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Using GIS to understand how humanitarian aid moves
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Over the last three decades, an increasingly formal and bureaucratic aid industry seeking stronger empirical grounds for their distribution and denial of aid in the Middle East has turned to geospatial data. Geographic information systems have been used to support flood preparedness, food security operations, shelter placement, and identify populations underserved by existing health services. As the Covid-19 pandemic highlights and exacerbates existing political and social inequalities in the politics of care and control, there are opportunities to learn from efforts to map hazard, exposure, and vulnerability by humanitarians, as well as scholars of health and conflict. In this piece, I describe how geospatial analysis and mapping are being used to explore humanitarian health response in the Middle East and amongst refugees more particularly. I identify pathways to collecting and analysing spatial data in response to three challenges political scientists might face: difficulty measuring baseline needs or specifying vulnerable groups, gathering data sub-nationally, and incorporating non-geographic features into spatial analysis. I then discuss the ethical implications of an accelerated mapping of vulnerable groups 'from above' due to the global pandemic.

Using GIS to Understand Need

Research on health during humanitarian crises has historically been limited, particularly in the Middle East where conflict and population displacement complicate data collection.[1] Scholars trying to measure the initial health status and needs of displaced populations and to specify vulnerable populations in conflict settings and during flight can face difficulties establishing a baseline understanding of humanitarian health needs. Such a baseline can be vital in the evaluation of health interventions and analysis of aid accountability and effectiveness, since meeting these needs should be the aim of organisations working in the health sector.

In the context of response to Syrian refugee needs in Lebanon, one approach to overcoming these challenges has been to use the United Nations High Commissioner for Refugees registration and vulnerability assessments in combination with convenience sampling to identify those who need care.[2] However, this method can exclude some of the most

[1] Karl Blanchet et al., "Evidence on Public Health Interventions in Humanitarian Crises," *The Lancet* 390, no. 10109 (November 2017): 2287–96; Francesco Checchi et al., "Public Health Information in Crisis-Affected Populations: A Review of Methods and Their Use for Advocacy and Action," *The Lancet* 390, no. 10109 (November 2017): 2297–2313; Udani Samarasekera and Richard Horton, "Improving Evidence for Health in Humanitarian Crises.," *Lancet (London, England)* 390, no. 10109 (2017): 2223–24; Ronald J Waldman and Michael J Toole, "Where Is the Science in Humanitarian Health?," *The Lancet* 390, no. 10109 (2017): 2224–26; Sandro Colombo and Enrico Pavignani, "Recurrent Failings of Medical Humanitarianism: Intractable, Ignored, or Just Exaggerated?," *The Lancet* 390, no. 10109 (2017): 2314–24.
[2] UNHCR, UNICEF, and WFP, "VASYR 2019 - Vulnerability Assessment of Syrian Refugees in Lebanon" (UNHCR, Government of Lebanon, 2019); Emily Lyles et al., "Health Service Utilization and Access to

vulnerable people of concern from study, including unregistered refugees and those whose vulnerabilities are less visible.[3] It also relies on a vulnerability assessment and scale, designed by the UNHCR and its partners in Jordan and Lebanon, that assesses needs based on these organisations' perceptions and values surrounding those whose needs and exposure to potential harm matter.

GIS sampling using aerial tools and population data, as opposed to government or international organization registries, is a promising alternative to using UNHCR-assessed need as a baseline. It increases the probability of including unregistered groups in studies and allows scholars to develop their own proxies for measuring need. It has been used to improve sampling where there is no census, populations move, or where in-person surveys are dangerous.[4] Scholars of health and conflict have generated gridded population counts and surveyed mortality using spatial population data to study the impact of conflict on health in Iraq.[5] Others have drawn on aerial geographic information, using LandScan, WorldPop, or UNOSAT services, to assess degrees of coverage in the delivery of health care[6] and gaps in utilization of health care services in Lebanon.[7]

Collecting Geospatial Data

Due to humanitarian interest in more empirically grounded practice, as well as efforts to make operations and outcomes more quantifiable and legible to outside funders, geospatial data for humanitarian sectors is increasingly available. Scholars of health, conflict, and aid can explore UNOSAT (UN Operational Satellite Applications Programme), UN OCHA's Humanitarian Data Exchange and Humanitarian Response, WHO, and UNHCR geocoded data. They can also consult experts at the UN Open GIS Initiative.[8]

Medicines among Syrian Refugee and Host Community Children in Lebanon," *Journal of International Humanitarian Action* 1, no. 1 (2016): 1–13; Nupur Kukrety and Sarah Al-Jamal, "Poverty, Inequality, and Social Protection in Lebanon," *Social Justice and Development Policy in the Arab World*, 2016.

[3] Maja Janmyr and Lama Mourad, "Categorising Syrians in Lebanon as' Vulnerable'," *Forced Migration Review*, no. 57 (2018): 19–21.

[4] Stephanie Eckman and K. Himelein, "Methods of Geo-Spatial Sampling," in *Data Collection in Fragile States Innovations from Africa and Beyond*, ed. Johannes Hoogeveen and Utz Pape (Washington, DC: Palgrave Macmillan, 2020), Chapter 7: 103-128.

[5] Lp Galway et al., "A Two-Stage Cluster Sampling Method Using Gridded Population Data, a GIS, and Google EarthTM Imagery in a Population-Based Mortality Survey in Iraq," *International Journal of Health Geographics* 11, no. 1 (2012): 12.

[6] Enrica Leresche et al., "Conducting Operational Research in Humanitarian Settings: Is There a Shared Path for Humanitarians, National Public Health Authorities and Academics?" *Conflict and Health* 14, no. 1 (December 2020): 25; Claudia Truppa et al., "Utilization of Primary Health Care Services among Syrian Refugee and Lebanese Women Targeted by the ICRC Program in Lebanon: A Cross-Sectional Study," *Conflict and Health* 13, no. 1 (December 2019): 7.

[7] Truppa et al., "Utilization of Primary Health Care Services among Syrian Refugee and Lebanese Women Targeted by the ICRC Program in Lebanon."

[8] UNOSAT, "UNITAR Operational Satellite Applications Programme (UNOSAT)," United Nations Office for Outer Space Affairs / UN-SPIDER, 2000, https://www.un-spider.org/space-application/emergency-mechanisms/unitar-operational-satellite-applications-programme-unosat; OCHA Services, "The Humanitarian Data Exchange," HDX, n.d., https://data.humdata.org/; OCHA Services, "Humanitarian Response," OCHA Services, n.d., https://www.humanitarianresponse.info/; WHO, "The Global Health Observatory," World Health Organization, n.d., https://www.who.int/data/gho/map-gallery; UNHCR,

However, a second challenge for the study of humanitarian health response arises because of a traditional focus on international and national levels of analysis, as well as data collection efforts that tend to stop at the level of the state. Data available through the United Nations Financial Tracking Service and provided by major donors, such as USAID and the European Union, provides a very limited picture of global aid once it flows *below* the state. This is particularly true in the Middle East, which is not yet included in efforts by groups like Aid Data to disaggregate and geocode data at sub-national levels.

Political scientists interested in analysis below the state may need to collect their own geospatial data. In health and humanitarianism, there has been an uptick in the use of volunteered geographic information (VGI). For example, hand-held GPS technology has been used to support response to complex emergencies,[9] including in refugee camp settings.[10] The UNHCR's RefuGIS project supported refugee creation of GIS data in Zaatari refugee camp in Jordan.[11]

Alternatively, in my current work, I assess the feasibility of using the location of humanitarian project sites as a proxy for funding flows and as a solution to this level-of-analysis problem. I use systematic content analysis of organizational reports and interviews, focusing on locations of health projects, their movement (opening/closure) over time, as well as budgets, funding sources, and nature of activities to build a geocoded dataset of *where* aid goes.

Not All Politics are Geopolitics

My research focuses on why we see variation in distributions of global health aid within states, with some refugees receiving aid while others are denied. I am interested in the role interactions between humanitarian, sovereign, and non-state actors play in shaping these patterns. My preliminary research indicates that aid workers are more likely to identify and respond to needs where they have preferred relationships with state and non-state actors and that these preferences vary across organizations. For example, my ethnographic and interview-based research in Lebanon and Jordan shows aid workers at one INGO were more likely to take on new activities among populations who had lived under Islamic State rule, while at another organization aid workers did more to justify activities where the Jordanian state was strongest.

"Geoservices," Operational Portal Refugee Situations, n.d., https://data2.unhcr.org/en/geoservices/; UN, "UN Open GIS Initiative," UN Open GIS, n.d., http://unopengis.org/unopengis/main/main.php.

[9] Firoz Verjee, "The Application of Geomatics in Complex Humanitarian Emergencies," 2005.

[10] Delf Rothe, Christiane Fröhlich, and Juan Miguel Rodriguez Lopez, "Digital Humanitarianism and the Visual Politics of the Refugee Camp: (Un)Seeing Control," *International Political Sociology*, October 27, 2020; Petra Füreder et al., "Earth Observation and GIS to Support Humanitarian Operations in Refugee/IDP Camps.," 2015.

[11] Brian Tomaszewski et al., "Using Geographic Information Systems (GIS) in Za'atari Refugee Camp, Jordan for Refugee Community Information Management and Mobilization: The RefuGIS Project," in *2017 IEEE Global Humanitarian Technology Conference (GHTC)* (2017 IEEE Global Humanitarian Technology Conference (GHTC), San Jose, CA: IEEE, 2017), 1–10.

However, a third challenge to using GIS emerges in analysing geographic features—like the spatial distribution of global health aid—alongside non-geographic factors—such as relationships amongst state and non-state health service providers. Scholars have been warned not to use GIS to "over-territorialize" analysis,[12] by representing interactions between people in networks or alliances as if they occupy an area with closed boundaries (using polygons) or borders as if they are hard where they are porous (using lines). There are strong examples of scholarship that avoids this trap. Starr disaggregates borders to analyze how they constrain and facilitate interaction and shape territorial disputes.[13] Tomaszewski points to the role GIS can play in analysing the spatial configuration of refugee camps and relationships to institutions and environments.[14]

Cluster Analysis and Hotspots

I turn to cluster analysis to bring geographic features "back in" to political science and help to integrate geographic and non-geographic features in my analysis. This type of analysis has the potential to answer questions about where aid goes, how closely aid follows the movement of populations that are most in need, the extent to which aid dollars flow beyond capital and major cities, and more. Cluster analysis supports the collection of spatial data and the development of understandings and/or hypotheses about geographic patterns. It can also reveal processes or mechanisms underlying geographic distributions.

A cluster can be thought of as an excess of events (such as a higher concentration of population or illness) or values (like a higher concentration of drought conditions) in a particular location.[15] Spatial clusters "pinpoint locations of statistically significant high- and low-value clusters of a phenomenon of interest" by assessing how likely it is that features are shared in neighbouring locations.[16]

Cluster analysis allows for scholars to scan their data for spatial autocorrelation (using Global Moran's I or Global Getis-Ord General G in ArcMap) and determine if characteristics are geographically linked. Areas are identified as statistically different from an assumed random geographic assortment of data or can be compared to a geographic control feature, such as the distribution of population. Should a phenomenon be found to have a geographic component, one can then identify the most relevant neighbourhoods, where particular phenomena are prevalent or absent (using Local Moran's I or Local Getis-Ord Gi*). These

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[12] Jordan Branch, "Geographic Information Systems (GIS) in International Relations," *International Organization* 70, no. 4 (2016): 854.
[13] Harvey Starr, "Opportunity, Willingness and Geographic Information Systems (GIS): Reconceptualizing Borders in International Relations," *Political Geography* 21, no. 2 (2002): 243–61.
[14] Brian Tomaszewski, *Geographic Information Systems (GIS) for Disaster Management* (Routledge, 2020).
[15] Geoffrey M Jacquez, "Spatial Cluster Analysis," in *The Handbook of Geographic Information Science*, ed. S. Fotheringham and J. Wilson (Blackwell Publishing, 2008), 395–416; Lance A Waller and Geoffrey M Jacquez, "Disease Models Implicit in Statistical Tests of Disease Clustering," *Epidemiology*, 1995, 584–90.
[16] Thomas J. Stopka et al., "Use of Spatial Epidemiology and Hot Spot Analysis to Target Women Eligible for Prenatal Women, Infants, and Children Services," *American Journal of Public Health* 104, no. S1 (February 2014): 183; J. K. Ord and Arthur Getis, "Local Spatial Autocorrelation Statistics: Distributional Issues and an Application," *Geographical Analysis* 27, no. 4 (September 3, 2010): 286–306.

methods have been used to identify risk "hotspots" where populations are vulnerable to hazards[17] or exposed to environmental, demographic, and cultural factors.[18]

In my work, I am exploring aid distribution in Lebanon as hot spots, cold spots, and spatial outliers and their spatial proximity to factors I expect to drive that distribution. For example, I look at how closely aid aligns with distributions of populations in need, the presence of other service providers, histories of violence, or patterns of state or non-state control. By comparing this with the possibility that aid is distributed as if randomly amongst refugees around the country, I aim to determine the factors most relevant to questions of *where* humanitarian actors engage in a politics of care and control.

The Ethics of Mapping in Light of the Covid-19 Pandemic

As Covid-19 strikes countries in the Middle East that are already suffering through long-term humanitarian crises, mapping of vulnerable populations is accelerating. Like other countries in the region, Lebanon and its Ministry of Public Health have responded by partnering with ESRI Lebanon and the World Health Organization to map the spread of Covid-19 and its movement across districts.[19] Humanitarian organizations pursuing additional funds are also contributing to a growing use of GIS. It can help them to make activities more quantifiable and externally verifiable to state donor agencies, like the European Union, USAID, or UKAID.[20]

Proponents suggest GIS will help with monitoring humanitarian needs and issues of access from a distance,[21] which is becoming even more common because of the global pandemic. However, mapping can also exacerbate existing inequalities[22] between those who create knowledge and those who are made subjects. It can become data-centric, fail to represent local, lived realities[23] or make events like migration or war appear technical.[24] It can give the

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[17] David A Ortiz, "Geographic Information Systems (GIS) in Humanitarian Assistance: A Meta-Analysis," *Pathways: A Journal of Humanistic and Social Inquiry* 1, no. 2 (2019): 4.
[18] Sudipto Banerjee, "Spatial Data Analysis," *Annual Review of Public Health* 37, no. 1 (March 18, 2016): 47–60; P. Gregg Greenough and Erica L. Nelson, "Beyond Mapping: A Case for Geospatial Analytics in Humanitarian Health," *Conflict and Health* 13, no. 1 (December 2019): 50.
[19] Mohammad Hammoud, "Lebanon MoPH Creates COVID-19 Public Portal," Kapcite, 2020.
[20] Dan Honig, *Navigation by Judgment: Why and When Top down Management of Foreign Aid Doesn't Work* (Oxford University Press, 2018).
[21] Kristin Bergtora Sandvik et al., "Humanitarian Technology: A Critical Research Agenda," *International Review of the Red Cross* 96, no. 893 (2014): 219–42; Patrick Meier, "New Information Technologies and Their Impact on the Humanitarian Sector," *Int'l Rev. Red Cross* 93 (2011): 1239.
[22] David Campbell, "Satellite Images, Security and the Geopolitical Imagination," in *From Above*, ed. Peter Adey, Mark Whitehead, and Alison Williams (Oxford: Oxford University Press, 2014), 289–98; Mark Duffield, "The Resilience of the Ruins: Towards a Critique of Digital Humanitarianism," *Resilience* 4, no. 3 (2016): 147–65.
[23] Delf Rothe and David Shim, "Sensing the Ground: On the Global Politics of Satellite-Based Activism," *Review of International Studies* 44, no. 3 (2018): 414. This issue is also discussed at length in Ahmad Gharbieh's contribution to this symposium.
[24] Huub Dijstelbloem, "Migration Tracking Is a Mess," *Nature News* 543, no. 7643 (2017): 32; Ryan Burns, "Rethinking Big Data in Digital Humanitarianism: Practices, Epistemologies, and Social Relations," *GeoJournal* 80, no. 4 (2015): 477–90.

appearance of thoroughness by wrapping up complex social, economic, and political processes in the neat little bows of borders.[25] What is more, efforts to predict the movement of people or to identify the locations of aid activities can be made into political tools and endanger people in flight or in need of care. This information in the wrong hands could be used, for example, to direct armed forces to locations where refugees are likely to be or to help redirect migrants to unsafe areas.

For these reasons, GIS is often best used as a complement to field-driven research.[26] Field work can provide researchers with the contextualized knowledge they need to ask better questions, collect better data, and draw more interesting and measured conclusions. Additionally, it can help them identify and address the ethical stumbling blocks that accompany the making of maps. As Covid-19 limits opportunities to conduct field work and encourages increased use of geographic information gathered from afar, scholars will need to be more transparent and guard more carefully against these limitations.

Conclusion

Geocoded data and geographic information systems offer a valuable way to explore how health care and aid resources are distributed in the Middle East. It has the potential to improve analysis of the geographic factors that shape aid accountability and effectiveness, particularly as a complement to other field-based methods. The use of geocoded data is challenging and has limitations, particularly when that data is collected by practitioners who see and represent people, crises, and needs in particular ways. Yet, GIS also has the potential to help political scientists understand how global aid moves through local spaces and areas of conflict and crisis.

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[25] Branch, "Geographic Information Systems (GIS) in International Relations."
[26] Chris Brennan-Horley et al., "GIS, Ethnography, and Cultural Research: Putting Maps Back into Ethnographic Mapping," *The Information Society* 26, no. 2 (February 18, 2010): 92–103.