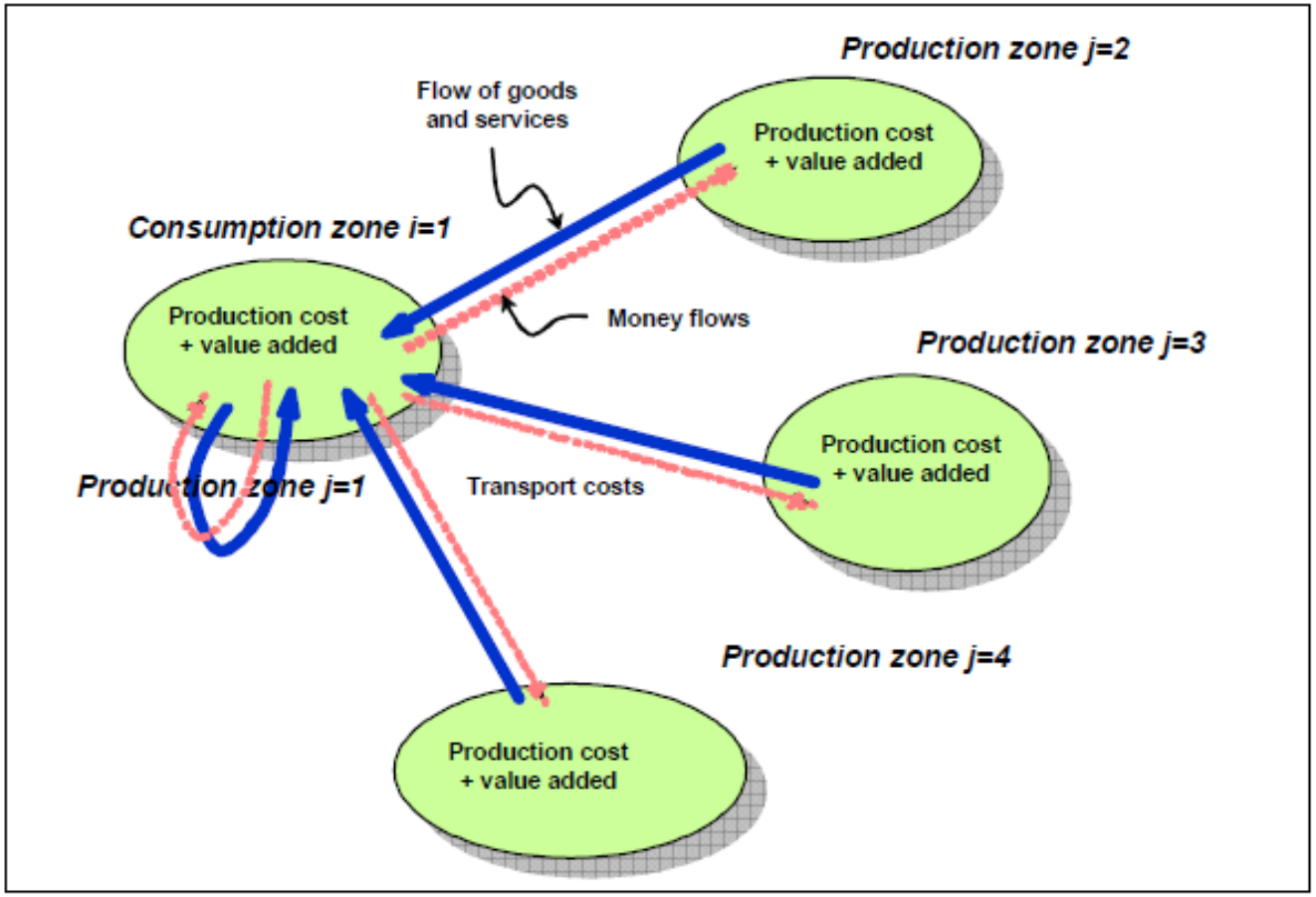
Source: Tranus User Guide

Figure 2: Main elements of the land use-transport system



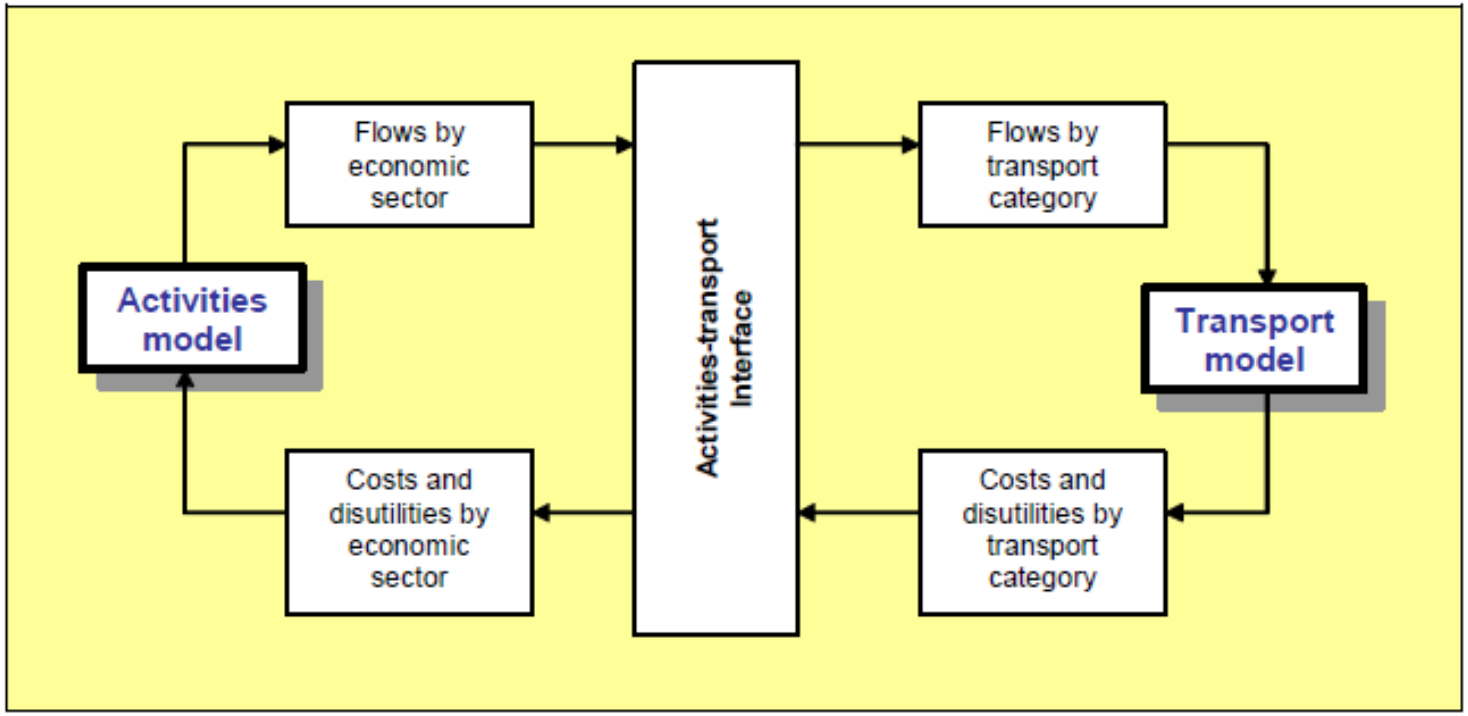
Source: Tranus User Guide

Figure 5: Production and consumption relationships



Source: Tranus User Guide

Figure 7: Activities - Transport Interface



Source: Tranus User Guide

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