Disentangling Population Mobility during Disasters using Digital Trace Data: the case of 2023 Earthquakes in Turkey

Ebru Şanlıtürk[1]

[1]Max Planck Institute for Demographic Research (MPIDR), Department of Digital and Computational Demography

Abstract

This study combines the population and mobility datasets released by the Data for Good initiative of Meta on disaster situations with official register data to explore the potential of their highly granular data in population studies. Focusing on the case of 2023 Earthquakes in Turkey, I aim to first assess the potential of Facebook population data to study disaster-related changes in population size, and second disentangle the different types of mobility streams during disasters. By linking the mobility data with annual data on internal migrations, I aim to reveal patterns and characteristics of different mobility flows in the disaster-time digital trace data, that allow for distinguishing the flows of crisis responders, short-term evacuations, and long-term internal migration flows.

Keywords: Disaster mobility, disaster migration, digital data

1 Introduction

On 6 February 2023, two powerful earthquakes hit Kahramanmaras province in Turkey and destroyed numerous provinces in the southeast region, as well as in neighboring Syrian provinces. The $7.7 M_w$ magnitude earthquake at 04:17 and the $7.4 M_w$ magnitude earthquake at 13:24 local time (GMT +3) together claimed more than 50 thousand lives in Turkey and Syria, injured tens of thousands of people and destroyed thousands of buildings (International Medical Corps, 2023).

Using the 2023 Earthquakes in Turkey as a case study, this work aims to explore the use and validity of digital trace population and mobility data in disasters from a demographic perspective. More specifically, I aim to (i) disentangle the different types of mobility streams during disasters, i.e. relocations, evacuations and crisis response, and (ii) explore the potential of Facebook population data during disasters. For the first aim of the study, I will take advantage of the highly granular *Movement Between Places During Crisis* data by Meta, and seek to identify the time window and volume of outflows from the disaster areas, that correlate with the registered long-term relocations to safer areas. Once the streams of relocations/internal migration, short-term evacuations and mobility of crisis responders are identified, I will map them separately, showcasing their characteristics. Second, I will explore the use of *Facebook Population During Crisis* data by Meta in a context of large-scale catastrophe, considering the challenges of not only human loss and mobility, but also cellular connectivity.

The source of digital trace data in this study is the datasets released by the Data for Good initiative by Meta on crisis situations. I will further use register data to compare digital trace data with the official records of internal migration flows, population size and death counts. Data for Good datasets, especially the mobility data, attracted researchers' attention during the COVID-19 pandemic. Several studies used mobility data from the Data for Good initiative or similar sources to estimate the public health risks of mobility (Spelta et al., 2020), as well as the consequences of mobility restrictions (Bonaccorsi et al., 2020; González-Leonardo et al., 2024). However, despite the supply of special datasets by Data for Good on various disasters and environmental crises, they are more often used for visualizations than academic research. This study will also use descriptive analyses to assess the potential of Facebook population data under disaster conditions. However, this study will also strive to disentangle the granular and messy mobility data, identify different kinds of mobility flows at disaster times, and compare it with the registered internal migration flows. To the extent of my knowledge, this will be the first attempt to link Meta disaster mobility data with the official records of disaster-related changes of residence.

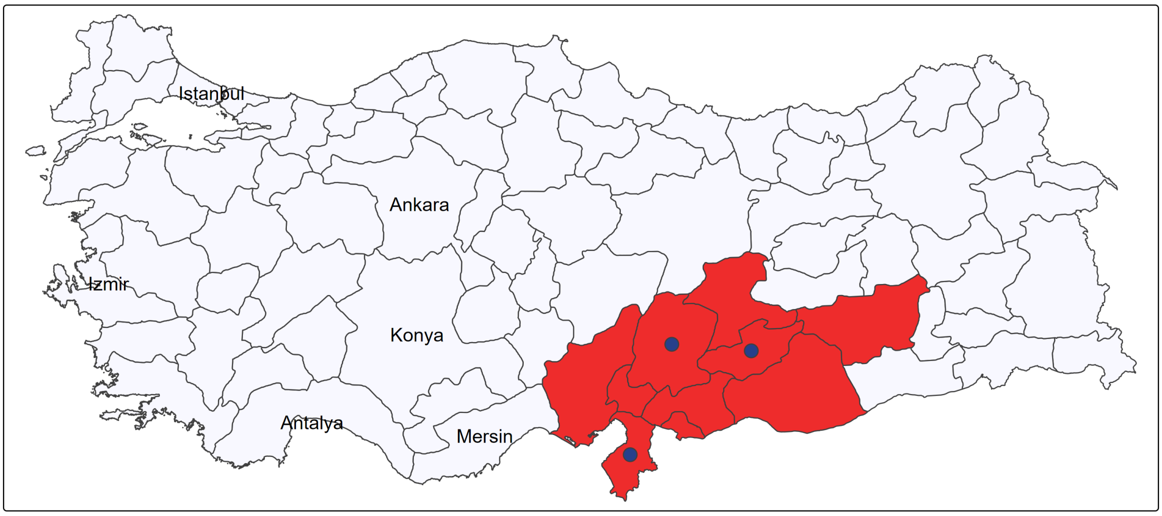

Figure 1: Map of Turkey indicating the ten provinces most-effected by the 2023 Earthquakes with red. The blue dots mark the three provinces with the highest casualties; Hatay (bottom), Kahramanmaras (top-left) and Adiyaman (top-right) respectively. Six large metropolitan provinces are labeled by name that played a key role in both transferring aid & support as well as sheltering the residents of earthquake-affected areas.

2 Data and Methods

2.1 Data

2.1.1 Digital Trace Data: Meta - Data for Good

The digital trace data source in this study come from the Data for Good initiative by Meta. I obtained access to Data for Good database through an institutional agreement with my employer; Max Planck Institute for Demographic Research. Data for Good publishes specific datasets related to major crises and/or disaster situations. The datasets cover the period of the crisis situation, as deemed by Meta, and removed from the database after a certain time. These datasets are typically released in four main categories; *Facebook Population During Crisis*, *Movement Between Places During Crisis*, *Network Coverage* [during Crisis], and *Business Activity Trends During Crisis*. In this study, I will use the first three of these datasets. The datasets on the 2023 Earthquakes in Turkey were released almost simultaneously on the Data for Good platform and were removed in late 2024. I work on saved data.

The data on 2023 Earthquakes in Turkey start with 2023-02-05 00:00 (Pacific Time) and end with 2023-03-06 00:00 (Pacific Time). In local time (GMT +3), this corresponds to 2023-02-05 11:00 am and 2023-03-06 11:00 am. The baseline period of comparisons starts with 22 Dec 2022, 45 days before the crisis as per standard.

The *Facebook Population During Crisis* data "show the number of Facebook users, observed in a location following a crisis compared to a pre-crisis baseline period" (Meta, 2023a). The data is not based on self-reported place of residence, but the information from the Location Services feature. Therefore, only the people who use the mobile Facebook app with the Location Services setting on are counted as the Facebook population.

While this creates an issue of undercounting, it also ensures greater accuracy in terms of location.

The *Movement Between Places During Crisis* data show the aggregate number of Facebook app users, who have turned on the Location Services on their devices, and have moved from one administrative region to another administrative region between 8-hour time windows (Meta, 2023b). The movement data provides high granularity in time, which will be beneficial in disentangling evacuations from crisis response movement.

The *Network Coverage* data show whether Facebook users have cellular connectivity at a Bing-tile grid level (Meta, 2023c). This information is especially useful for observing the time and location of connection interruptions. While the *Facebook Population During Crisis* data and *Movement Between Places During Crisis* data will be the key data for the analyses on Facebook population and crisis-related movements respectively, the *Network Coverage* data will be used as input for the Facebook population analysis.

2.1.2 Register Data

The register data will be used primarily to account for the official internal migration figures (TurkStat, 2025b). Annual international migration data are based on self-reported address registers. Although they might suffer from under-reporting, they are still the most reliable traditional data source that also includes migration reason and allows for comparison with previous years. Data for 2023 and 2024 are currently available[1], where disaster-related outmigrations can be traced for 2023, as well as return migrations in the following year, 2024.

Additionally, population (TurkStat, 2025a) and mortality (TurkStat, 2025c) data for 2023 and 2024 will be used in the comparisons between the actual population and the Facebook population.

2.2 Methods and Expected Outcomes

The purpose of this study is to analyze the *Movement between Places during Crisis* data by the Meta - Data for Good initiative and to disentangle the migratory movements from the movements of crisis response. Data from Meta are highly granular regarding both time and location, however, the internal data that will be used for validation is available at province level. As the number of observations for ten provinces a year would not allow advanced statistical analyses, the intended method is to identify statistically significant correlations between evacuations from earthquake-affected areas and official internal migration flows. I will focus more on the distance (proximity to the origin province) and timing (daily movements out of the then affected provinces) of evacuations that turn into internal migration flows, i.e. change of residence for at least one year. Identifying these correlations would thus disentangle the often circulatory crisis-response flows from long-term evacuations and would be informative for policy-makers in future disaster situations. Based on the findings of this analysis, I will map the migratory movements and crisis response movements observed in the Facebook data separately.

[1]Data for each year are released in July-August of the next year.

I will also analyze the change in the Facebook population during the observable crisis period (5 February 2023 to 9 May 2023) in order to assess the suitability of using Facebook population estimates under the conditions of severe network disruptions, mass casualties, and movements of crisis responders. However, loss of mobile devices is another potential reason that may be responsible for an apparent decrease in population, which might bias estimates and lower the suitability of the data source. Meta's *Network Coverage* data will be the main input for network disruptions. Similarly, Meta' *Movement between Places during Crisis* data will be used to track the movements of first responders and aid workers. To account for the reduction in the general (and Facebook) population, official data of the number of earthquake-related deaths will be used.

2.3 Preliminary Outlook

Tables 1 and 2 in the Appendix show the change in the Facebook population in four different districts of Hatay, the province hit by the earthquake the hardest. Table 1 shows three different districts; Samandag, Iskenderun, and Merkez which have experienced high numbers of casualties and extensive damage to the infrastructure. Samandag is a relatively smaller and more rural district compared to the other two, Iskenderun is the district that hosts one of the largest harbors in Turkey, and Merkez is the central and most-populated district of Hatay, also known as Antakya (Antioch). The Erzin district in Table 2, also a small and more rural district, has experienced minimal damage relative to the other three in Table 1.

In both tables, the time and date indicated in the *Facebook Population During Crisis* data (Pacific Time) and the corresponding local time (GMT +3) in the last column. "N Baseline" stands for the estimated Facebook population 45 days before the start of the disaster/crisis, also accounting for the day of the week. "N Crisis" refers to the Facebook population at the indicated date and time. The difference between the baseline and crisis time point is shown in column 5. The "% Change" indicates the percent change in the Facebook user population counts per region. The approximate time window of the hot of the first earthquake on 6 February 2023 is marked bold.

The difference between the pattern of change in the Facebook population in Erzin (Table 2) and other three districts is striking. Although Erzin also experienced a sharp decline just around the time of the earthquake, it quickly recovered within the same day, suggesting that the decline was possibly due to a problem in connectivity rather than an actual loss of people and/or damage to their mobile devices. It is observed that the Facebook population in Erzin has increased by 25% one week after the earthquake and 37% one month after the earthquake, which could indicate that Erzin district started to host residents of earthquake affected-districts and/or crisis responders as a relatively safe area within the province. In the case of Iskenderun, the decline in the Facebook population has been so sharp that even one month after the earthquake the population could not reach the baseline level, even though the Iskenderun harbor was used by the crisis responders[2]. The situation of the Facebook population appears to be the worst in the central district Antakya (Merkez), which reflects the fact that Antakya was overall the worst-hit district by the earthquake.

[2]Hatay Airport was severely damaged by the earthquake. Highways in Hatay were also destroyed. Despite certain damages in the harbor, Iskenderun was used for the transfer of aid and first responders.

2.4 Appendix

Table 1: Comparison of Three Hatay Districts

District	Date & Time	N Baseline	N Crisis	Difference	% Change	Local Time
Samandag	Feb 5 00:00	6,035.25	6,106	70.75	1.17	Feb 05 11:00
Samandag	Feb 5 08:00	5,408.29	5,172	−236.29	−4.37	Feb 05 19:00
Samandag	**Feb 5 16:00**	**3,942.25**	**599**	**-3,343.25**	**-84.78**	**Feb 6 03:00**
Samandag	Feb 6 00:00	5,609.46	397	−5,212.46	−92.91	Feb 6 11:00
Samandag	Feb 6 08:00	5,415.46	600	−4,815.47	−88.90	Feb 6 19:00
Samandag	Feb 6 16:00	3,894.92	382	−3,512.92	−90.17	Feb 7 03:00
Samandag	Feb 7 00:00	5,556.77	412	−5,144.77	−92.57	Feb 7 11:00
Samandag	Feb 8 00:00	5,529.23	685	−4,844.23	−87.60	Feb 8 11:00
Samandag	Feb 9 00:00	5,553.69	868	−4,685.69	−84.36	Feb 9 11:00
Samandag	Feb 10 00:00	5,554.77	1,760	−3,794.77	−68.30	Feb 10 11:00
Samandag	Feb 13 00:00	5,609.46	3,637	−1,972.46	−35.16	Feb 13 11:00
Samandag	Feb 20 00:00	5,609.46	5,011	−598.46	−10.67	Feb 20 11:00
Samandag	Feb 27 00:00	5,609.46	4,622	−987.46	−17.60	Feb 27 11:00
Samandag	Mar 6 00:00	5,609.46	5,384	−225.46	−4.02	Mar 6 11:00
Iskenderun	Feb 5 00:00	24,872.67	25,274	401.33	1.61	Feb 05 11:00
Iskenderun	Feb 05 08:00	23,986.30	23,839	−147.30	−0.61	Feb 05 19:00
Iskenderun	**Feb 05 16:00**	**15,795.83**	**4,575**	**-11,220.83**	**-71.03**	**Feb 6 03:00**
Iskenderun	Feb 06 00:00	24,052.85	4,841	−19,211.85	−79.87	Feb 6 11:00
Iskenderun	Feb 06 08:00	24,058.41	7,587	−16,471.41	−68.46	Feb 6 19:00
Iskenderun	Feb 06 16:00	15,868	7,063	−8,81	−55.49	Feb 7 03:00
Iskenderun	Feb 07 00:00	23,878.77	10,991	−12,887.77	−53.97	Feb 7 11:00
Iskenderun	Feb 08 00:00	23,797.15	15,363	−8,434.15	−35.44	Feb 8 11:00
Iskenderun	Feb 09 00:00	23,814.46	18,551	−5,263.46	−22.10	Feb 9 11:00
Iskenderun	Feb 10 00:00	23,542.62	18,713	−4,829.62	−20.51	Feb 10 11:00
Iskenderun	Feb 13 00:00	24,052.85	19,576	−4,476.85	−18.61	Feb 13 11:00
Iskenderun	Feb 20 00:00	24,052.85	19,557	−4,495.85	−18.69	Feb 20 11:00
Iskenderun	Feb 27 00:00	24,052.85	20,333	−3,719.85	−15.47	Feb 27 11:00
Iskenderun	Mar 06 00:00	24,052.85	21,489	−2,563.85	−10.66	Mar 6 11:00
Merkez	Feb 05 00:00	41,638	44,187	2,55	6.12	Feb 05 11:00
Merkez	Feb 05 08:00	40,056.51	41,091	1,034.49	2.58	Feb 05 19:00
Merkez	**Feb 05 16:00**	**27,921.58**	**4,302**	**-23,619.58**	**-84.59**	**Feb 6 03:00**
Merkez	Feb 06 00:00	41,961	1,920	−40,041	−95.42	Feb 6 11:00
Merkez	Feb 06 08:00	40,578.19	2,415	−38,163.19	−94.05	Feb 6 19:00
Merkez	Feb 06 16:00	28,069.62	1,953	−26,116.62	−93.04	Feb 7 03:00
Merkez	Feb 07 00:00	41,784.33	2,551	−39,233.33	−93.89	Feb 7 11:00
Merkez	Feb 08 00:00	41,472.69	5,140	−36,332.69	−87.60	Feb 8 11:00
Merkez	Feb 09 00:00	41,380.61	8,371	−33,009.61	−79.77	Feb 9 11:00
Merkez	Feb 10 00:00	40,995.31	10,149	−30,846.31	−75.24	Feb 10 11:00
Merkez	Feb 13 00:00	41,961	11,193	−30,768	−73.32	Feb 13 11:00
Merkez	Feb 20 00:00	41,961	16,069	−25,892	−61.70	Feb 20 11:00
Merkez	Feb 27 00:00	41,961	16,701	−25,260	−60.20	Feb 27 11:00
Merkez	Mar 06 00:00	41,961	17,320	−24,641	−58.72	Mar 6 11:00

Table 2: Example of a Less-affected District in Hatay

District	Date & Time	N Baseline	N Crisis	Difference	% Change	Province
Erzin	Feb 05 00:00	$3,230.84$	$3,354$	123.16	3.81	Feb 05 11:00
Erzin	Feb 05 08:00	$2,982.78$	$3,083$	100.23	3.36	Feb 6 19:00
Erzin	**Feb 05 16:00**	**2,501.50**	**1,687**	**-814.50**	**-32.55**	**Feb 6 03:00**
Erzin	Feb 06 00:00	$3,954.77$	$3,278$	-676.77	-17.11	Feb 6 11:00
Erzin	Feb 06 08:00	$3,234.62$	$3,432$	197.39	6.10	Feb 6 19:00
Erzin	Feb 06 16:00	$2,565.54$	$2,613$	47.46	1.85	Feb 7 03:00
Erzin	Feb 07 00:00	$3,988.46$	$3,626$	-362.46	-9.09	Feb 7 11:00
Erzin	Feb 08 00:00	$3,955.08$	$4,070$	114.92	2.91	Feb 8 11:00
Erzin	Feb 09 00:00	$3,942.54$	$4,344$	401.46	10.18	Feb 9 11:00
Erzin	Feb 10 00:00	$3,884.92$	$4,607$	722.08	18.58	Feb 10 11:00
Erzin	Feb 13 00:00	$3,954.77$	$4,950$	995.23	25.16	Feb 13 11:00
Erzin	Feb 20 00:00	$3,954.77$	$5,162$	$1,207.23$	30.52	Feb 20 11:00
Erzin	Feb 27 00:00	$3,954.77$	$5,337$	$1,382.23$	34.94	Feb 27 11:00
Erzin	Mar 06 00:00	$3,954.77$	$5,428$	$1,473.23$	37.24	Mar 6 11:00

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