INSTITUTO NACIONAL DE ESTADISTICA

Analysis of population mobility during the COVID-19 state of alarm based on mobile phone positioning

National Statistics Institute

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Experimental

The data presented come from an analysis of the position of more than 80% of mobile phones throughout Spain. The analysis has been prepared by the INE in close collaboration with the three primary mobile phone operators (Orange, Telefónica, Vodafone).

1 Study Objective

The aim of this study was to obtain a decent approximation of the mobility or immobility of the Spanish population **during the State of Alarm**, which began on March 15th, as compared to a normal situation: that is, we wished to estimate how many people were leaving their households during working hours on these day - as well as which areas they travelled to during working hours- in relation to the flows observable on a normal day.

2 Geographical scope

Results are offered for the entire national territory, which is divided into some 3,200 "mobility areas". These areas are detailed in an annex to this note.

At the time of the COVID-19 outbreak, the INE was developing a project to measure daily mobility[1] whose methodology will also be used in this study. Spain is thus divided into some 3,200 mobility areas. These are population groups of between 5,000 and 50,000 inhabitants (and are far more homogeneous than municipalities). An area in a depopulated zone will be the sum of several small or very small municipalities (up to 5,000 inhabitants). In the cities, however, the areas will be districts or even disaggregations of the districts.

For example, in Madrid, the city is divided into some 150 different areas, with an average of 20,000 inhabitants. This allows for a very fine analysis of population mobility.

The three telephone operators use the same mobility areas, meaning that the data they provide for the study can be fully aggregated.

3 Time scope Frequency of information and calendar

Mobility information is obtained from the study of full days. So long as the confinement measures are in place, information will be offered every two days, indefinitely, from Monday, March 16th onwards.

In order to facilitate comparison and to have a valid reference regarding how much population mobility has varied, the data for a weekday that can be considered "normal" is taken as a reference.

[1] For more information and methodological details consult the Pilot Statistics on Mobility based on mobile phone positioning: https://ine.es/censos2021/movilidad_proyecto.pdf

For this study, the "normal" day that has been considered is that resulting from the average of the days 18 (Monday) to 21 (Thursday) of November 2019. These data were already received as part of the aforementioned project and are therefore taken as a reference for this study.

The project is based on a commitment by the operators to deliver information **during the State of Alarm. As such, its temporal scope is limited exclusively to this period**.

4 What information is published?

The following data is published for each mobility area:

- Population residing in the area (official figures from the Register as of 1-1-2019)
- Estimated number of persons that stay in their area of residence (*)
- Number of people absent from their area of residence (*)
- The main destinations (mobility areas) to which those who leave their area are going, and an estimate of how many persons travel to them.

(*) See section "How is the information prepared?"

Detailed data is offered with all daily origin-destination flows (when they affect more than 15 people), as well as daily maps with the main results for each area.

5 How is the information prepared?

For each mobility area, each operator provides a count of the number of terminals that will comprise the resident population: a person (a mobile phone) will be considered resident in the area where the phone spends the majority of the time in the 0am to 6am schedule. Each mobile phone is thus associated with an **area of residence**.

For each cell phone, the operators calculate the **destination area** as the area where the phone is most frequently detected during the 10 am to 4 pm period of the day in question, so long as it has been there for at least two hours. This area can be the same as the area of residence, any other location, or even none, in the case that the person is continuously moving or if the phone is switched off or out of range.

For each area of residence the operators provide the number of movements to destination areas, if this number exceeds 10 or 15 units (depending on the operator), to protect privacy and to respect statistical secrecy. **The INE therefore does not receive information on movement between areas when the number of terminals is below that amount**.

Using the data provided by the operators, the INE aggregates the results for each one and obtains the total number of mobile phones that move from one area to another or which are kept in the same areas of residence.

Since the objective is to estimate **the population that moves**, not the number of terminals that move, the INE elevates these data to the population as a whole.

Only flows between areas whose estimated amount exceeds the threshold of 100 people are offered. Given the methodology used, flows of a lesser magnitude cannot be offered.

This information provides a decent approximation of "immobility" and shows which areas still have greater movement, both in terms of origin (how many people leave their homes during working hours) and of destination (the areas where more people tend to concentrate during those working hours).

As an approximation to "immobility" it is considered that all the residents in an area that we do not find in different areas remain in their area.

6 Can these data show who is at home and who is working?

No. What can really be determined -always with a certain margin of error- is what part of the population generally stays in their area of residence; but this methodology cannot detect movements within that area.

In addition, movements observed between bordering areas should be taken with caution because they may be caused by an error made when setting each terminal's position. This can result in a terminal being counted that is immobile in two different adjacent areas at different times.

Nor can sporadic movements that would imply leaving the areas of residence for a very short time (less than two hours) be detected.

Thus, the population that stays in their area of residence is estimated as that which does not leave it; and if it does, does not do so for more than two continuous hours or we cannot find them in any other area.

On the other hand, the population that leaves their area is comprised of those who are not frequently present from 10 am to 4 pm. It is an approximation of the working population, with the limitations imposed by this methodology.

7 Why are mobility areas used?

The **"mobility area,"** created by the INE, is the level of detail at which all information is offered. This is more homogeneous unit than the municipality while being less detailed than the coverage area for each antenna. The complete list of mobility areas and their geographical delimitation is published together with this methodological description. Both the INE and the operators consider this level of detail to be optimal in the short term, since lowering the antenna level, or something similar, could lead to information that is misleading or difficult to analyse.

It should be taken into account that, even if the entire population were immobile, the telephone network could still give false impressions of movement. Determining mobile phone position has an error of at least tens of meters in urban areas, and it is considerably higher in unpopulated areas. This means that counts can vary even in the absence of actual movement. Furthermore, at the antenna, or other, level, information from different operators could not be added (each would have its own geography based on its antennas). The level proposed is, therefore, the most detailed level that is also compatible with the three operators. It allows data to be added together, along with providing a certain amount of short-term data stability.