Processes of urban regionalization in Italy: a focus on mobility practices explained through mobile phone data in the Milan urban region

Fabio Manfredini, Francesco Curci (DASU, Politecnico di Milano)
Processes of multi-scalar regional urbanization are occurring worldwide, with characteristics that clearly distinguish them from processes studied by 19\textsuperscript{th} and 20\textsuperscript{th} century urban studies, through the traditional concepts of both the city, first, and the metropolis, later.
Assuming this perspective, that we could synthetically indicate with the concept of the "post-metropolis" (Soja, 2011), we are aiming at exploring the new urban forms of contemporary Italy, with a particular attention to the production of processes of regionalization of the urban (i.e. regional urbanization).
The hypothesis is that classic categories and scales of city and metropolis must be abandoned and new socio-spatial formations, which compose the post-metropolitan space, must be taken into consideration.

Three epiphenomena, according to Soja, can be identified:
• the flattening and shrinking of the gradient of urban density;
• the progressive erosion of the boundary between urban and suburban;
• the homogenization of the urban landscape as well as an increasing differentiation and specialization of the suburban.

Among the effects, according to Soja, one can list:
• the disappearance of significant differences in lifestyles between urban and suburban, with the emergence of different (sub) urban ways of life;
• the mixing between forms of urban and suburban;
• the combination of paradoxical forms of decentralization and recentralization, tied on the one hand to the expulsion of some urban functions in peri-urban contexts, capable of generating new centers and to shape new geographies in the suburban and the reverse;
• the emergence of a new urban form: a polynuclear, densely reticulated and intensive information.
BEYOND BOUNDARIES

Public administration and planning need “hard boundaries” at different levels…
BEYOND BOUNDARIES

…but administrative geography fails to cope with processes of regional urbanization.

SOURCES: Istat + Database ESPON http://database.espon.eu/db2/
The scale and patterns of urban regionalization phenomena call for the **definition of analytical frames independent from administrative boundaries**

Image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
The PRIN Research Project
An atlas of post-metropolitan Italian cities

12 SQUARES (9 + 3)
100x100 km
Turin, Milan, Venice, Genua, Bologna, Florence, Rome, Naples, Bari

Less than 100x100 km
Palermo, South-eastern Sicily, Gallura

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
Furthermore, the urban regionalization phenomena call for the definition of other analytical frames independent from administrative boundaries.
The PRIN Research Project
An atlas of post-metropolitan Italian cities

INTERACTIVE WEB SITE
www.postmetropoli.it (from July 2015)

MENU/LIST OF INDICATORS

<table>
<thead>
<tr>
<th>C.</th>
<th>Mortale e dinamica socio-demografica e abitativa</th>
</tr>
</thead>
<tbody>
<tr>
<td>c.1</td>
<td>Composizione demografica</td>
</tr>
<tr>
<td>c.2</td>
<td>Composizione familiare</td>
</tr>
<tr>
<td>c.3</td>
<td>Popolazione straniera</td>
</tr>
<tr>
<td>c.3.2</td>
<td>Tasso di crescita medio della popolazione straniera - 2010-2013</td>
</tr>
<tr>
<td>c.3.3</td>
<td>Tasso di esecuzione della popolazione straniera - 1991-2011</td>
</tr>
<tr>
<td>c.3.5</td>
<td>Popolazione straniera in numero assoluto - 2013</td>
</tr>
<tr>
<td>c.4</td>
<td>Residenza e titolo di godimento delle abitazioni</td>
</tr>
<tr>
<td>c.4.1</td>
<td>Percentuale di abitazioni occupate da persone residenti per titolo di godimento - 2001</td>
</tr>
<tr>
<td>c.4.2</td>
<td>Percentuale di abitazioni occupate solo da persone non residenti sul totale delle abitazioni - 2001</td>
</tr>
<tr>
<td>c.5</td>
<td>Dimensioni e affidamento delle abitazioni</td>
</tr>
<tr>
<td>c.6</td>
<td>Circostanze in ambiente introduttivo</td>
</tr>
<tr>
<td>c.6.1</td>
<td>Bed/influenze dei lettori - 2013</td>
</tr>
<tr>
<td>c.6.2</td>
<td>Assiduità orari diversi di lettori - 2001</td>
</tr>
<tr>
<td>c.6.3</td>
<td>Percentuale di abitazioni in cui residenti non dichiarano abitazioni accettare - 2011</td>
</tr>
<tr>
<td>c.7</td>
<td>Livelli e strutture e occupazione</td>
</tr>
<tr>
<td>c.8</td>
<td>Offerta e composizione scolastica</td>
</tr>
<tr>
<td>c.8.1</td>
<td>Vitaminato e riscita allostruzione delle scuole secondarie di primo e di secondo grado - 2012</td>
</tr>
<tr>
<td>c.8.2</td>
<td>Scuole di istruzione C dello scuola per l’infanzia, pratica e secondario di primo grado - 2012</td>
</tr>
<tr>
<td>c.8.3</td>
<td>Scuole nell’infanzia o primaria per comune - 2012</td>
</tr>
<tr>
<td>c.9</td>
<td>Esistere e risco interattivo</td>
</tr>
<tr>
<td>c.9.4</td>
<td>Indici di alcune attività - 2011</td>
</tr>
</tbody>
</table>

FULL/DEFAULT VISUALIZATION

CUSTOMIZED VISUALIZATION
An atlas of post-metropolitan Italian cities
The case of Milan urban region

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
The Milan urban region
A dense urban continuum, a polycentric urban region

Building density goes beyond metropolitan patterns and gradients

URBAN GROWTH
- 1955
- 1980
- 2012

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
The Milan urban region
The ongoing explosion of urbanized areas

Land take dynamics show and ongoing ‘isotropic’ process of urbanization
Land take dynamics show and ongoing ‘isotropic’ process of urbanization

From arable land to construction sites - image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
The Milan urban region
An extended explosion

URBAN GROWTH 1955-2012
POLYCENTRIC PATTERN
FILTERED BY PROVINCIAL
BOUNDARIES

1955

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space”
The Milan urban region
An extended explosion (and implosion)


image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space” – data source: ISTAT Census

Fabio Manfredini, Francesco Curci
The Milan urban region
An extended explosion (and implosion)

A. DETAILED POPULATION DENSITY 2001
   (cells 500 x 500 m)

B. POPULATION TREND 1951-2011

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space” – data source: ISTAT Census

Fabio Manfredini, Francesco Curci
Centre-periphery gradient are becoming less prominent.

Image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space” – data source: ISTAT Census.
The Milan urban region
The flattening out of the density gradient

Centre-periphery gradient are becoming less prominent

POPULATION AT DIFFERENT DISTANCE FROM THE CENTER OF MILAN
image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space” – data source: ISTAT Census
Commuting is increasing...

A. MOBILITY INDEX 2001
DENSITY OF DISPLACEMENTS FOR WORK

B. MOBILITY INDEX 2011
DENSITY OF DISPLACEMENTS FOR WORK

image by PRIN Research Program “Post-metropolitan territories as emergent forms of urban space” – data source: ISTAT Census
Exploring mobility practices
Origin Destination Data

Growing network of less hierachical relationships inside dynamic places in the urban region

Commuters fluxes $> 100$
(excluded fluxes for and from regional cities)
The Milan urban region
The flattening out of the density gradient

…but new functions are changing non work-related mobility
The Milan urban region
Accessibility

Urban poles  Commercial poles  Multiplex

Road accessibility to different urban poles and facilities: Isochrone representation (15, 30, 45, 60 minutes)
The Milan urban region
Accessibility

University

Railway stations

Airports

Milan city center

Fabio Manfredini, Francesco Curci
Mobility practices are linked with the complexity of the socio-spatial fabric and the emergence of new multiple centralities.

New forms of mobility are emerging and have intensified the density and typologies of movements that traditional sources are unable to describe with continuity.
Exploring mobility practices
New sources vs conventional data

Traditional data sources for urban investigations:
pros
- Socioeconomic and demographic information is public, open to wider users and referred to all the population

... and known limitations
- high cost
- low frequency
- difficulty of updating
- Time dimension is missing

New data sources can help in understanding mobility patterns, in describing and assessing urban changes and diversified uses of the city.
In contemporary urban research debate, there is a growing interest in the study of the behavior of people in urban spaces, in the definition and in the analysis of urban populations and of community practices and how these reshape the boundaries of the city.

The main element of interest is how to qualify different places according to their use with a specific focus on emerging spatial and temporal patterns and how to acquire novel information on the different practices that happen in these places.
### Active and passive mobile positioning

<table>
<thead>
<tr>
<th>Data</th>
<th>Research area</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracks of displacements of individuals of a small selected sample</td>
<td>Tracking technologies (GPS, SMS, …)</td>
<td>Study of mobility behaviour of specific group/population category</td>
</tr>
<tr>
<td>(case study)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tracks of calls of individual phone users (active mobile positioning)</td>
<td>Network science</td>
<td>Study of geometrical patterns of the mobility of individuals (deprived of the specific geographical reference)</td>
</tr>
<tr>
<td>Spatial distribution of cell phone network traffic intensity</td>
<td>Mobile landscapes</td>
<td>Study of the density of use of a territory</td>
</tr>
<tr>
<td>(derived from cellular network log files)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mobile phone data
Measure of traffic intensity - Erlang

Georeferenced Erlang matrices for Lombardia Region - Matrices of mobile phone traffic (voice) expressed in **Erlang**: traffic is anonymously recorded by each cell of the network as the average number of concurrent contacts in a time unit.

- **Temporal resolution**: 15 minutes
- **Spatial resolution**: 250 m. x 250 m. (pixel dimension)
- **Period**: 2009-2011

The mobile phone traffic data spatial resolution superimposed to building blocks, the more detailed available statistical unit, for the central area of Milan.
Micro scale analysis
II – Impact of a special event on the urban system
- Elaboration: map of the ratio between the activity of a whole day with events and a whole normal weekday (ratio

Variability of cell phone traffic (Erlang) at the Rho-Pero Exhibition District during the 2009 International Design Week (black) and in a typical weekday, without events (gray).
Increasing intensity of red color corresponds to higher cell phone traffic.

It is possible to observe the parts of the city where phone activity is high, largely due to the International Design Week activities.

Numbered boxes highlight areas of particular interest:
1 = Exhibition District; 2 = Milan city centre; 3 = Tortona District; 4 = San Siro Stadium.
**Aim:** identification of useful information on hidden patterns of mobile phone use.

These hidden patterns regard different usages of the city in time and in space which are related to individual mobility, outlining the potential of this technology for the urban planning community.

The methodology allows to obtain a **reference basis** that reports the specific effect of some activities on the Erlang data recorded and a **set of maps** showing the contribution of each activity to the local Erlang signal.

We selected some results as significant for explaining specific mobility and city usages patterns (commuting, nightly activities, distribution of residences, non systematic mobility) and tested their significance and their interpretation from an urban analysis and planning perspective at the Milan urban region scale.
Treelet 1 – The “average use” treelet map. The treelet contains different temporal patterns of mobile phone activity (i.e. daily, working day versus week end) that fit with actual city usage.

Reference Basis

Map
Treelet 82 (left) and 83 (right) - **Mobility practices**. Weekdays commuting flows at the Milan urban region scale: morning rush hours (left) vs to evening rush hours (right).
Treelet 93 - **Mobility practices**. Saturday (10am- 8pm), shopping and leisure activity.
localized and aggregated tracks of anonymized mobile phone users (period: 2011)
Tilab + DASTU research group

Tessellation

Call Detail Records (sensitive accounting informations)

- Number of localized phone users: 3M
- Number of users with more than 8 activities per day: ~ 35%
## Mobile phone data vs conventional data for mobility analysis

<table>
<thead>
<tr>
<th></th>
<th>Survey on mobility (OD) Lombardy Region 2002</th>
<th>Census (on commuting) ISTAT 2001</th>
<th>Mobile phone data (Aggregated O/D tracks)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample</strong></td>
<td>750K interviews</td>
<td>All residents</td>
<td>Mobile phone users ~1.5M per day</td>
</tr>
<tr>
<td><strong>Type of movement</strong></td>
<td>All</td>
<td>Study and work</td>
<td>All</td>
</tr>
<tr>
<td><strong>Reference Period</strong></td>
<td>“Typical” working day of 2002 (one Wednesday)</td>
<td>One working day of October 2001</td>
<td>Every day</td>
</tr>
<tr>
<td><strong>Updates</strong></td>
<td>No</td>
<td>Census 2011 (results not yet available)</td>
<td>Continuous</td>
</tr>
<tr>
<td><strong>Information on vehicle</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Spatial resolution</strong></td>
<td>Municipalities, aggregation of minor municipal districts, subdivision of major municipalities</td>
<td>Municipalities</td>
<td>Variable aggregation of cells</td>
</tr>
<tr>
<td><strong>Temporal resolution</strong></td>
<td>24 hours</td>
<td>7 a.m.-10 a.m.</td>
<td>Hourly or sub-hourly</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Expensive</td>
<td>Very expensive</td>
<td>Not known</td>
</tr>
</tbody>
</table>
Main hourly distribution of origin – destination movements of a huge sample of people (more than one million per day).

Goal: display a synthetical view of fluxes of mobility at different hour of a typical working day.

Set of maps of the sum vector moving from each zone at different hours has been produced in order to highlight the main patterns of mobility during a typical working day.
Systematic mobility – going to work
h. 9 a.m. 19th October 2011

www.ladec.polimi.it/maps/od/fluxes.html
complex chains of movements
multiple purposes
Conclusion

• Urban regionalization processes are distressing the administrative boundaries and conventional data;

• Mobility is one of the most relevant issues within urban regionalization processes because it interrelates spatial development, urban practices and lifestyles;

• New data, tools and methodologies are needed by urban studies and policies to address the complexity of contemporary urban regions;

• Mobile phone data (Erlang and aggregated OD tracks) show new spatial-temporal patterns of mobility and complex usages of urban and suburban spaces.
PRIN Research Program website
www.postmetropoli.it (from July 2015)


francesco.curci@polimi.it  fabio.manfredini@polimi.it