CHAPTER 2: THE POLITICAL GEOGRAPHY OF AERIAL IMAGING

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How do we use drones to get good data for good purposes? Packed into this question are judgments about what good data is, how it can be controlled as it enters a networked world with a long digital memory, what good purposes are, and who exactly "we" are. It is a question without easy answers, but it is at the root of the ethics of drones as information-gathering devices.

The answer we have to offer is a simple one with no easy implementations: Data should be collected by, or in collaboration with, the people being observed, for questions they have a stake in defining, and for decision-making processes controlled by the affected people. At every stage from study design to rule-making, public participation and accessible data collection methods, when implemented well, increase the quality of collected data, the nuances of decision-making, and the legitimacy of resulting rules. As a 2008 study of environmental data-gathering by the U.S. National Academy of Sciences found, public participation is highly correlated with quality data, accurate hypothesis formation, and decision legitimacy.[1]

Drones are potent symbols of automation, surveillance, and secrecy, a tangible physical target amid a rush of networked sharing, snooping, and mass data storage. Emerging from collected advances in low-power computing, cameras, positioning, data transmission, sensors, and batteries, drones bring a distinct economy and scale to capturing images and information. It is tempting to take the novelty of drones as epochal given the breadth of technical mastery expressed by these nimble automated aircraft, but the capabilities united in drones, and the dilemmas they raise, are present in a variety of existing and emerging technologies. The symbolism of drones makes them convenient targets in debates about surveillance, citizenship, and technology. But these debates are not really about drones. They are debates over the dynamics of power and representation in science, surveillance, and mapmaking—debates with a long history.

The questions of "Who gets to make and view official pictures of the world?" and "Who and what get included in those pictures?" have remained stubbornly immune to purely technical fixes. Technologists have repeatedly

This picture taken by NASA's Terra satellite shows the Deepwater Horizon oil spill. Sunlight can be seen reflecting off the oil slick on the surface. Public Lab mapped the spill from lower altitudes using kites and balloons.

enthused that more precise data could put an end to bias in mapmaking, but when politics are pushed aside, innovations such as digital geographic information systems (GIS) have reproduced existing biases.[2] In public policy, maps detail both existing knowledge and future plans.

In April 2010, an oil rig in the Gulf of Mexico, the Deepwater Horizon, exploded and sank. Eleven people were killed and oil gushed into the gulf for months. The core tenet of Public Lab (then called Grassroots Mapping)—the organization we cofounded to response to the oil disaster—is that everyone has the right to capture their own geographic data to provide context for their situation, and should be able to control both the data and the process of data collection. The disaster gave Grassroots Mapping participants the opportunity to test these initial assumptions when Gulf Coast residents took to boats and beaches using simple point-and-shoot cameras and a stabilizing rig made from the top of a two-liter soda bottle, lofted to 1,000-2,000 feet on tethered balloons and kites. Mappers collectively captured over 100,000 images of 100-plus miles of coastline, documenting the movement of oil across the gulf between April 2010 and July 2010.

The initial goal—to create an archive of images of the disaster that would help people tell their stories—took on new urgency when the Federal Aviation Administration banned unapproved air traffic from flying under 3,000 feet above the gulf.* Images couldn't be captured from airplanes (or, for that matter, drones) because of the flight restrictions. So we took pictures from cameras attached to balloons and kites, which were tethered to the ground and light enough to evade the FAA's limits. This became both a technical and a social means of critiquing corporate and government power. Public Lab aerial mapping tools now include hardware kits including kites, balloons, and poles for aerial photography, as well as browser-based software (MapKnitter.org) for image collection, collation, editing, analysis, annotation, and export to standard geographic formats. The Public Lab mapping program supports communities in creating their own narratives and shaping civic discourse around rural and urban land access, environmental destruction, and contested populated spaces.

SURVEILLANCE AND DATA-SHARING

"In the pre-computer age, the greatest protections of privacy were neither constitutional nor statutory, but practical. Traditional surveillance for any extended period of time was difficult and costly and therefore rarely undertaken. "

—Supreme Court Justice Samuel Alito in *United States v. Jones* (2012)[3]

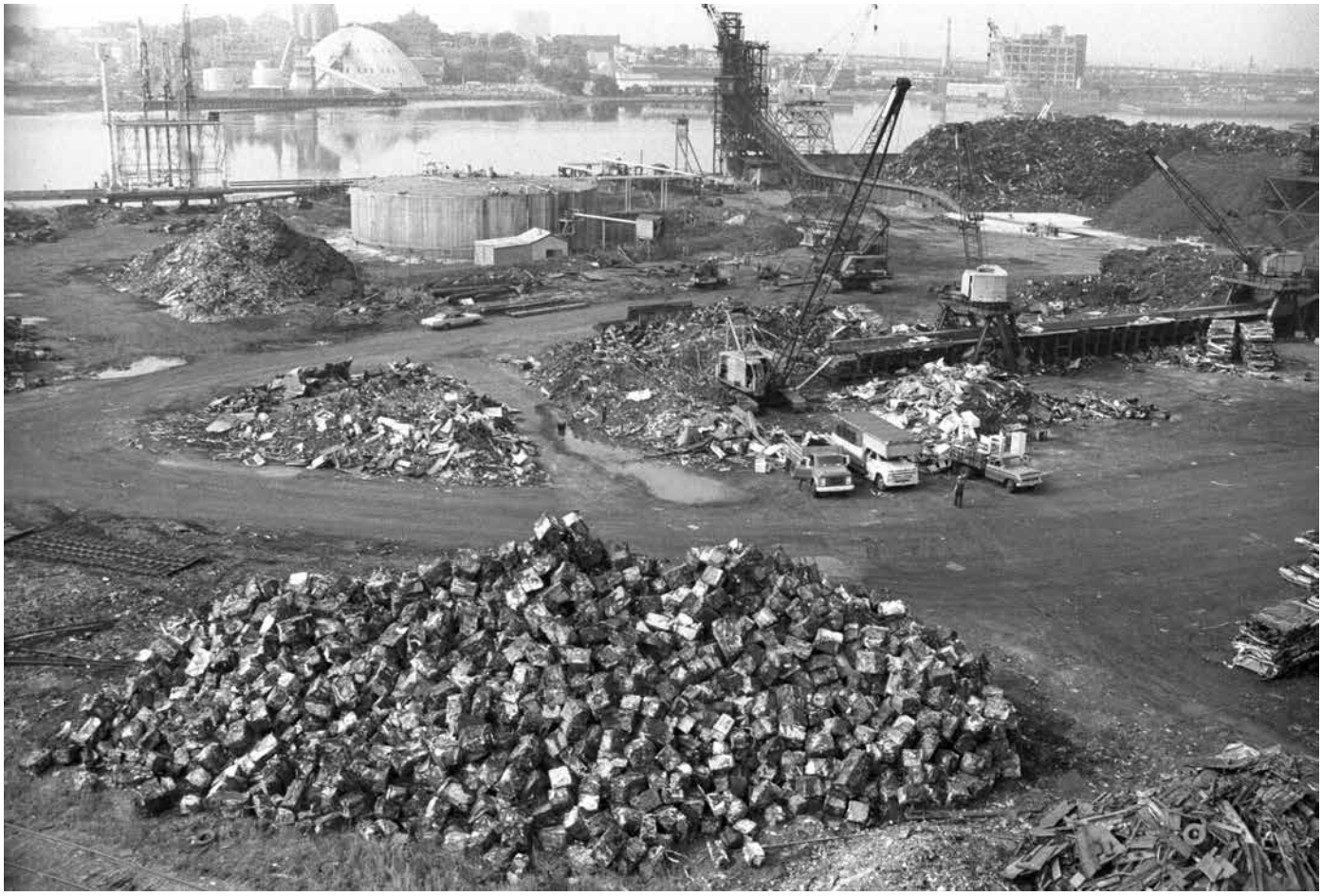
In 2010, a neighborhood group approached the Conservation Law Foundation (CLF), a Boston-based policy and legal nonprofit, about a scrap metal facility on the Mystic River. Observable rain water runoff demonstrated that the facility had never built a stormwater system†, as required by law. A quick search of Environmental Protection Agency (EPA) records revealed that the facility had never applied for or received a permit. It was flying under the EPA's enforcement radar, and so were four of its neighbors. Since then, CLF's environmental lawyers have initiated 45 noncompliance cases by looking for industrial facilities along waterfronts in Google Street View, then searching the EPA's stormwater permit database for the facility's address. Most complaints are resolved through negotiated settlements, in which the facility owners or operators agree to fund what are formally known as Supplemental Environmental Projects for river restoration, public education, and water quality monitoring that can catch other water quality criminals.[4] Together, CLF and a coalition of partners are creating a steady stream of revenue for restoration, education, and engagement in the environmental health of one of America's earliest industrial waterways.

Aerial and street-level geotagged imagery on the Web is a boon to both environmental lawyers and the small teams of regulators tasked by states with enforcing the Clean Water Act. Flyovers and street patrols through industrial and residential districts can be conducted rapidly and virtually, looking for clues to where the runoff in rivers is coming from. When combined with searchable public permitting data, the 1972 Clean Water Act's stormwater regulations are now more enforceable in practice than they have ever been.[5] With roughly half of commercial facilities violating the Clean Water Act every year and few receiving enforcement actions, state and federal regulators have little time for improving compliance, especially for unidentified facilities' self-report permits.[6] Lawyers are able to intercede in enforcement, bringing with them 40 years of Clean Water Act case law and returning a portion of the fines to themselves as well as to Supplemental Environmental Projects funds controlled by the local community.

Automated surveys like Google Street View make it so much easier for private parties to search for building code and environmental violations that they may encourage a shift away from government-provided safety and environmental health services. Environmental health and safety may improve or it may be degraded when public services like permit enforcement are left to private parties. This depends on the accessibility of data collection, accuracy of the data, and accessibility of the decision-making process, as well as the perceived legitimacy of the resulting decision. These factors are interrelated; if a decision-making process is not perceived as open and responsive to affected parties, it will be perceived as having less legitimacy.[7] If a decision is not considered legitimate, people are likely to ignore or evade it. If data can be collected only by a limited group or during limited times, data collection can be gamed to momentarily hide noncompliance.

* The flight restriction was put in place in order to coordinate air traffic involved in recovery operations, but had the effect of making it difficult for independent groups to gather aerial data about the oil spill.

† These are systems that either clean rainwater on site or send it to a treatment plant.



Compressed autos at Mystic River scrap yard, Everett, Massachusetts, 1974. The Clean Water Act took effect in 1972.

Spencer Grant/Getty Images

When government services are conceived only as arbitrations, parties must represent themselves authoritatively to government. Depending on the costs of representation, doing so may create power imbalances between those who can and those who cannot afford to represent themselves, either with lawyers or with data. Courts in the United States are an especially inaccessible decision-making framework. Only one in five low-income people are able to get legal services when seeking them.[8]

But businesses are not necessarily the villains in this situation. Legal threats are stressful and often expensive, even when threatened polluters are acting in good faith to clean up their act. Noncompliant small businesses on the Mystic River that had been operational since before the Clean Water Act may never have been alerted to their obligations under the law. Their absence from the EPA database reflects the EPA's lack of knowledge, but may also reflect the businesses' ignorance of the EPA as well. Businesses bear the direct costs of installed equipment, staff time, and facility downtime, indirect costs to their professional reputation from delayed operations or being seen as a polluter, and transactional costs of paying for legal assistance or court fees. Indirect and transactional costs are hidden punishments that can accrue regardless of guilt or readiness to comply.

Fear of surveillance contains fear over the stress, cost, and hidden punishment of explaining oneself in legal language. Is someone watching secretly from a distance, building a compromising narrative branding one a criminal for violating rules that aren't known or even readable? Can a narrow, legalistic charge represent the complexity of one's interactions with a landscape ranging from industry to stewardship, recreation, and consumption?

CLF proactively works to fit itself into a community-centered watershed management strategy. CLF and its partners run public education and outreach campaigns and begin any enforcement activity with a warning rather than a court filing.[9] Identifying and working with businesses operating in good faith is a tenet of community-based restoration efforts. By using courts as a last resort and participating in public processes where citizens can express the complexity of their relationships to the landscape, CLF and its partners are increasing participation in environmental decision-making and establishing the legitimacy of restoration and enforcement decisions.

Drone-based surveys will expose rule-breaking, just as Google Street View does. The acceptability of conducting surveys and the accuracy of those surveys will depend heavily on how rule-breakers are treated. Will drone surveys encourage stealthier violations of the rules, or a public evaluation of rules and community goals? Will homeowners camouflage their unpermitted toolsheds, or

have a conversation about the nature of toolshed permitting? Hostility toward data collection and falsification of data are directly related to the accessibility of the decision-making process in which data will be used. The more distant the process, the more likely an attempt at measurement will become a target to be gamed for personal advantage.

One response to people who cheat surveys is to do more surveys. Some spaces are becoming subject to near-total surveillance to catch evasions and rule-breaking, a trend that drones' economy encourages. If increased surveillance allows more enforcement, then total surveillance raises the specter of "perfect enforcement," a theoretical state in which all the rules are enforceable all the time.[10] How perfect would perfect enforcement be? Currently, surveillance systems and police are deployed preferentially among historically disadvantaged groups and the poor. Whoever is watched for criminality is who will be caught for crimes and labeled criminal.[11] Automation and mass data collection may create more opportunities for discretionary enforcement than they solve, as every new camera angle adds another incomplete frame of view.

Surveillance can produce detailed data that rules cannot handle. Already, traffic cameras and automated toll-taking on some roads mean that every car's speed is known. If someone breaks the speed limit for 20 minutes, are they fined the same as someone who breaks it for two minutes? What if someone breaks the speed limit for a total of 20 minutes, but in 10 two-minute periods? There is no legal guidance as of yet, leaving jurisdictions to make their own discretionary judgments, few of which are published.[12] Existing surveillance technologies are leading to secret rule-making around public spaces.

Data does not stand alone. It is always worked into narratives shaped by authors' choices, ethics, and biases, in service of a point. Protecting data and setting privacy standards are about giving the subjects of a data collection program a say in the narratives that others can build about them. Aerial images are most powerful when associated with other information. Drone surveyors need to consider not just privacy as it relates to their own data, but also how it relates to cross-referenceable data. For decades, computerized, cross-referenced databases have been raising data privacy questions around how narratives are built. In 1973, the U.S. Department of Health, Education and Welfare issued a statement of remarkable clarity on the collection and use of personal data:

The Code of Fair Information Practices is based on five principles:

- There must be no personal data record-keeping systems whose very existence is secret.
- There must be a way for an individual to find out what information about him is in a record and how it is used.
- There must be a way for an individual to prevent information about him that was obtained for one purpose from being used or made available for other purposes without his consent.
- There must be a way for an individual to correct or amend a record of identifiable information about him.
- Any organization creating, maintaining, using, or disseminating records of identifiable personal data must assure the reliability of the data for their intended use and must take precautions to prevent misuses of the data.

—U.S. Department of Health, Education and Welfare, Secretary's Advisory Committee on Automated Personal Data Systems. Records, Computers, and the Rights of Citizens, viii (1973).[13]

These are principles that should be followed today. However, since the 1970s, government policy and corporate practice have moved in the opposite direction, despite little change in citizens' desire for privacy.[14] Personal information is routinely collected, stored, and sold in secret by both public and private entities, undermining trust. We suggest the following guidelines for collecting and using data:

- If you don't need the data, don't collect it. If you're building a set of data via aerial mapping techniques, know why you're collecting the information. Don't collect information that won't be used for a specific purpose.
- Collect data in a way that allows for participation: Work with people who are affected by the data you'll be collecting. In doing so, create relationships centered on trust and common goals.
- Avoid gathering or storing data about others without their knowledge. Surreptitious data-gathering may be necessary, for instance, in documenting human rights violations. If it is possible to obtained informed consent, do so.
- Store data contextually: If the information is necessary in a certain context but presents risks in others, create a system of storage that limits future context changes through record sunset provisions or other means.
- Support ownership and control of the data by the people it is about. Information will be richer in context, scope, and applicability when people feel it is honestly for them.

Right now we appear to be in a civic arms race to collect data and expose other people's secrets, pitting state and corporate surveillance against activist counter-surveillance. In the realm of video, narratives about policing are built around footage of police. Police cameras, dash cameras, and security cameras compete with cop-watching mobile phones and public data requests to get footage and move opinion. Counter-surveillance extends beyond visible light into invisible frequencies, with activists deploying midwave infrared video cameras to detect leaks at gas facilities and new software-defined radios to track secret FBI planes.[15] This surveillance arms race is indicative of low trust in official decision-making and the expanding use of secretive and adversarial tactics by government and corporate actors. Drones are rapidly being deployed on all sides in this arms race, and adversarial fear-based tactics appear to be driving debates about the place of drones in civil society.

In environmental monitoring, planning, and policy, adversarial relationships are widespread but government policy has been shifting toward open data and participatory processes. The U.S. Geological Survey (USGS), a scientific

agency that is part of the Department of the Interior, combines imagery from private providers and the Department of Agriculture, and has worked to become a standards-based storehouse of map data rather than the primary surveyor.[16] OpenStreetMap, an open-source mapping initiative built on user contributions like Wikipedia, has attracted many municipalities seeking the advantages of pooled efforts and open licensing for their map data. The EPA has also warmed to civic science and low-cost monitoring tools with programs such as its Air Sensor Toolbox, a guide to air monitoring for community groups looking to gather their own data.[17]

Increasingly, mappers and researchers find themselves creating data in the official public record, raising questions about the public duties of volunteers and the accuracy of public data. The participatory, open-source geographic information system (GIS) response is circular but functional, as stated by Eric Wolf of the USGS. Wolf posits a feedback loop, where if data is good enough for people to use, then it will be used frequently enough to maintain and improve its quality.[18] Repeated use of geographic data in a real-world context lets people check its accuracy. Users who rely on the data will keep it accurate enough for their own use, as long as there are participatory avenues for improving the information. This open, process-oriented, and civic-minded approach to data collection offers a route out of the surveillance arms race.

MAPS AND LEGAL ACCESS

In the 1820s in what is now New Zealand, a Maori band under Nuku-pewapewa captured Maunga-rake *pa*[*] in a daring aerial night raid that opened the fortifications from inside. Nuku-pewapewa's warriors lifted a man quietly off a cliff and into the *pa* on a *raupo manu*, a bird kite woven out of rushes.[19] *Raupo manu* were kites that could fly without tails, the precursors to airplanes not yet known in the Western world.[20] Maori and other Polynesian peoples had practical kites for meteorology, fishing, and bird-scaring. However advanced their kite technology, Maori were unprepared for a defining colonial technology: the court system. The Native Land Court was created in the 1865 Native Lands Act. As the law's preamble states, the court was designed to "encourage the extinction of [Maori] proprietary customs."[21] The colonists' bureaucratic technology mixed accurate cadastral[22] mapping with arbitrary and litigious land titling to build a framework for acquiring Maori land.

Maori land tenure was based on nonexclusive use by individuals under nested power structures of *iwi* (overarching tribes), *hapu* (sub-tribes), and *whanau* (extended families). The Native Land Court assigned exclusive co-owned titles to no more than 10 individuals. Properties were subdivided and passed to heirs, increasing the difficulty of making land-use decisions and connecting individuals to a host of small fragmented parcels. Absenteeism and the difficulty of coordinating heirs in land-use decisions encouraged many Maori to bring their titles to the Native Land Court to convert to freehold titles. Between 1860 and 1890, 8 million acres were sold.[23] Many traditional land-management schemes ceased, and raupo manu disappeared from the skies, their capabilities later reinvented by and attributed to Westerners. Nonsensical land fragmentation still haunts contemporary Maori in areas where customary titles were retained.[24]

To implement a mapping project equitably, one must understand the historical reproduction of bias through mapmaking, surveying, and titling. People-centric mapping has emerged from a recognition that new technologies in mapmaking have reproduced old biases, and their prescriptions are coherent only when viewed through a historical lens. Modern geography has its roots in state projects of land formalization that overwhelmingly favored powerful interests over marginalized peoples. The systematization of bias through maps is most acutely visible in land formalization. Land formalization is best defined as "the recognition and inscription by the state of rights and conditions of access within specific boundaries."[25] We will use "informal land tenure" to define customary land use practices that are not recognized by or registered with the state, acknowledging that these practices are quite formalized within their geographic scope and culture. While the systems of rights and conditions attached to formalized land have varied immensely between different states and regimes, these systems have been implemented under a shared desire to make land calculable and governable from a distance.[26] In contemporary practice this usually means registering ownership through single-holder land titles and maps in order to integrate parcels into a market and quantify their taxable resources.[27]

Moving from informal to formal land tenure involves translating varied local practices into standardized forms. Exploiting this process to usurp land has been the rule rather than the exception. Local populations have often been treated as mutable features of a remotely managed landscape, setting the stage for exploitation and degradation. If, rather, surveyed populations are actively engaged as participants, the transition to formal tenure can be an improvement over the status quo. And change is needed. Developing nations have cadastral surveys for less than 30 percent of their domains.[28] Aerial imaging and automated computer vision assessments of factors such as population and building density are gaining popularity as methods for counting and locating informal settlements.[29]

A LIGHTNING HISTORY OF LAND FORMALIZATION

Pre-modern and early modern states relied on import duties, conscripted labor, and production quotas for revenue. Most modern and contemporary states prefer to quantify land and resources in order to regularize taxation and revenues. Land formalization is therefore a crucial means of asserting the rule of law and making taxation and

* A "pa" is a fortified village or hilltop fort.

the provision of state services transparent and legible* to citizens, especially following displacement by natural or human-made disasters. However, land formalization has served a dual role of describing space and remaking space into bureaucratically legible, mappable forms, a process eloquently described by James C. Scott in his book *Seeing Like a State* (1998). Land formalization programs are almost universally something more than registering existing owners' parcels, because informal land tenure is rarely defined by contiguous parcels, each with a single owner. Different resources may each be divided among different owners in non-contiguous and often overlapping plots. For instance, harvestable foods in a forests' understory may be divided in a different manner than those in the canopy, while firewood collection follows yet another pattern. Land-use rights may vary from season to season, especially where the territories of nomadic pastoralists overlap settled agriculturalists.[30] Rights may be transferable to others or not, and may be gender- or age-dependent. Resources may be held by households, individuals, or communities who trade or redistribute resource plots. Systems of informal land tenure may be equitable or discriminatory, egalitarian or hierarchical, but they have never been consistent.

Informal land tenure is usually very hard to draw on maps, and paper-based cartography is certainly inadequate for the task. The difficulty of recording and tracking informal land tenure for outsiders at a distance has led states to prefer simple schemes that fit their bureaucratic capabilities. Land boundaries and map scales are chosen for their bureaucratic legibility. States prefer simple forms of land management, especially contiguous parcels each assigned to a single owner with no seasonal variation. For those who have grown up under systems of single-holder land titles, informal land-use patterns may seem complex and illegible. Illegibility is often conflated with disorder, in both historical and contemporary land formalization. Land formalization and its disastrous consequences for many residents has been extensively documented in 18th to 20th century histories of Western, colonial, communist, post-colonial, and post-communist states. Formalization and the end of traditional land use may not only displace people and reduce agricultural productivity, but also increase state revenues through legibility, as it did in Tsarist Russia.[31] The interests of mappers and the mapped have rarely aligned.

WHY WE MAP

Despite the power dynamics that cartography has inherited, all sorts of people find making pictures of our world and linking them to locations on Earth attractive. Visually understanding our place in the world provides us with a sense of belonging. Maps communicate. They are a limited picture, cropped and simplified, claiming: "This is here."[32] Regardless of whom the map favors, all viewers are treated to an omniscient view. This omniscient view is seductively explanatory, regardless of whose claims the map validates.

Aerial and satellite photographs, stretched and processed into photo maps, have given an extra edge of realism to maps' perspective. At first restricted to large institutional and state actors, photo maps present an authoritative and naturalistic aesthetic, even though they are the result of heavy manipulation and combinations of sources whose origins are often hard to trace.[33] With the advent of consumer digital photography, decent aerial photo maps can be captured from technologies ranging from kites to the passenger seat of a commercial airliner. Access to photo mapping is broadening, with unknown effects on the authoritative aesthetic of aerial views.

When access to mapping requires privilege, the privileged alone paint authoritative-looking pictures about land use and tenure. When privilege is enshrined in systemic bias, mapping programs can formalize people's marginalization. Mapping programs can neglect to record existing land use accurately, effectively erasing people's customary tenure. People being mapped often do not have a voice in selecting which categories and systems are included in the map, or further engagement with official policy and geography.

The result is to inscribe the map's bureaucratic fragmentation onto the landscape. The map does not merely describe the world, but can catalyze the displacement of people and degradation of social structures as the world is reshaped to the map.

PEOPLE-CENTRIC MAPPING

Putting people at the center of a mapping program offers opportunities to unite inhabitants around their landscape and reclaim health and welfare as land-management virtues. A people-centric mapping program actively works to limit the privileges needed to engage in mapping, so that the people whose spaces are mapped can:

- Archive and review changing landscapes and uses
- Control the taxonomy of description
- Own and use the formats of presentation
- Access the prevailing discourse on geography and policy
- Open space for dialogue with all stakeholders

Changes in land-use norms and rules are usually justified with reference to maps. The above five points are key criteria for evaluating a mapping program or technology to examine whether it is actively countering systemic marginalization, accidentally reproducing injustice, or deliberately ignoring affected people.

The Public Lab New York City chapter has successfully engaged in a people-centric mapping program. Since 2011, community organizers and organizations around the EPA's Gowanus Canal Superfund site have used aerial mapping with balloons and kites to document and manage the urban ecosystem, contribute community-collected imagery to assist in the EPA Superfund plan, and act as advocates for

* Which is to say it is understandable through documentation.

the community and people in the watershed's reach. Using a people-centric approach to the aerial mapping of the canal has allowed the community to own and manage the imagery it has collected and provide a means for stakeholders to discuss the management and cleanup of the canal.

Aerial imagery is especially compelling when combined with direct observation from people canoeing the canal. Activists from the Gowanus Low Altitude Mapping (GLAM) project have been able to confirm their on-the-ground hunches about runoff and hidden drains with aerial images, adding to the Superfund cleanup map—and increasing the Superfund site by a city block. It is much easier to make a convincing case when the hands-on experience of community groups is mixed with clear images. Being able to use images in advocacy encourages GLAM and the Gowanus Conservancy to continue flying in their neighborhood, but they also do it because it's fun and generates local attention.

Recognizing residents as experts on their land and creating a fun space for them to annotate the best possible maps is a feature of Participatory 3D Modeling (P3DM), a PGIS/PPGIS (Public Participatory Geographic Information Systems) method in which room-filling 3D topographic maps are set up in public places.[34] P3DM was developed in the late 1980s through the Thailand Upland Social Forestry Project's Participatory Land Use Planning program with anthropologist Uraivan Tan-Kim-Yong. Its use in land planning has since expanded in Thailand and entered regular use in the Philippines and elsewhere, especially Pacific and Indian Ocean islands. At once high resolution, approachable, and a great conversation piece, the topographic models attract crowds. The models are designed to survive repeated planning sessions involving colored dots, tape, and toothpick flags. They often remain in villages and towns to help resolve disputes and track illegal logging and other encroachments. The greatest barriers to implementing P3DM have been the scarcity of good topographic data and high-resolution images, and the inability to scan and share the 3D maps themselves. Drone technologists and programmers working on SfM (structure from motion) 3D scanning are fast solving both problems.

Public Lab's balloons and kites and P3DM maps are readily crafted objects extending the reach of mapping networks into social spaces in a way communities can control. P3DM depends on topographic surveying, now simplified by GPS satellites and algorithmically generated 3D models made from aerial imagery. Our MapKnitter software lets users stretch their aerial photos on top of existing satellite imagery, relying on existing precision satellite imagery to make higher-resolution maps. As GPS, satellite data, and imaging capabilities are encapsulated in consumer devices, it becomes easier to craft extensions of networked maps from simple materials. Community technology access is more than owning a device; it is the ability to depend on a technology's capabilities and build it into future plans, confident that the devices can be acquired and used. Every community will have different answers to the questions of accessibility in line with their available resources, especially money and time.

A good public process is an informative curiosity that attracts a crowd, whether it involves a land-use planning decision or flying to take aerial photos. Success rarely comes quickly; such processes cannot be hurried, though this should not be used as an excuse for foot-dragging.[35] When local residents are the experts, a fun and involving decision-making process will maximize the number of participants, the quality of the information presented, and ultimately the time devoted to decision-making. When flying and getting aerial imagery, local expertise is crucial to understanding both the targets to image and where to fly safely. The more time participants spent on a mapping problem, the better the results.

Wikimedia Commons

The Gowanus Canal from Hamilton Avenue Bridge. A project called GLAM has been using aerial imagery to confirm suspicions about runoff and hidden drains.

In many technical processes, the technical expert pigeonholes other people in places that relate comfortably (for the expert) to the expert's professional hierarchy. Labor can be divided along expert lines, as in the fields of volunteered geographic information and citizen science, where "citizens as sensors" collect data to

support the researchers' questions with little thought to how the data returns to and supports the participants.[36] Instead of segregating individuals by credentials and customs, restricting their participation to different points in the inquiry process, Public Lab attempts to open all points in the process to everyone. People are encouraged—and through the collaborative nature of the community, *required*—to be involved in the process of questioning—why, how, and who—through the development of social and technical methods.[37]

Socially, Public Lab creates relationships with data advocates and environmental justice organizations to actively build data analysis and interpretation into our process to ensure that data-use decisions lie in the hands of the people collecting the data. Technically, the community works to critique and translate GIS formats in our mapping system so people can create locally impactful and bureaucratically acceptable maps from a community level.

aIn the Public Lab community, aerial mapping as a means of stakeholder engagement has been demonstrated in settings as diverse as coal terminal pollution in southeast Louisiana and land disputes in Kampala, Uganda. In Louisiana, organizers captured aerial images via kite of a coal terminal dumping into the Mississippi River. These images led to engagement on different levels. The community came to better understand coal terminal operations. The Louisiana Department of Environmental Quality visited the terminal, then filed a notice of intent to sue under the Clean Water Act. In Kampala, a women's craft market used aerial images captured by a balloon to hold off the eviction of the market. The images proved to be an effective means to communicate with government ministries involved in decision-making about access to that plot of land.[38]

CONCLUSION

Maps began as a language of the powerful. They have since become a widely used language of power with a broad range of speakers. People-centric mapping has emerged from people using existing and new technologies to counteract the observable reproduction of bias in mapping systems. Though the people-centric mapping movement did not originate with drones, drones will play an increasingly central role in people-centric mapping and science. While maps are still created in the service of centralized control for national or commercial advantage, mapmakers have both broadened access to maps and decentralized the techniques of production, distribution, and analysis. Generations of critical practitioners have made hard-won gains in people-centric mapping and recognition of its legitimacy in local practices, government processes, and international land formalization standards.

Geographers are technically oriented social scientists. People-centric mappers have worked to document systems of participatory geography and the mapping of customary land-use patterns. They've also made these programs compliant with international standards and interoperable with other geographic systems. The Social Tenure Domain Model, created by UN-Habitat, the International Association of Surveyors, and the Global Land Tool Network, is approved by the World Bank and is an approved specialization of the Land Administration Domain Model, certified by the International Organization for Standardization. Civic engagement is built around dialogue and compromise, finding the common ground needed to sustain united action. Participatory data collection is past the experimental stage. It is ready to go to be integrated into civic life as an evidence-based methodology for supporting public decision-making. §

1 Thomas Dietz and Paul C. Stern, eds., *Public Participation in Environmental Assessment and Decision Making*, in *Committee on the Human Dimensions of Global Change Division of Behavioral and Social Sciences and Education* (Washington, DC: National Academies Press, 2008), 91.

2 Elwood, Sarah, "Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions" Transactions in GIS (2006), 693-708

3 United States v. Jones, 132 S. Ct. 945, 963 (2012).

4 Guy Alsentzer, Zak Griefen, and Jack Tuholske, CWA Permitting & Impaired Waterways, Panel session at Public Interest Environmental Law Conference (University of Oregon, 2015); Conservation Law Foundation, "Coming Clean", Winter 2014, http://www.clf.org/wp-content/uploads/2014/01/CM-Winter-2014.pdf; D.C. Denison, "Conservation Law Foundation suing alleged polluters", *Boston Globe*, May 10, 2012, https://www.bostonglobe.com/business/2012/05/09/conservation-law-foundation-suing-alleged-polluters/G81t2DMBcJasbgvF3JZIMI

5 Guy Alsentzer, Zak Griefen, and Jack Tuholske, *CWA Permitting & Impaired Waterways*, Panel session at *Public Interest Environmental Law Conference* (University of Oregon, 2005).

6 Karl Russell and Charles Duhigg, "Clean Water Act Violations: The Enforcement Record," *New York Times,* September 1, 2009, http://www.nytimes.com/interactive/2009/09/13/us/0913-water.html?_r=1&.

7 Dietz and Stern, *Public Participation in Environmental Assessment and Decision Making*, 77-78.

8 Legal Services Corporation, *Documenting the Justice Gap in America: The Current Unmet Civil Legal Needs of Low-Income Americans*, September 2009, 16, http://www.lsc.gov/sites/default/files/LSC/pdfs/documenting_the_justice_gap_in_america_2009.pdf.

9 Alsentzer, Griefen, Tuholske, "CWA Permitting & Impaired Waterways."

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