Validation of a new Meta database usage to understand population's mobility: the February 6th, 2023, Türkiye event case study

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However attentive I was during the writing of the master thesis. I figured out I did the greatest possible writing mistakes.

In the Introduction, I forgot to add some of the references. Therefore, the page 12 and 13 have change considerably. Please a look at the page below as a right introduction.

As I am doing an Erratum, I would also add that the the pages 9 and 10 have a wrong figure quotation numbers. The new page 9 and 10 are before the introduction.

Such correction goes with the change of the figure number inside the document.

Here are the changes in the main document :

- Page 36 : Figure 7 should be Figure 6
- Page 37 : Figure 8 should be Figure 7
- Page 38 : Figure 9 should be Figure 8
- Page 39 : Figure 10 should be Figure 9
- Page 41 : Figure 11 should be Figure 10
- Page 42 : Figure 12 should be Figure 11
- Page 42 : Figure 13 should be Figure 12
- Page 43 : Figure 14 should be Figure 13
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- Page 109 : Figure 33 should be Figure 53
- Page 110 : Figure 34 should be Figure 54
- Page 114 : Figure 35 should be Figure 55

- Page 115 : Figure 36 should be Figure 56

- Page 117 : Figure 37 should be Figure 57

- Page 119 : Figure 38 should be Figure 58. 0n that page, the figure's legend start with socio-demographic instead of Socio-demographic.

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I Introduction

Big Data is playing an increasingly significant role in academic research, offering insights that surpass those obtainable through traditional data sources. Its greatest strengths lie in its capacity to integrate vast amounts of data, encompassing diverse formats and spanning broad spatial and temporal scales (Borko Furht, 2016; Chen and Yu, 2018). Examples include remote sensing data, geo-tagged datasets, and social media information (Mark Graham, 2013; Chun et al., 2019; Chuan Liao, 2018; Ivan et al., 2017).

Despite its widespread use, the definition of Big Data remains a topic of debate within the scientific community. Among the various approaches to defining Big Data, the "Vs" framework (Variety, Velocity, and Volume) stands out as the most widely accepted. For the purposes of this study, we adopt the definition provided by the European Commission (nd), which aligns with this framework (Li Cai, 2015; Maddalena Favaretto, 2020; Rob Kitchin, 2016; Xiaoyao Han, 2024; Chuan Liao, 2018; Borko Furht, 2016; Hrehova, 2018; Shukla et al., 2015; Alvarez-Dionisi, 2016).

In geographical research, Big Data has emerged as a powerful tool due to its affordability and ability to provide spatio-temporal insights across interdisciplinary subjects. It has enabled significant advancements in fields such as climate modeling, medical geography, and human geography (Borko Furht, 2016; Bao, 2023; Shukla et al., 2015). Specifically, in the context of human geography and natural disaster research, Big Data facilitates the study of human mobility patterns, behavioral responses, and temporal trends (Wu and Ma, 2022; Ginzarly et al., 2018; Longley et al., 2015; Huang and Wong, 2015; Carvalho et al., 2021). These insights are invaluable for optimizing land-use planning and disaster preparedness strategies (Lam et al., 2023; Muniz-Rodriguez et al., 2020; Han et al., 2024; Li et al., 2024).

Human mobility studies utilizing Big Data often rely on text mining and geo-tagged attributes derived from social media or mobile phone data (Borko Furht, 2016). These datasets capture sentiment and location-based movements, offering unique perspectives on mobility dynamics. However, such studies face limitations at smaller spatial scales, such as districts or towns. Researchers must often choose between a detailed spatial analysis with limited temporal scope or broader temporal studies constrained to larger geographic scales (Wu and Ma, 2022; Ginzarly et al., 2018; Longley et al., 2015; Huang and Wong, 2015; Carvalho et al., 2021).

In natural disaster research, social media data is particularly valuable for identifying local clusters of activity and analyzing time series of human mobility (Muniz-Rodriguez et al., 2020; Lam et al., 2023; Huo et al., 2024; Li et al., 2024; Schwaller et al., 2024) . Yet, these datasets are insufficient for understanding mobility impacts at finer spatial scales. Similarly, mobile phone datasets, while offering detailed insights, are often inaccessible due to privacy concerns and commercial restrictions (McKitrick et al., 2023; Poullet, 2020; Heydari et al., 2023).

The Movement Distribution Map (MDM), a dataset provided by Meta for Good (Meta, 2024), offers a promising alternative. This open dataset captures daily mobility patterns at the district level, reflecting the distances traveled by fractions of the population. Unlike traditional datasets, MDM is publicly available and has yet to be extensively utilized in scientific research. Preliminary studies, such as Heydari et al. (2023), have used earlier versions of the dataset for validation purposes, but its full potential remains unexplored.

The February 6, 2023 EQ (EQ) in Turkey and Syria, which affected over 16 million people, provides a critical context for evaluating the relevance of the MDM dataset. Traditional datasets, whether derived from social media or mobile phone records, are limited in their ability to capture the nuanced mobility changes resulting from such large-scale events (Li et al., 2024). By leveraging the MDM dataset, this study aims to fill this gap and provide new insights into population mobility during extreme events.

Therefore the research question of this paper is :

> **How relevant and effective is the use of the Meta database in understanding population mobility during extreme events, such as the February 6, 2023 earthquake in Turkey?**

The main hypothesis is that MDM is accurate in natural disasters with the sensibility of national-wide events like national holidays and summer holidays. In the context of natural disasters, MDM provides a net change in the daily mobility of the population (Meta, 2022). This mobility is mostly changing mainly in the EQ-affected area. This change depends on the vulnerability of the people, the intensity, and the community resilience (Ozer, 2019; Komatsuzaki et al., 2022; W Sharp and W Beadling, 2013; Castillo Betancourt and Zickgraf, 2024; Aguilera and Villagra, 2023; Wang et al., 2024; Yu et al., 2021).

This study is divided into two main parts: Validation of the Meta Database and the analysis of the February 6, 2023 EQ event.

Validation of the Meta Database implies the methodology and results of these part:

- Overview of population mobility patterns.
- Examination of the impact of Laplace noise on the dataset.
- Tests to assess how different events influence daily mobility.

Analysis of the February , 2023 EQ is divided in three main part with their methodologies and their results. Here are the part:

- National Scale: Assessing population reactions to the EQ across Turkey.
- District Scale: Exploring localized mobility responses in affected areas.
- Urban vs. Rural Comparison: Evaluating variations in mobility responses based on geographic and demographic factors.

The study begins with a review of the relevant scientific literature, followed by an overview of the event and study area. After presenting and processing the data, the two main analyses are conducted. The findings are then discussed in relation to existing literature, highlighting the study's limitations and implications. Finally, the conclusion summarizes the key insights and contributions of this research.