

Transforming humanitarian assistance through geographic data science

As conflict disasters and climate change drive record levels of internal displacement worldwide, researchers at the University of Liverpool's Geographic Data Science Lab are working with the International Organization for Migration to harness digital data and real-time analytics to transform how humanitarian crises are monitored and responded to.

Internal displacement is one of the most pressing humanitarian challenges of our time. At the end of 2024, a record 83.4 million people were living in internal displacement worldwide, having been forced to flee their homes due to conflict, violence, persecution or disasters. The global number of internally displaced people is predicted to grow over the coming years as wars, climate change and pandemics uproot communities around the world with increasing frequency and speed.

Harnessing geographic data science

The scale of the crisis highlights the urgent need for innovative, data-driven solutions to track and understand displacement dynamics to help some of the most vulnerable people in the world. The Geographic Data Science Lab (GDSDL) at the University of Liverpool and the International Organization for Migration (IOM) at the United Nations have been working in partnership to transform how displacement crisis is measured, understood and acted upon.

Traditional data collection methods, such as household surveys, administrative records and registration systems, remain essential pillars of crisis responses for humanitarian agencies and organisations. Yet when disasters strike and populations move, these data systems are frequently stretched, delayed or absent where and when they are needed most, creating a

gap between the pace of displacement and the pace of knowledge about the crisis.

This gap leaves policymakers and humanitarian agencies working from incomplete pictures at precisely the moments when accurate, real-time, granular evidence is critical to effective policy decision making and humanitarian response coordination. The collaboration between GDSDL and IOM was founded on a shared conviction that this gap could be narrowed to improve outcomes for the tens of millions of internally displaced people worldwide using geographic data science.

Geographic data science sits at the intersection of social science, computational science and spatial analysis. It bridges expertise from geography, statistics, computer science, economics and public health to transform large and complex datasets into meaningful evidence about people and places.

Humanitarian agencies often face difficult decisions about where to deploy resources, establish shelters, distribute aid or provide healthcare services. By providing more timely and geographically precise information, geographic data science offers new opportunities to understand crises as they unfold, rather than weeks or months afterwards, improving the capacity of humanitarian organisations to effectively identify emerging needs and allocate support.



Professor Francisco Rowe

Professor in Population Data Science, Lead of the Geographic Data Science Lab, University of Liverpool



Dr Elisabetta Pietrostefani

Senior Lecturer in Geographic Data Science, Deputy Lead of the Geographic Data Science Lab, University of Liverpool



Dr Carmen Cabrera

Senior Lecturer in Geographic Data Science, University of Liverpool

Triangulating digital trace and traditional data for displacement monitoring

Together, the GDSDL and IOM teams explored how digital trace data, including mobile phone GPS signals, social media activity, internet traffic and other passively generated data streams, can complement and strengthen traditional humanitarian data systems. To do this, GDSDL connected its frontier methods in geographic data science to the IOM's operational realities of humanitarian response, where evidence must be timely, trusted and actionable.

Rather than treating these new data sources as replacements, the collaboration between GDSDL and IOM has developed methods for triangulating diverse data streams, using each to validate and enrich the others. Crucially, the partnership has built a more responsible model for the use of digital trace data. The model recognises and addresses bias and uncertainty in this type of data, ensures privacy protection, provides accurate contextual interpretations and establishes clear governance frameworks.

Co-developing these transparent methodologies is essential to maintain public trust in digital trace data for humanitarian support.

The partnership's work is reshaping how displacement during disasters is estimated at a global scale. It has

informed the practices of international agencies and contributed to emerging standards for digital data use in humanitarian contexts. Drawing lessons from recent crises, such as the war in Ukraine and the 2022 floods in Pakistan, the team have created a scalable framework for integrating real-time, high-resolution data into humanitarian decision-making. It provides technical insights, open datasets and replicable methodologies to support global efforts in building resilient, rights-based solutions for displaced populations while maintaining the standards of validation, accountability and protection required in displacement contexts.

Experts from the GDSL team have also recently contributed to emerging international standards on the responsible use of mobile phone data for official statistics, including a new UN manual, Design and Implementation of Mobile Phone Data Initiatives. Developed by the Mobile Phone Data Task Team of the United Nations Committee of Experts on Big Data and Data Science for Official Statistics, the manual highlights how mobile phone data can generate valuable insights into population mobility, disaster response, migration, transport and digital society, while emphasising the importance of strong governance, privacy protection, quality assurance and trusted partnerships.

A real-time picture of displacement in Iran

Since strikes began in late February 2026, millions of Iranians have been living under conditions of active conflict and severely restricted communications, with limited access for journalists and humanitarian agencies. In situations like this, large-scale population movement is expected. Yet in Iran, the scale and shape of that movement has remained almost entirely hidden. In an information blackout, with internet access almost completely shut down across Iran, building a detailed picture of this population movement to swiftly act and support displaced people has been a major challenge for humanitarian agencies.

In the absence of conventional data on internal population displacement in Iran, the GDSL team have been piecing

together where people are moving by looking at faint but persistent signals of internet activity. Weeks of active hostilities and Iran's tight information controls closed off most of the usual population statistics typically used to monitor population movements, so the team developed a model translating internet traffic requests to population numbers.

GPS-based mobile data and Meta's population maps have been useful in other crises, but for Iran, they are unavailable. Instead, the digital trace-data source was Cloudflare Radar, a US-based content delivery network which publishes aggregated, anonymised counts of encrypted web requests passing through its network, broken down by province.

Despite the widespread internet shutdowns, some weak internet signal remained which enabled estimation of population numbers at the sub-national level in near real time. We compared these numbers with a baseline control set in December 2025 to assess increases and decreases in population during each day of the year, adjusting for network shocks and coverage, and cross-checked the patterns against Farsi Wikipedia pageviews for border regions and against recorded strike locations. More requests than usual is a tentative signal that more people are present and online. Fewer requests may suggest fewer people or less activity.

The GDSL team published an analysis and situation report in March 2026, covering the war since its outbreak which showed a clear geographic pattern and timeline of movement. The findings pointed humanitarian agencies to three pressure points in Iran: the northwestern border corridor, the provinces adjoining Afghanistan and Tehran's hinterland. This was one of the first near real-time pictures of displacement within Iran, complementing cross-border figures from the UN IOM team.

The data offers a partial but very important view of movement inside the country, where conventional methods of counting displaced people have largely broken down, helping humanitarian agencies to respond faster and more effectively.

Transforming humanitarian assistance

As displacement continues to rise globally, policymakers require tools capable of operating at the speed and scale of modern crises. Geographic data science offers a solution by transforming vast quantities of information into operational intelligence that can inform humanitarian planning and response. But this is not simply about developing new analytical techniques. It is about creating better evidence for effective action. As crises become more dynamic and interconnected, governments and humanitarian organisations will require increasingly sophisticated capabilities to monitor displacement, anticipate needs and coordinate responses.

For the UK, this work demonstrates how investment in data science research can generate practical tools that support international humanitarian action, strengthen evidence-based decision-making and contribute to global stability.

Building the future of humanitarian assistance

The challenge now is to ensure that these innovations are translated into practice. This will require continued investment in research, stronger partnerships between academia and humanitarian organisations, and robust governance frameworks that ensure data are used responsibly and ethically. The GDSL team is engaging with relevant units within Foreign, Commonwealth & Development Office (FCDO) to support model initiatives, such as the ones deployed in Iran, to assist their own policy discussions.

The promise of geographic data science lies in its ability to transform new insights into positive impact. By combining traditional expertise with new forms of digital evidence, it offers a pathway towards more responsive, targeted and effective humanitarian assistance. At a time when displacement is affecting millions of people worldwide, that capability is no longer a technological luxury; it is becoming a humanitarian necessity.