Geospatial Research in Settings of Contested Sovereignty

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Contests over the territorial sovereignty of states have been, and will continue to be, a prominent feature of politics in the MENA region. Globally, between 2011 and 2019, 64 out of 99 armed conflicts recorded in the UCDP/PRIO Armed Conflict Dataset (version 20.1) were over the status of territory.[1] Among them were conflicts spanning 12 countries in the MENA region, including well-known, protracted conflicts (Israel/Palestine) and internationalized civil wars (Syria, Libya, and Yemen); episodic violence against Islamic State affiliates (Algeria, Egypt, Iran, Jordan, Lebanon, and Tunisia); Kurdish separatist conflict in Turkey and Iran; and the end of a war of secession from Sudan.[2]

Geospatial research can help us better understand political processes and outcomes in such settings of contested sovereignty. In contexts where there is ongoing conflict over territorial boundaries, conventional data sources (e.g., censuses and surveys) may be absent, partial, unreliable, or even deliberately withheld by authorities. Geospatial data, however, can sometimes offer a way around these obstacles. Satellite imagery is often free[3] and available at increasingly granular spatial and temporal resolution, allowing researchers to measure electrification, economic vibrancy, urban and agricultural development patterns, activity at ports and transit hubs, the movement of populations, and even observe markers of conflict such as structural damage, barriers, land use change, and bomb craters. Hard copies of maps can be digitized and georeferenced, while contemporary fault lines of conflict can be superimposed upon, and compared to, historical boundaries.

While geospatial data are no panacea -- indeed, geographic data are among the most likely to be politicized in contested settings -- they can complement conventional data sources to understand how politics in the Middle East and North Africa interacts with the region's physical environment itself. Political scientists working with observational data often rely on the collection efforts of organizational actors on the ground -- such as states or within-

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[1] Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M., & Strand, H. (2002). Armed Conflict 1946–2001: A New Dataset. *Journal of Peace Research, 39*(5): 615–637. Pettersson, T., & Öberg, M. (2020). Organized violence, 1989-2019. *Journal of Peace Research, 57*(4). Pettersson, T. (2020). UCDP/PRIO Armed Conflict Dataset Codebook v 20.1. (https://ucdp.uu.se/downloads/). As described in Pettersson (2020), "UCDP defines state-based armed conflict as: 'a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in a calendar year,'" (1).

[2] Interestingly, Iraq's war against the Islamic State and its predecessors during this period is coded as a conflict over government rather than a conflict over the status of territory.

[3] For example, nighttime satellite imagery and derivative datasets are available for free at: https://ngdc.noaa.gov/eog/download.html.

country NGOs -- or international organizations that may or may not have a formal presence within the country. These include surveys, censuses, and various aggregates measuring key features of the political, social, or economic landscape. Territorial conflict, however, introduces unique challenges to data collection and quality. In extreme cases, fear of violence may force data collection to be limited or suspended altogether. Lebanon, for instance, has not conducted a census since 1932, with some claiming that revealed changes to the country's demographic breakdown could reignite conflict. Similarly, Iraq had not conducted a census covering the full country, including the northern Kurdistan region and disputed territories, since 1987.

Even where data are collected, however, they may be withheld. States, and, even at times, NGOs, have an interest in the conflict's outcome and may not be neutral data collectors. For example, conflict researchers sometimes find that governments are more willing to share data on rebel violence than comparable data on government violence toward civilians.[4] Finally, even where data are shared, a researcher's continued access to data from that collection authority may be conditioned on the interpretations they publish. One of the authors, for example, was advised by a senior researcher to tone down their criticism of the Palestinian Authority (PA) in order to ensure continued access to data from the Palestinian Central Bureau of Statistics (PCBS). Further, political considerations may still impact labeling decisions. Hirsch-Hoefler and Ben Shitrit (2020) carefully document how the counting of Jewish settlements in the West Bank by the Israeli statistics bureau has been subject to the ideological pressures of annexation and territorial maximalism.[5] Finally, if researchers wish to analyze local phenomena in contested cities such as Jerusalem, they face choices between Palestinian and Israeli official data sources and multiple, competing definitions of how the city, and its population, are defined.[6]

Remote sensing data can be used to circumvent some of these data challenges. Satellites deployed by the United States and the European Union, among other governments and private actors, routinely scan the Earth's surface to gather environmental telemetry -- a practice known as *remote sensing*. Though typically intended for natural scientific purposes, the imagery can often be repurposed for social science research. Perhaps the most well-known example of such repurposing is nighttime lights imagery. Originally

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[4] Wright, A. L., Condra, L. N., Shapiro, J.N., and Shaver, A.C.. (2017). Civilian abuse and wartime informing. *The Pearson Institute Discussion Paper, 42*.

[5] Hirsch-Hoefler, S., & Ben Shitrit, L. (2020). So, how many settlements are there? Counting, tracking, and normalizing Jewish settlements in the Israeli Central Bureau of Statistics (CBS) Yearbook, 1967 to the present. *Project on Middle East Political Science, 41*.

[6] Greenwald, D.B. (2017, December). Before Deciding Who Rules Jerusalem, Decide What Jerusalem Is. *The National Interest.* https://nationalinterest.org/feature/before-deciding-who-rules-jerusalem-decide-what-jerusalem-23523.

collected by US Air Force satellites to detect weather patterns by way of the reflection of moonlight on cloud tops, it was quickly realized that, on clear nights, the satellites recorded light patterns on the Earths' surface, typically corresponding to human settlements. The image tiles were cleaned and mosaicked into global composites by the National Oceanic and Atmospheric Administration (NOAA), and have been uploaded to the public for free via NOAA's website.[7] Economists eventually demonstrated that, after differencing out country and year effects, year-to-year fluctuations in light intensity could be reliably correlated with year-to-year fluctuations in GDP, essentially offering social scientists a worldwide proxy for subnational economic growth.[8]

In the occupied Palestinian territory of the West Bank, such a proxy has proven useful to assess the economic impact of Israeli army road obstacles, which disrupted labor and trade flows within the territory during and after the Second *Intifada*.[9] Van Der Weide et al. (2018) find that the luminosity of Palestinian neighborhoods dims as Israeli checkpoints are deployed along routes to commercial centers and brightens when these obstacles are later removed. Abrahams (2021), on the other hand, exploits pre-*Intifada* luminosity to predict asymmetries in the flow of Palestinian commuters between West Bank neighborhoods.[10] Digitizing a series of UN maps to geolocate Israeli obstacles along the internal road network, the paper merges Palestinian census data from before and after the uprising to triangulate the impact of Israeli obstacles on Palestinian employment rates. The asymmetric commuting flows, interacted with obstacle deployment, end up giving rise to countervailing impacts, with some Palestinian laborers gaining jobs that others could no longer reach (see Figure 1).

These recent applications of remote sensing data to Palestine are only the latest examples of such research in the MENA region.[11] Recent research on Turkey and Iraq uses nighttime

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[7] See: https://ngdc.noaa.gov/eog/download.html.

[8] Henderson, J. V., Storeygard, A., & Weil, D. N. (2012). Measuring economic growth from outer space. *American economic review*, *102*(2), 994-1028.

[9] Abrahams, A. (2021). Hard traveling: Unemployment and road infrastructure in the shadow of political conflict. *Political Science Research and Methods,* 1-22. doi:10.1017/psrm.2021.8. van der Weide, R., Rijkers, B., Blankespoor, B., Abrahams, A.S. (2018). Obstacles on the road to Palestinian economic growth. *World Bank Group, Policy Research Working Paper, 8385*.

[10] Due to the proximity of Israeli settlements to Palestinian neighborhoods and well-known blurring problems in the lights imagery, economic activity cannot be reliably estimated at the neighborhood level without first deblurring the imagery. See Abrahams, A., Oram, C., & Lozano-Gracia, N. (2018). Deblurring DMSP nighttime lights: A new method using Gaussian filters and frequencies of illumination. *Remote Sensing of Environment*, *210*, 242-258.

[11] See, e.g., Witmer, F. D.W. (2015). Remote sensing of violent conflict: eyes from above. *International Journal of Remote Sensing 36* (9): 2326-2352. Some of the earliest applications of remote sensing to study conflict zones were in, or proximate to, the MENA region. For example, Witmer (2015) notes that satellite technology was used to detect environmental damage in Kuwait after the First Gulf War, and in Sudan's War in Darfur that began in 2003. At the time, much of this data was used by militaries or applied humanitarian researchers.

luminosity data to either proxy for economic development or to capture other variables of central theoretical importance.[12] The usefulness of lights data, moreover, is not limited to the study of subnational explanatory variables. Sanctions against Iran, as well as negative shocks to oil prices, have been shown to differentially impact nighttime luminosity in districts of Lebanon that rely heavily on the patronage of Hezbollah.[13] Further, satellite imagery captures more than just nighttime lights. As satellite resolution becomes more granular, one can view roads, changes in urbanization, settlements, traffic, agricultural land use patterns, public spaces, and even air pollution. For example, remote sensing was used to estimate crop production levels in ISIS-controlled territory in Iraq and Syria[14] and to identify damaged structures in the densely populated Jenin refugee camp in the wake of the Israeli invasion in 2002, when the camp was declared a closed military zone and, thus, inaccessible to outsider researchers.[15] Satellite data can also be merged with geocoded data from the ground, as was done in a recent study of electricity provision and exposure to violence in the Syrian civil war.[16]

[12] See, e.g., Livny, A. (Forthcoming.) Remote Sensing Religiosity in the Muslim World: An Assessment in the Turkish Case. *Public Opinion Quarterly*. Bozçağa, T., & Christia, F. (2021). Imams and Businessmen: Non-State Service Provision by Islamist Movements. Unpublished manuscript. Parreira, C. (Forthcoming). Power Politics: Armed Non-State Actors and the Capture of Public Electricity in post-invasion Baghdad. *Journal of Peace Research.* https://doi.org/10.1177/0022343320940768.

[13] Arbatli, C.E., & Gomtsyan, D. (2021). Sectarian Aid, Sanctions and Subnational Development. *SSRN Working Paper*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3798717.

[14] Jaafar, H. H., & Woertz, E. (2016). Agriculture as a funding source of ISIS: A GIS and remote sensing analysis. *Food Policy, 64*: 14-25.

[15] Al-Khudhairy, D.H.A., Caravaggi, I., & Giada, S. (2005). Structural Damage Assessments from Ikonos Data Using Change Detection, Object-Oriented Segmentation, and Classification Techniques. *Photogrammetric Engineering & Remote Sensing, 71*(7): 825-837.

[16] De Juan, A., & and Bank, A. (2015). The Ba'athist blackout? Selective goods provision and political violence in the Syrian civil war. *Journal of Peace Research 52*(1): 91-104.

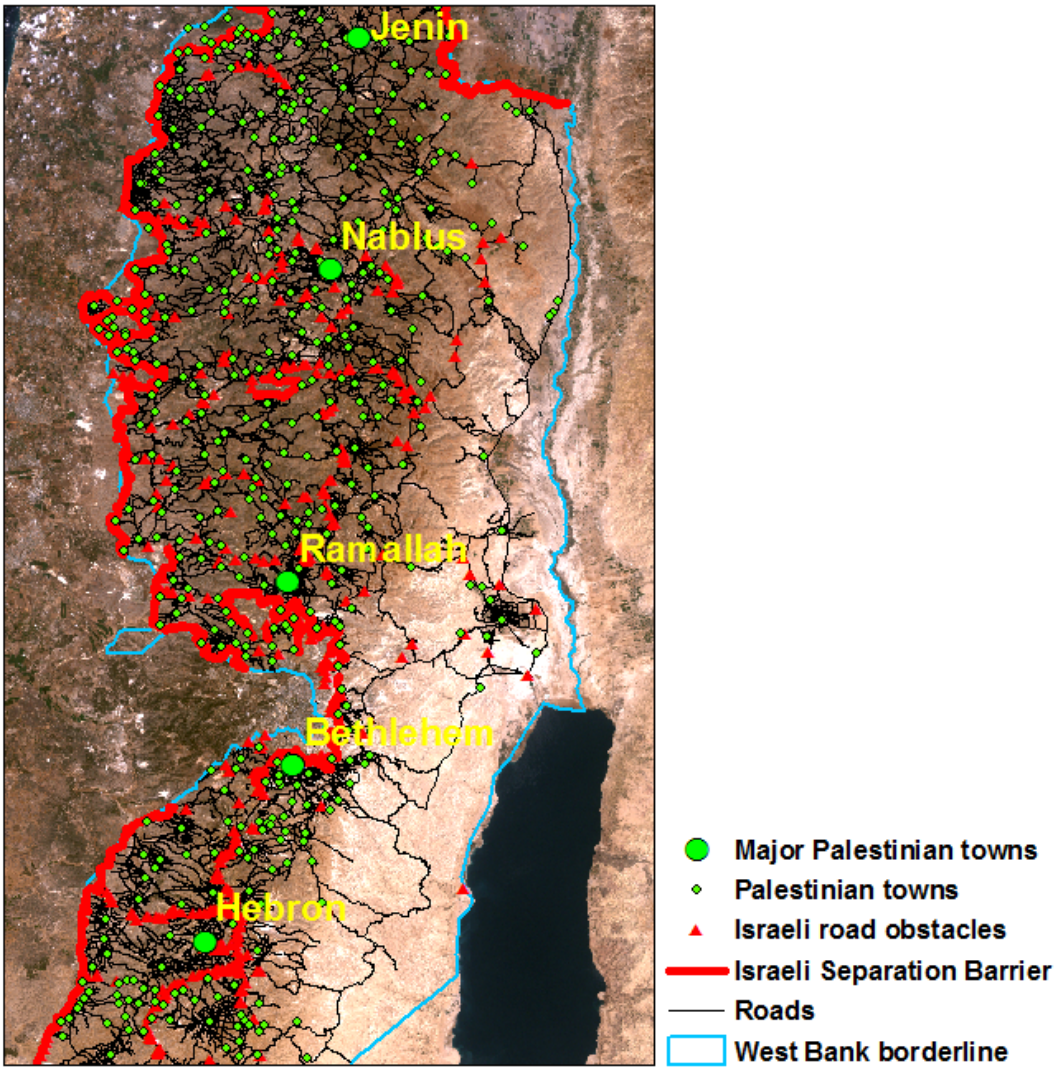

Figure 1. Map re-digitized from pdf by author, showing Israeli road obstacles in the West Bank, circa December 2007. Reprinted from Abrahams (2021).

Beyond data that are remotely sensed from above, MENA researchers can study geographic variation by digitizing and geocoding historical maps, as described by Elshehawy in this newsletter. This type of analysis can be fruitful for uncovering long-run processes in areas of contested sovereignty. For example, Palestine Open Maps is a project that has digitized a set of maps from British Mandate Palestine, recently made publicly available by the Israeli national library, and merged in other sources such as village-level statistics, "historic photography, oral histories and present-day digital maps and data."[17] This type of visual merging of multiple data sources may allow researchers to uncover local-level research puzzles that they would not have otherwise observed. More traditional data can also be geo-referenced: i.e., surveys can be geocoded with the addition of a random shock to the

[17] See: https://palopenmaps.org/about.

respondent's geolocation, or with a sufficient level of aggregation to ensure the data remains deidentified. For example, Afrobarometer and AidData have partnered to geocode six rounds of Afrobarometer surveys in 37 African countries providing data on citizen attitudes and preferences at a locally aggregated level.[18] Notably, this effort includes surveys from Morocco, Algeria, Tunisia, Egypt, and Sudan from 2013 to 2015. In addition, interest in local-level experiences with the state has spurred survey sampling strategies that aim to achieve representativeness at a highly local level: The Local Governance Performance Index, conducted by the Program on Governance and Local Development and implemented in Tunisia in 2015, is one prominent example.[19] To the extent that such efforts can be scaled up to more localities and more countries, locally representative survey data could be combined with other geocoded variables and datasets of theoretical interest. Hypothetically, interviews or other forms of qualitative observation done by researchers on the ground could also be coded by geolocation.

Importantly, remote sensing data complements, but does not substitute for, data collected in the field. While we suggest GIS data are a way to circumvent the state, when it comes time to analyze remote sensing data, political scientists may find that decisions by the state continue to impinge on their research. For example, the assignment of imagery-based data to geographic units requires assumptions about those units including, at times, their orthogonality to other key variables in the analysis. Unfortunately, boundaries between units in territorial conflict zones are rarely random and can thus complicate causal identification. For example, the Oslo Accords between Israel and the Palestinian Liberation Organization (PLO) assigned nearly all of the territory of the West Bank to Areas "A", "B", and "C", distinguished by the extent of security control that the Israeli military shares with the Palestinian police apparatus (see Figure 2 for a snapshot of these areas around the city of Nablus). While the delineation of these zones clearly reflected political interests, the sensitivity of the issue of territorial sovereignty means that, as per one author's experience, extensive field-based qualitative research is needed to identify possible causal factors that led one Palestinian town to be located in Area A while a neighboring, similarly-sized town is in Area B. Thus, moving from imagery-based data to the definition of meaningful geographic units often requires knowledge of the local context.

All conflict zones feature aspects of political calculus and aspects of randomness, whether the conflict is over territory or something else. However, even asking questions about the *origins* of geographic delineations in settings of contested sovereignty can be difficult. Further, remote sensing data can have their own ethical implications, even if they are not regulated as "human subject" data. Scott's contribution to this symposium discusses some

[18] See: https://afrobarometer.org/data/geocoded-data.
[19] See: https://gld.gu.se/en/projects/local-governance-performance-index-lgpi/.

of these issues in the context of research on refugees. While current remote sensing data are not granular enough to introduce concerns about non-consensual identification of human subjects, social scientists should think about what they will do when they become so. Researchers that use geocoded, human subject data (i.e., cell phone data) must consider these questions more directly.

As GIS data becomes available at increasing resolution, researchers may be tempted to design their research questions around hyper-local forms of variation. In settings of longstanding, intractable conflict, a disproportionate focus on local-level variation could be seen by some as "missing the forest for the trees." However, here it is important to note that just because one is looking at local-level variation doesn't mean they are ignoring "aggregate"-level or even international-level drivers of that variation (i.e., see the aforementioned piece on the local impact of international sanctions in Lebanon). As discussed by Parreira in this newsletter, GIS data can allow scholars to link macro-, meso-, and micro-level explanations. In a current book project, Greenwald seeks to do this, using features of the occupation regime at the central level -- namely, the relationship between Israel and the PA -- to explain local-level variation in governance in the West Bank. A focus on distributional outcomes or local-level variation does not rule out additional research on bigger equilibrium shifts and large-scale transformation.

Territorial conflict will continue to shape politics in the MENA region. GIS data, insofar as they map political borders, human movement, and the environmental effects of armed conflict, are clearly useful to making sense of these contests. While they carry their own ethical considerations, GIS data can complement conventional data sources to make sense of the dynamics of political conflict at local, national, and even regional levels.

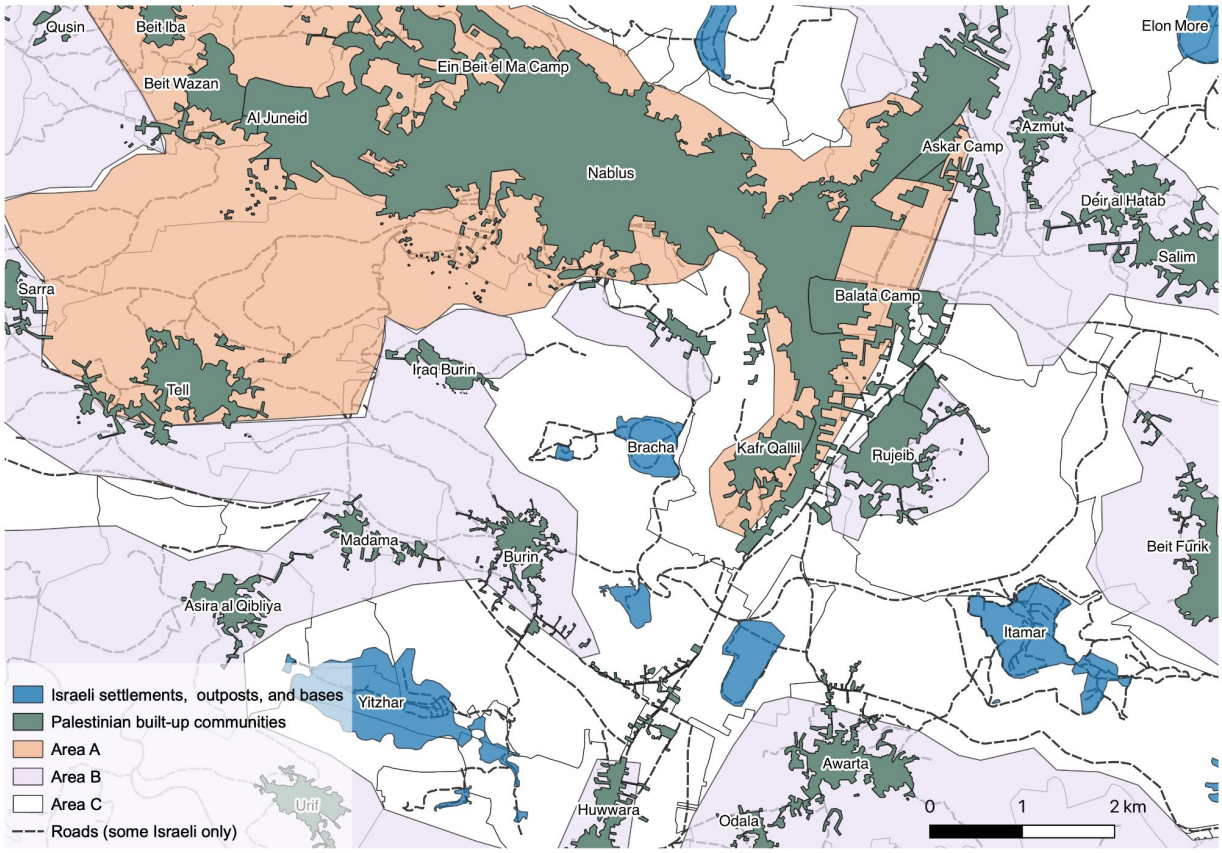

Figure 2. Palestinian communities, Israeli settlements, and security zones (Areas A, B, and C) around the city of Nablus. Map by author, using data provided by the Palestinian Ministry of Local Government, B'Tselem, and the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA).

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