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# Evolution of mobility during the COVID-19 crisis in the region of Madrid

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## Abstract

The World Health Organization (WHO) declared COVID-19 a pandemic on March 11, 2020. Three days later, the Spanish Government declared a state of alarm, which lasted until June 20. This state consisted of a two-month lockdown with mobility restrictions and a two-month phased easing of lockdown. This paper analyses the evolution of mobility patterns in the Region of Madrid through statistical information to study the impact of the COVID-19 crisis based on data from the Spanish National Statistics Institute (INE). The results obtained in this paper show that, during the lockdown, trips made in the Region of Madrid fell by 70% compared to the normal scenario. However, the variations in mobility were very different in each area of the territory. For example, trips to San Sebastián de los Reyes were reduced by more than 90%, while trips from San Fernando de Henares decreased by only 30%. Once the easing of lockdown phases began, there was an increase in trips in the Region of Madrid of more than 60% compared to trips made during the lockdown. This growth was also very irregular. For example, travels from Arganda del Rey increased by more than 260%, while trips to the same municipality only increased by 13%. The mobility study is complemented with the analysis of socioeconomic variables, land use, and transport network to clarify the evolution of the different zones in the Region of Madrid during the COVID-19 crisis.

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## 1. Introduction

On March 14, 2020, the Spanish Government declared a state of alarm because of the health crisis triggered by the COVID-19 pandemic. This legal prevision began with a lockdown that lasted two months, followed by a phased easing of the lockdown to control the return to the new situation. This led to the end of the state of alarm on June 21, 2020.

This state of alarm brought about a precedent-shattering change in the habits and mobility of the citizens at a national level. Given the unusual situation, multiple public agencies have collected data about the impact of the pandemic on the habits of the population.

Among the agencies, the Spanish National Statistical Institute (INE) stands out as one that publicly shares a significant amount of the collected data. The INE's provided information consists of numbers related to the sociodemographic, economic, health and mortality realms, and mobility data, specifically observed in the present publication.

## 2. Methodology

Mobility data finds its source in anonymized mobile phone records with samples from more than 80% of mobile phones from every corner of Spain. Figures provided by the census on January 1, 2019, complement mobility data.

To gather this information, the INE has divided the national territory into 3,200 mobility areas, consisting of units created by this body composed of groups from 5,000 to 50,000 inhabitants, thus becoming a more homogeneous tool than municipalities.

Consequently, the areas of residence are identified as those where the phone is located between 12 a.m. and 6 a.m. and the destination areas as the most frequent ones where the phone is between 10 a.m. and 4 p.m. for more than two hours.

The temporary scope of the offer covers only the state of alarm, in such a way that the data goes from March 16 to June 20, 2020, along with the reference data for the week from November 18 to November 21, 2019.

## 3. Mobility study

Madrid is one of Spain's most populated regions and one of the most affected by this pandemic. It is on that basis that the Region of Madrid had longer restrictions.

The territorial division of the region proposed by the INE established 293 mobility areas. For this study, the mobility areas from the same municipality have been unified to create the study areas. In this way, the Region of Madrid will be divided into 102 study areas.

The analysis of the evolution of mobility in Madrid has been based on the origin-destination data provided by the INE by selecting a representative date for each period of the state of alarm:

- Normality: average data from November 18 to November 21, 2019.
- Lockdown: average data from March 26 and April 30, 2020.
- Phase 0: May 21, 2020.
- Phase I: May 28, 2020.
- Phase II: June 18, 2020.

In the first place, by analyzing the total data, it is observed that during the lockdown, the trips made, which were more than one million in the period of normality, fell over 70%. With the easing of the lockdown, travel increased progressively but did not reach 600,000 trips.

To make the evolution of the relationships of the study areas more understandable in the course of the state of alarm, different flow maps have been made. The first one corresponds to normality, and it shows how travel is concentrated in the metropolitan area and the simplicity of the relationships in the provincial area.

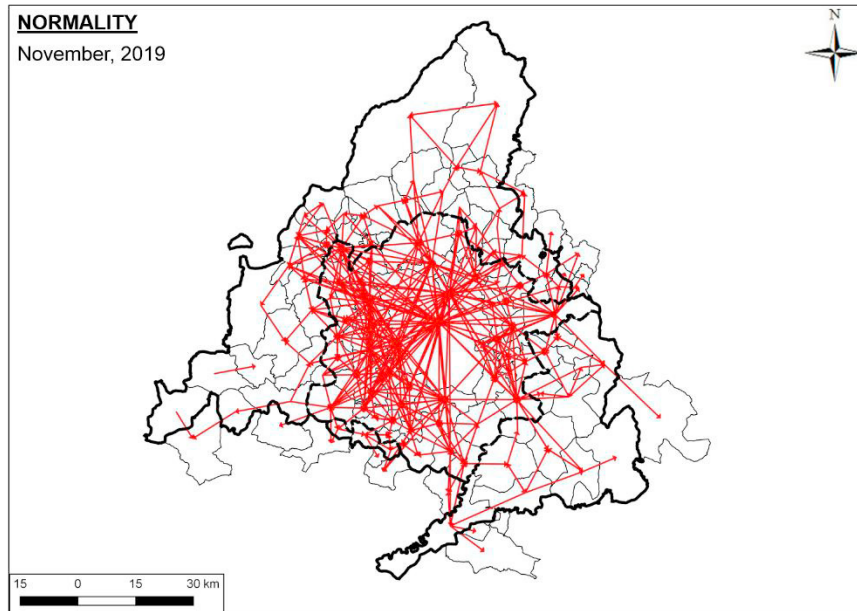


Fig. 1. Origin-destination flows during the normal period (November 2019)

During the lockdown, the volume of flows was considerably reduced, and it was almost disappeared along the provincial area. The increase in mobility during the easing of lockdown was not associated with a marked increase in relationships, but the existing ones were intensified.

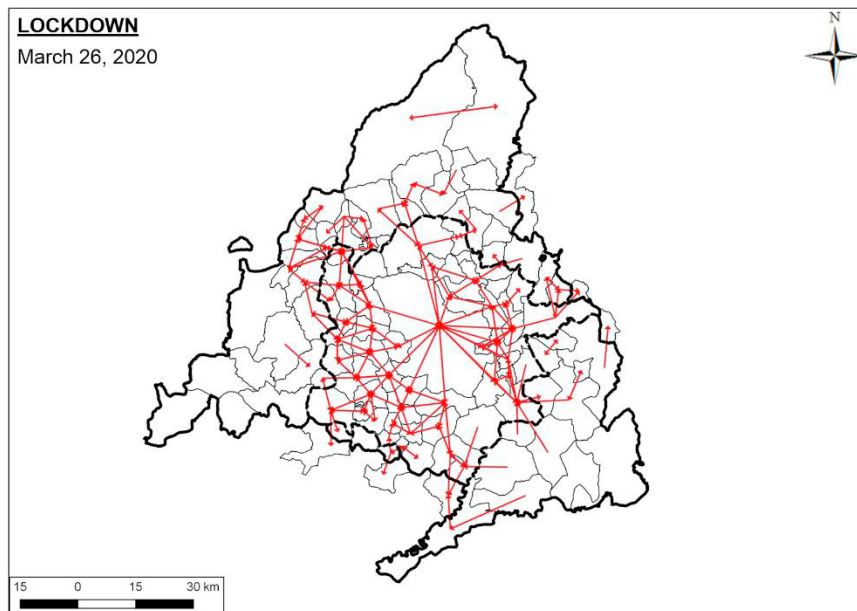


Fig. 2. Origin-destination flows during the lockdown I (March 2020)

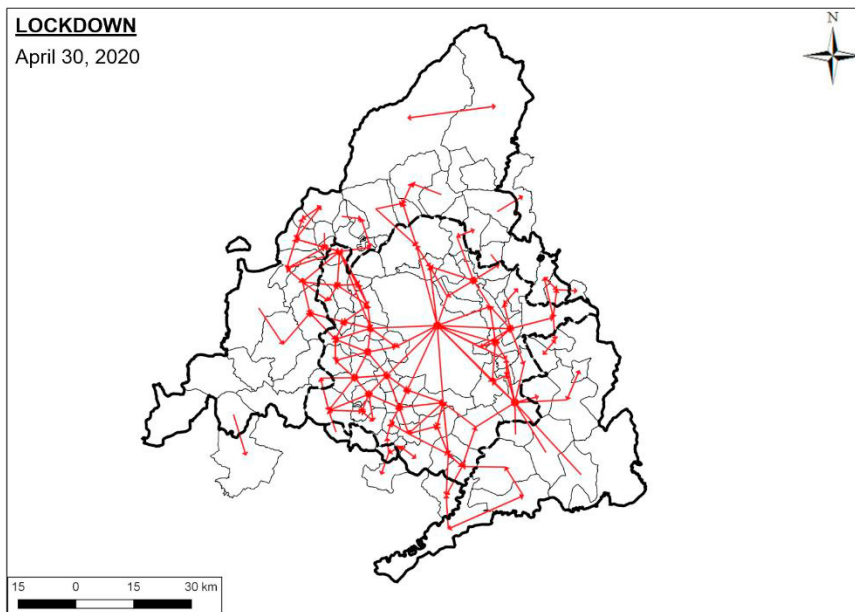


Fig. 3. Origin-destination flows during the lockdown II (April 2020)

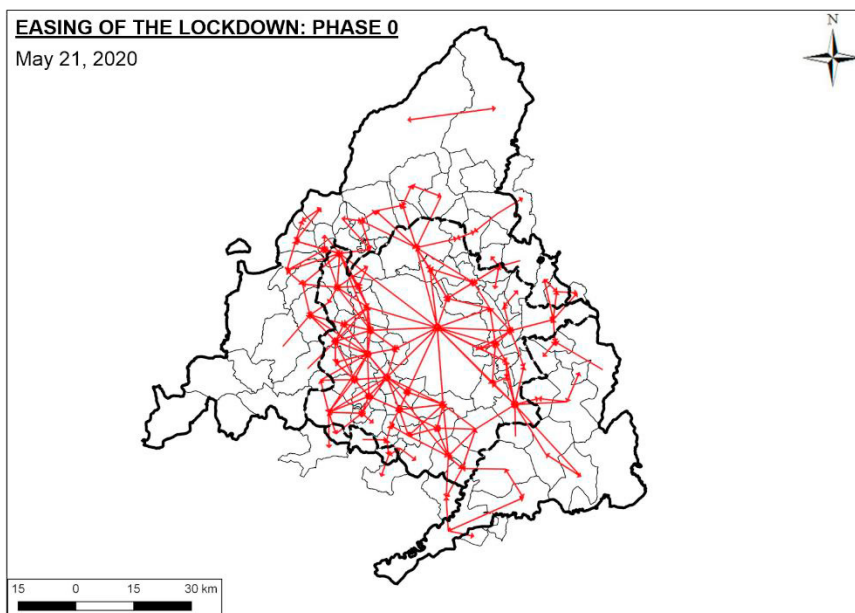


Fig. 4. Origin-destination flows during the Phase 0 (May 2020)

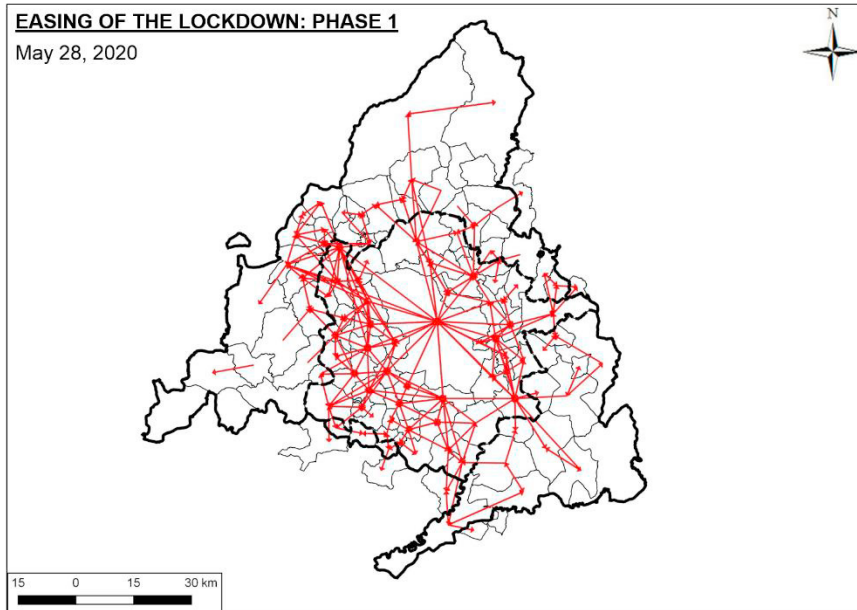


Fig. 5. Origin-destination flows during the Phase I (May 2020)

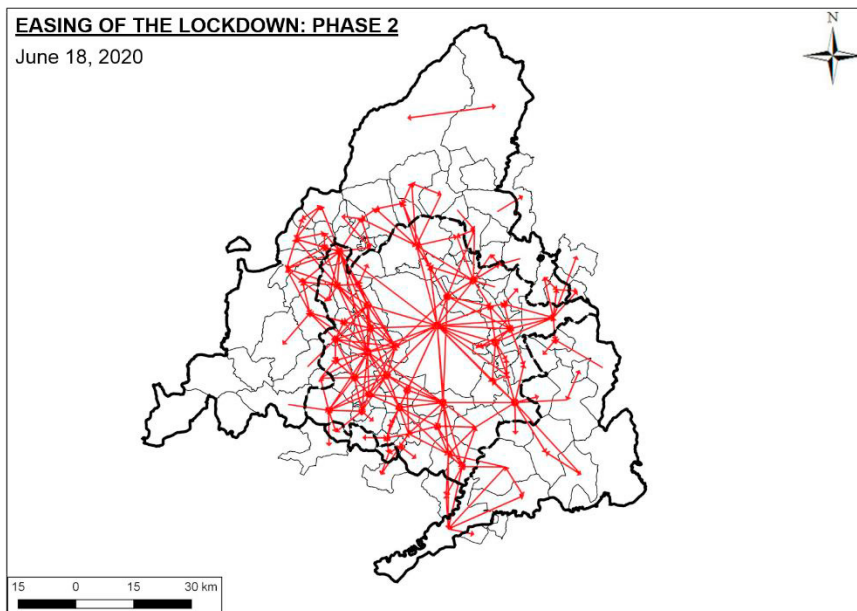


Fig. 6. Origin-destination flows during the Phase II (May 2020)

The reduction of outgoing movements during the lockdown was more significant in the metropolitan area and some areas of the Northeast and Southwest of the region. The increase during the easing of the lockdown was high-moderate within the metropolitan area. There were significant increases in the north of the provincial area, contrasting with de low increases in the east and west.

As for the incoming movements, during the lockdown, there was a considerable decline in the Central and Southeast areas, noting that the Southern areas of the metropolitan area did not suffer significant changes. The increase in incoming trips was generally moderate-high, with high increases in the South.

#### 4. Socioeconomic study

To tackle the condition of restrictions in different areas, different socioeconomic variables, land use, and transport data have been studied.

Data on population density, per capita income, and employment data have been taken among the socioeconomic variables. The latter are of great interest as the Home Mobility Survey of the Region of Madrid (EDM2018) points out that 20% of the trips are associated with work. These employment figures consist of Social Security members, unemployment rate, and branches of activity.

On the other hand, the analysis of land uses constitutes a great indicator of the employment generation and, therefore, the propensity to travel. Finally, the transport data is based on the motorization index of each area and the evolution of travelers transported by city bus and Metro.

#### 5. Discussion of results

The analysis focuses mainly on employment numbers because of its close relationship with the generation and reception of travel, starting with studying branches of activity.

Hence, it is observed that the areas in which the majority of the population is engaged in Business and Financial Services (Madrid, Alcobendas, Majadahonda, Pozuelo de Alarcón, etc.) suffered a great drop during the lockdown and moderate increases after it. Similarly, the areas that base their activity on these services lost a large percentage of travel and did not regain mobility in the easing. This is explained as the presence of these services was reduced and, following the lockdown, a teleworking regime was adopted.

As for the Distribution and Hospitality Services branch, the areas in which citizens perform these jobs and the areas that base their economy on it were not affected by the lockdown primarily and therefore suffered fewer increases in the easing. This dynamic is associated with the high degree of presence of these activities.

Analyzing per capita income, it is noted that areas with fewer resources suffered fewer decreases during the lockdown than high-income areas in terms of mobility. This may reflect unemployment rates in areas with fewer resources, so people who did not go to work did not make as many trips as pre-COVID-19 times.

#### 6. Conclusions

In conclusion, this analysis has made it clear that mobility patterns have been greatly affected by the arrival of the pandemic in the Region of Madrid. The lockdown resulted in high decreases in the volume of travel in the region. With the easing of lockdown, there were increases, but the mobility that took place in periods of normality was not recovered in light of the data.

Delving into these conditions, the study shows that the employment status quo highly conditions the region's mobility patterns in the different areas of Madrid. Consequently, the business and financial branch was more affected than the distribution branch, mainly because of the presence associated with each activity. These findings can lead to different strategies, adapted to each branch and study area, to act on the new waves of the pandemic in the future.

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