CLOSE UP AT A DISTANCE

MAPPING, TECHNOLOGY, AND POLITICS

Laura Kurgan

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Astronaut photograph AS8-14-2383, December 24, 1968. NASA's original caption reads: "This view of the rising Earth greeted the Apollo 8 astronauts as they came from behind the Moon after the lunar orbit insertion burn. Earth is about five degrees above the horizon in the photo. The unnamed surface features in the foreground are near the eastern limb of the Moon as viewed from Earth. The lunar horizon is approximately 780 kilometers from the spacecraft. Width of the photographed area at the horizon is about 175 kilometers. On the Earth 240,000 miles away, the sunset terminator bisects Africa." This image has come to be known as *Earthrise*. PHOTO: NASA

Astronaut photograph AS17-148-22727, December 7, 1972. NASA's original caption reads: "View of the Earth as seen by the Apollo 17 crew traveling toward the moon. This translunar coast photograph extends from the Mediterranean Sea area to the Antarctica south polar ice cap. This is the first time the Apollo trajectory made it possible to photograph the south polar ice cap. Note the heavy cloud cover in the Southern Hemisphere. Almost the entire coastline of Africa is clearly visible. The Arabian Peninsula can be seen at the northeastern edge of Africa. The large island off the coast of Africa is the Malagasy Republic. The Asian mainland is on the horizon toward the northeast." This image has come to be known as *The Blue Marble*. PHOTO: NASA

Mapping Considered as a Problem of Theory and Practice

Consider two similar images that have transcended mere publicity to become iconic. *Earthrise*, or image AS8-14-2383, is a color photograph taken by Apollo 8 astronaut William Anders in December 1968, showing the Earth in half shadow against the foreground of a lunar landscape. The second picture comes from the Apollo 17 astronauts in December 1972, a circular image of a shadowless globe. NASA labeled it image number AS17-148-22727, but it has come to be called *The Blue Marble*.

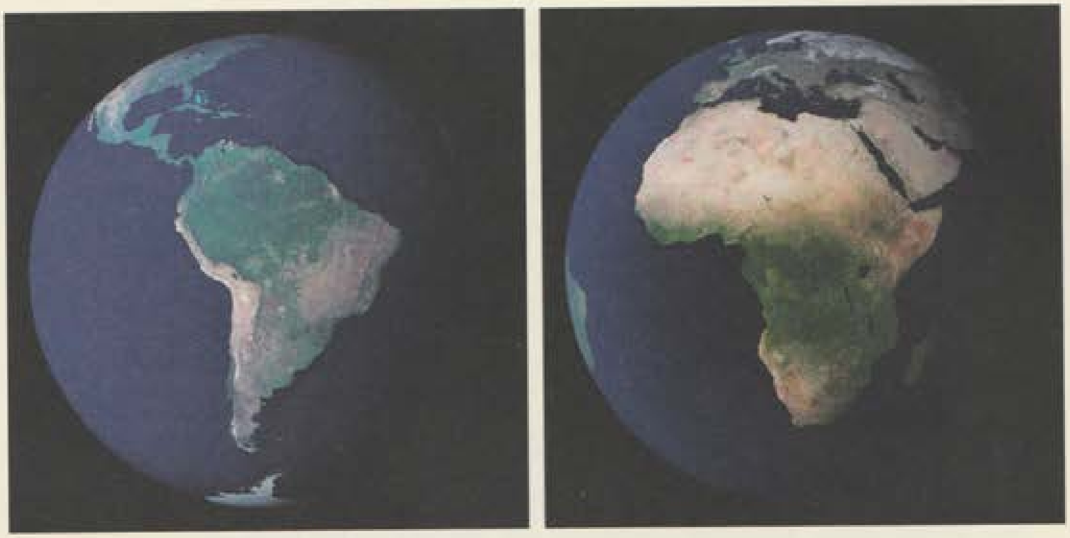
Earthrise is a photo of the Earth taken while orbiting the Moon. It is a perspectival view—the foreground offers a sort of ground and seems to suggest the position of a viewer, so that you can almost imagine being there, looking across the lunar surface. *The Blue Marble* is perhaps more unsettling, because it is without perspective, a floating globe, an abstracted sphere, something like a map.

Denis Cosgrove, in *Apollo's Eye*, calls our attention to these two images and to the role they played in producing "an altered image of the Earth."[1] Each in its own way is credited with representing or even catalyzing a notion of global or planetary unity, whether in universalist terms, humanist ones, or precisely nonhumanist environmental or natural ones. The view across the Moon's surface, it seems, provoked thoughts of an Earth without borders. Cosgrove quotes Apollo 8 mission commander Frank Borman's reading of the *Earthrise* image: "When you're finally up at the moon looking back at the earth, all those differences and nationalistic traits are pretty well going to blend and you're going to get a concept that maybe this is really one world and why the hell can't we learn to live together like decent people?"[2] This "concept" of "one world" can be evaluated in many ways: as "the universal brotherhood of a common humanity" (Cosgrove paraphrasing Archibald MacLeish), as a gesture of imperial domination, as an abstract and artificially totalizing erasure of very real differences, as the basis of new global political

The Blue Marble 2002 is a composite image stitching together quarterly observations, at a spatial resolution of 1 square kilometer per pixel, from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Terra satellite.
NASA IMAGE BY RETO STÖCKLI WITH ENHANCEMENTS BY ROBERT SIMMON; ADDITIONAL DATA FROM USGS EROS DATA CENTER, USGS TERRESTRIAL REMOTE SENSING FLAGSTAFF FIELD CENTER (ANTARCTICA), AND DEFENSE METEOROLOGICAL SATELLITE PROGRAM

movements for human rights or planetary responsibility, or as what Martin Heidegger called "the uprooting of man"—"I was shocked when a short time ago I saw the pictures of the earth taken from the moon. We do not need atomic bombs at all—the uprooting of man is already here.... It is no longer upon an earth that man lives today," he told an interviewer in 1966, just a month after an even earlier *Earthrise* image, taken from the Lunar Orbiter 1, had been released.[3] Whatever the evaluation, as Cosgrove underlines, these photographs "have become the image of the globe, simultaneously 'true' representations and virtual spaces."[4] The 1972 photograph, no doubt because it both offered the viewer the whole Earth and seemed to remove any viewer from the picture, became perhaps even more of an icon, not only of totality and unity but likewise singularity and freestanding vulnerability.

But these two images are not the only examples of their type, and their afterlife is indicative of an important shift in the way we represent the planet—and the political stakes of those representations. The iconic status of the images, particularly the second one, is perhaps attested to by the fact that most people will not be able to notice a difference between the 1972 *Blue Marble* and a number of new ones. In 2002, NASA produced a pair of new images, together called once again



The Blue Marble: The Next Generation, 2005, is a composite image using twelve monthly cloud-free observations in 2004, at a spatial resolution of 500 square meters per pixel, from the MODIS onboard NASA's Terra satellite. IMAGE: RETO STÖCKLI, NASA EARTH OBSERVATORY

The Blue Marble (one of the Western Hemisphere, and one of the Eastern), put together out of four months' worth of satellite images assembled into what the space agency called a "seamless, photo-like mosaic of every square kilometer of our planet." The resolution of the images, collected by the Moderate Resolution Imaging Spectroradiometer, was one kilometer per pixel. Three years later, they did it again, at twice the resolution and based on twelve months' worth of remote sensing, and called the images *The Blue Marble: The Next Generation*.[5] And in 2012, there were two more, again one of the Western Hemisphere and the other of the Eastern, called *Blue Marble Next Generation 2012*, assembled from data collected by the Visible/Infrared Imager Radiometer Suite (VIIRS) on the Suomi NPP satellite in six orbits over eight hours.[6] These versions are not simply photographs taken by a person traveling in space with a camera. They are composites of massive quantities of remotely sensed data collected by satellite-borne sensors.[7]

The difference between the generations of *Blue Marbles* sums up a shift in ways of thinking about images, what they represent, and how we are to interpret them.

The new blue marbles now appear everywhere: in advertisements and as the ubiquitous default screen of the iPhone.[8] So where you might think you're looking at image number AS17-148-22727, handcrafted witness to earthly totality, in fact what you're seeing is a patchwork of satellite data, artificially assembled—albeit

Blue Marble Next Generation, 2012, is a composite image using a number of swaths of the Earth's surface taken on January 4, 2012, by the VIIRS instrument aboard NASA's Suomi NPP satellite. IMAGE: NASA/NOAA/GSFC/SUOMI NPP/VIIRS/NORMAN KURING

with great skill and an enormous amount of labor. This is not the integrating vision of a particular person standing in a particular place or even floating in space. It's an image of something no human could see with his or her own eye, not only because it's cloudless, but because it's a full 360-degree composite, made of data collected and assembled over time, wrapped around a wireframe sphere to produce a view of the Earth at a resolution of at least half a kilometer per pixel—and any continent can be chosen to be in the center of the image. As the story of the versions suggests, it can always be updated with new data. It bears with it a history that mixes, unstably, both precision and ambiguity and that raises a series of fundamental questions about the intersection between physical space and its representation, virtual space and its realization.

Cosgrove described the astronauts' photographs as "simultaneously 'true' representations and virtual spaces," and we can now begin to appreciate just how precise that description is for the sequence of satellite-generated images to which they gave rise. The photographs were true, at least in the trivial mechanical sense, and then provided a platform for something more abstract or virtual, the "concept" of "one world." Now it is the virtuality of the data-based constructions that seems self-evident. And their basis in remotely sensed data helps us understand what has become of truth in the era of the digital data stream: it is intimately related to resolution, to measurability, to the construction of a reliable algorithm for translating between representation and reality. The fact that they are virtual images does not make them any less true, but it should make us pause and consider what we mean today by truth.

It is the intersection between the true and the virtual that is the subject of what follows. In it, I offer an account of the technologies that produce global imagery and that both necessitate and facilitate the interpretation of images at once measurable and digital, uncentered and ambiguous, yet comprehensive and authoritative. My account rests on and results from research conducted through practice, working with maps and images I have created, data I have acquired or generated, installations and projects I have undertaken.

RESEARCH CONDUCTED THROUGH PRACTICE

Since the early 1990s—since the first Gulf War, to be precise—I have been thinking about and working with new technologies of location, remote sensing, and mapping. I understand this work as a form of research conducted through practice. The propositions and claims I offer here, however theoretical they are, only emerged for me through the process of experimenting with the technologies themselves, working with and through them to create images. That research has not simply been aimed at developing a theoretical framework for better understanding these new sorts of spatial representations, but has taken the form of a series of projects utilizing the technologies that have produced these images in order to investigate them. That work is presented here in terms of a series of projects that have formed the basis of my inquiry. They both exemplify the approach to understanding digital images articulated here and, I hope, suggest further lines of exploration.

The technologies of global positioning, imaging, and interpretation made available by the development of satellites tasked with surveillance and mapping first emerged to serve the needs of governments and their military and intelligence establishments. Subsequently, these technologies have been made available to the public for commercial and other ends. In the projects documented here, my aims were neither military nor commercial, but while many began as exhibitions in art galleries or museums and then were extended in print and online, they have been no less political than those of the governments and militaries that underwrote the technologies in the first place. This book gathers and reframes a number of these projects in order to make claims and arguments about what the technologies of spatial representation have to do with the spaces they represent, beyond simply representing them.

It offers a series of images created as the once-classified government and military digital technologies of mapping became publicly available, and with them the data on which they rely. In a certain sense, these images are nothing but maps, although not in the ordinary sense. Maps construct space—physical, propositional, discursive, political, archival, and memorial spaces. For many of us, maps now are as omnipresent as the more obvious utilities (such as electricity, water, gas, telephone, television, the Internet), functioning somehow like "extensions" of ourselves, to co-opt Marshall McLuhan's famous definition of media. They have become infrastructures and systems, and we are located, however insecurely, within them. Drawn with satellites, assembled with pixels radioed from outer space, and constructed out of statistics joined to specific geographies, the maps presented here record situations of intense conflict and struggle, on the one hand, and fundamental transformations in our ways of seeing and of experiencing space, on the other.

Central to the ways these projects unfolded and to the fact that they do not simply analyze, but in fact employ, these technologies, is this claim: we do not stand at a distance from these technologies, but are addressed by and embedded within them. These projects explicitly reject the ideology, the stance, and the security of "critical distance" and reflect a basic operational commitment to a practice that explores spatial data and its processing from within. Only through a certain intimacy with these technologies—an encounter with their opacities, their assumptions, their intended aims—can we begin to assess their full ethical and political stakes.[9]

These projects were made possible by and unfolded in reaction to a series of events over the last two decades that amount to a cataclysmic shift in our ability to navigate, inhabit, and define the spatial realm. They were brought on by: the operationalizing of Global Positioning System (GPS) satellites for both military and civilian uses in 1991; the democratization and distribution of data and imagery on the World Wide Web in 1992; the proliferation of desktop computing and the use of geographic information systems for the management of data; the privatization of commercial high-resolution satellites later in the 1990s; and widespread mapping made possible by Google Earth in 2005. They are also conditioned by and explore a series of political, military, and social conflicts that have defined what is loosely called the "post–Cold War" period, a time in which war fighting became ever more deeply invested in image and information technologies and in which the borders between the civilian and the military, the domestic and the international, became more and more blurred. Each project captures a moment in time politically and, with the technical means possible at that moment, zooms in and expands that moment in space and time, with all the complexities entailed in the repurposing of any image from its intended functions to new ones.

A THEORY MACHINE

Toward the end of *Einstein's Clocks, Poincaré's Maps*, Peter Galison insists on the ways in which, in the twentieth century, "machines tied clocks and maps ever closer together." He focuses on the systems constructed by "American defense planners" that "turned satellites into radio stations that would beam timed signals to earth." In that transmission, an extremely precise accounting of time can translate into an extremely accurate recording of location: "50 billionths of a second per day provide[s] a resolution on the earth's surface of fifty feet."[10]

But the accuracy is, Galison argues, *relative*—indeed, the entire operation is for him a sort of concrete, real-world exploration and realization of Einstein's theory of relativity. The desired accuracy comes, rather precisely, at the cost of fixed or absolute understandings of space and time.

Galison is of course talking about the Global Positioning System, the network of twenty-four military satellites that today helps everything from missiles to mobile phones know more or less exactly where they are on the face of the Earth: "The late twentieth-century GPS satellites provided precision timing (and therefore positioning) for both civilian and military users. Built into this orbiting machine were the software and hardware adjustments required by Einstein's theories of relativity. The result is a planet-encompassing, $10 billion theory machine."[11]

GPS, Galison says, unhinges our sense of stable and fixed location: "so accurate had the system become that even 'fixed' parts of the earth's landmass revealed themselves to be in motion, an unending shuffle of continents drifting over the surface of the planet on backs of tectonic plates." This "relativization" is not only a result of the unprecedented accuracy of the new measuring technology, however. It is also embedded in the very way in which it works. The system functions only because it takes this relativity into account in its timekeeping: "According to relativity, satellites that were orbiting the earth at 12,500 miles per hour ran their clocks slow (relative to the earth) by 7 millionths of a second per day," and "eleven thousand miles in space, where the satellites orbited, general relativity predicted that the weaker gravitational field would leave the satellite clocks running fast (relative to the earth's surface) by 45 millionths of a second per day." When corrections for these relativistic errors were built into the system, it worked: "relativity—or rather relativities (special and general)—had joined an apparatus laying an invisible grid over the planet. Theory had become a machine."[12]

But what kind of theory? Galison limits his claims to Einstein's theory of relativity, but he draws radical conclusions nonetheless. Einstein's theory, he argues, "designed a machine that upended the very category of metaphysical centrality. Absolute time was dead. With time coordination now defined only by the exchange of electromagnetic signals, Einstein could finish his description of the electromagnetic theory of moving bodies without spatial or temporal reference to any specially picked-out rest frame, whether in the ether or on earth. No center remained."[13]

In fact, GPS and a whole new set of technologies linked to it have introduced, or hyperbolized, a profound decentering or disorientation, and it is that loss of absolute reference points—and the political engagements and commitments that can be *enabled* by that loss—that are explored in the projects chronicled here.

FROM THEORY TO PRACTICE

We constantly read maps. In print and on computers, mobile phones, PowerPoint presentations, and blogs, maps visualize everything from the movement of hurricanes and refugees to the patterns of traffic and shifting electoral landscapes. Maps and the sophisticated technologies that create them are not limited, of course, to the public domain—we can only imagine the complex maps housed in the nose cone of a cruise missile or those that detail the location of every phone call and email intercepted by the Department of Homeland Security. But we tend generally to reduce maps to the diagrams we hold in our hands. They show us where we are and how to get somewhere else, and in doing so, they can contribute to a sense of security and self-possession. The solidity and certainty of the phrase "You are here" would be the motto of that identity-reinforcing—and maybe even identity-constitutive—function of maps.

The more they become our everyday means of navigating simple and complex situations alike, the more we take maps for granted. Rather than the interpretations of information that they are, we too often see them simply as representations and descriptions of space. This makes the task of analyzing them even more critical.

Maps locate. We can read them because they come laden with conventions, ranging from their legend, scale, and codes of graphic representation to what counts as the information they represent. They depend on a system of notation or of coordinates that places things in relation to one another.

This holds for maps that claim to represent physical spaces as well as those that diagram or chart the relative location of nonphysical entities: maps of a family or kinship structure, for instance, or the flows of data through a network. The spaces that maps try to describe can be ideal, psychological, virtual, immaterial, or imaginary—and they are never *just* physical.

This drive to locate, to coordinate, however revelatory and even emancipatory it can be, also has its price. It seems as though in the end, maps—the successful ones, the ones that show us where we are and get us from here to there—risk offering only two alternatives. They let us see too much, and hence blind us to what we cannot see, imposing a quiet tyranny of orientation that erases the possibility of disoriented discovery, or they lose sight of all the other things that we ought to see. They omit, according to their conventions, those invisible lines of people, places, and networks that create the most common spaces we live in today.

It is this comfortable sense of orientation, of there being a fixed point, a center from which we can determine with certainty where we are, who we are, or where we are going, that the projects in this book challenge. They put the project of orientation—visibility, location, use, action, and exploration—into question, and they do so without dispensing with maps.

The maps here are built with GPS, satellite images, databases, and geographic information systems (GIS) software: digital spatial technologies originally designed for military and governmental purposes such as reconnaissance, monitoring, ballistics, the census, and national security. Rather than shying away from the politics and complexities of their intended uses, these maps attempt to understand them. Poised at the intersection of art, architecture, activism, and geography, they intend to uncover the implicit biases of the new views, the means of recording information that they present, and the new spaces they have opened up. These projects expose the materials they work with in order to reclaim, repurpose, and discover their inadvertent, sometimes critical, often propositional, uses. They can be used to document, memorialize, preserve, interpret, and politicize, or simply as aesthetic devices, but as with all maps, the ones here—as well as the data sets and the technologies used to chart them—are not neutral.

"WHAT IS CALLED REALITY IS CONSTITUTED IN A COMPLEX OF REPRESENTATIONS"

Every spot on earth can be located, calculated, and represented in multiple descriptive systems. The digitization of the globe was prefigured by the ancient Greek system of latitudinal and longitudinal lines, translating the surface of the Earth into an abstract and universal grid. Irrespective of politics, place names, borders, or changing environments, places were fixed within the mathematical descriptions of their location.

A network of atomic clocks, cameras, and computers has built a virtual globe on which any point of physical space is easily coordinated with digital space. With this change comes the potential to move digital information very quickly from one place to another. We are familiar with the idea that new spaces are today being constructed—spaces different from the ones in which our bodies normally move—but we don't quite know what to think about them. They are the netherland spaces of electronic money, information warfare, and dataveillance, but they are also the spaces of the everyday, such as mobile phone calls, radio stations, navigation systems, and online social networks.

To call this the "coordination" of physical space with digital space, as I just did, perhaps understates things. The digital and the physical globes interact in profound ways, constituting in effect a question about which globe has the priority. In these days when virtual coordinates direct missiles to their targets and social networks have allowed phone companies and other collectors of our data trails to predict our next move in physical space, the shift has resulted in a radical transformation—we can never be sure which coordinate system takes priority in terms of representing our identity or our spatial movements.

Some years ago, Rosalyn Deutsche noted that "what is called reality—social meaning, relations, values, identities—is constituted in a complex of representations." This book experiments with that claim, tests its bearing on our new digital spatial realm, and ends up confirming it in its most radical formulations:

> Reality and representation mutually imply each other. This does not mean, as it is frequently held, that no reality exists or that it is unknowable, but only that no founding presence, no objective source, or privileged ground of meaning, ensures a truth lurking behind representations and independent of subjects. Nor is the stress on representation a desertion of the field of politics; rather, it expands and recasts our conception of the political to include the forms of discourse. We might even say that it is thanks to the deconstruction of a privileged ground and the recognized impossibility of exterior standpoints that politics becomes a necessity. For in the absence of given or nonrelational meanings, any claim to know directly a truth outside representation emerges as an authoritarian form of representation employed in battles to name reality. There can never be an unproblematic—simply given—"representation of politics," but there is always a politics of representation.[14]

Representation and the Necessity of Interpretation

In 1977, the Eames Office, founded by Charles and Ray Eames, made a film called *Powers of Ten*. They aimed to explain "the relative size of things in the universe" by way of a sequence of images, zooming out in a series of frames from the aerial view of an unremarkable event, a couple having a picnic on a lawn, to the Milky Way and then back to a microscopic view of DNA.[15]

Citing the architect Eliel Saarinen, the Eameses argued for "the importance of always looking for the next larger thing—and the next smaller." This profoundly relativistic view animates their film about scale and the aesthetics of sliding along a scale; it is subtitled *About the Relative Size of Things in the Universe*. *Powers of Ten* constructs a seamless zoom into outer space, moving farther and farther away from the ground until the Earth becomes a tiny point in a much larger universe. Beginning with what we might call the human scale—the man and woman lying on a picnic blanket—the sequence of images reduces them (and their scale) to invisible insignificance, then reverses direction, returns to the surface of the Earth and its inhabitants, and then proceeds farther, all the way to the symbolic double helix of a DNA strand. "With a constant time unit for each power of ten," Ray Eames writes, "an unchanging center point, and a steady photographic move, we could show 'the effect of adding another zero' to any number." This steady move was what filmmakers Philip and Phyllis Morrison called "a disciplined smooth flow," "a long and uninterrupted straight line."[16]

The film intends to demonstrate that the universe is constructed as a set of transparent pictures, homogenous and continuous, telling more and more about its relational scale. In fact, however, the film tells us about the techniques of taking pictures of the Earth, its features and its context, at different scales. The zoom is *simulated* in the Eames movie, using more than a hundred separate images, many obtained from scientists and from NASA, others made in the studio, some even drawn and painted by hand.[17]

In a way, the apparently uninterrupted flow of the film, its seamless transition from one scale to another, might be seen as an attempt to compensate for its radically disorienting premise: There is no absolute scale, just as there is no natural or logical starting or stopping point for the zoom. It is not anchored anywhere—least of all in the human scale. Every scale is relativized by its proximity to and distance from the next, and there is no base or ground for the process of zooming itself. In the zoom we can see reaffirmed, even literalized, what Galison called the "upending" of "the very category of metaphysical centrality." The Eames's use of powers of ten as "an unchanging center point" was actually an exercise in radical decentering.

It took the Eames Office a long time and a lot of work to construct their zooms. Today, a nearly real-time zoom from the whole Earth to a picnic blanket is available on our desktops. And with a very easy interface, almost anyone can look at almost anything—not just a sentimental summer scene. The upending of the category of metaphysical centrality now is an everyday experience.

Today, "Google Earth" barely even names an application and its associated database; it is more of a nickname for our access to images of anyplace on the globe. Although it appears as a smooth zoom, the overhead view in Google Earth is just as much a composite, in its own way, as the "steady photographic move" of *Powers of Ten*. Instead of a comprehensive blanket of uniform-resolution (or real-time) images, it is a patchwork of archived aerial and satellite images of varying origins, sources, motivations, and resolutions. In fact, Google generates no overhead images of its own, but rather accesses them indirectly through the commercial enterprises that operate imaging satellites and via the people and governments who have tasked the satellites to collect data about specific locations at particular times. Google then assembles a composite map of these images, regardless of origin or resolution. For some places on the globe, Google Earth even has its own "archeological" record of the history of images of the spot, if and when those are available in the satellite company's database, and so it becomes possible to move backward and forward in time, as well as almost everywhere on Earth in space. Since 2008, by virtue of pressure from satellite image providers, Google also includes the name of the satellite company that has taken the picture.

How has this come about? The ease with which we can conduct these experiments often hides the reasons for the existence of the images in the first place. Why are they in the database, anyway? How did they get to be freely viewable online from 2005 on? The consumers of generally available satellite imagery, or even the ones who download images for a price from a commercial satellite database, will never know who has tasked a satellite to take a picture (unless they did it themselves) in order to see something close up, but from far away. And every view from a satellite is an experiment with the technology of looking close up at a distance, remotely examining and representing something as small as fifty centimeters of the ground from a height of four hundred miles in the sky.

In the ease of the Google Earth interface, as in the simplifications of a map, the political, military, and economic stakes that underwrite the creation and expansion of the database can often disappear. All that's left are the minimal data: the image has a date, a time stamp, and a series of coordinates in which it has been registered and made available for purchase by others, including Google Earth.[18]

Thus, when we use the ubiquitous zoom of Google Earth to look at our houses or neighborhoods, how many of us stop to consider that the image of our backyard was almost impossible to see—either because the image did not exist or its technology of the zoom was a military secret—only a short time ago? Moreover, how many people know what it is that they are looking at—a high-resolution commercial satellite image, a low-resolution one, or an aerial photograph?

The transition of satellite images from state secrets to commonplace everyday instruments that can be used for indulging idle curiosity, not just for implementing drone strikes on suspected terrorists, has been gradual, but accelerating. Only a few years separate the first Corona satellite mission (1964), tasked on high-resolution and top-secret image collection flights that were not declassified until thirty years later, and the launch of the first Landsat satellite (1972), a low-resolution environmental mission generating a potentially complete and publicly available world picture every three days. Some significant events mark the transition of satellite imagery from top secret to the taken-for-granted public availability that characterizes them now.

In August 1995, as a debate about mass killings the previous month at Srebrenica, in Bosnia, unfolded, Barbara Crosette reported in the *New York Times* that the Clinton administration had shown classified satellite and aerial photographs of mass graves and execution sites to the United Nations Security Council, but had made a distinction between them for the press.

> The administration made public three of the photographs, which showed disturbed soil, taken from a U-2 spy plane. It declined, however, to let reporters see the satellite photographs taken several days earlier, which were said to include pictures of people crowded into a soccer field. American officials said the satellite photographs were classified, although Secretary of State Madeleine Albright showed them to the other fourteen members of the Security Council.[19]

Thus, a residue of reticence and secrecy remained, for some images, just weeks after Vice President Al Gore had inaugurated one of the most ambitious declassification efforts in U.S. history with the unveiling of the CIA's Cold War–era Corona project and its extraordinary visual archive.[20] The example of the Srebrenica images, though, was the significant one: since then, we have lived in a geopolitical

U.S. satellite image taken on July 13, 1995, showing about six hundred people gathered in a soccer field at Nova Kasaba, Bosnia-Herzegovina, near Srebrenica. It was one of several classified images shown to members of the UN Security Council on August 10, 1995, as evidence of mass killings by the Bosnian Serb Army.
IMAGE: INTERNATIONAL CRIMINAL TRIBUNAL FOR THE FORMER YUGOSLAVIA, VIA U.S. HOLOCAUST MEMORIAL MUSEUM

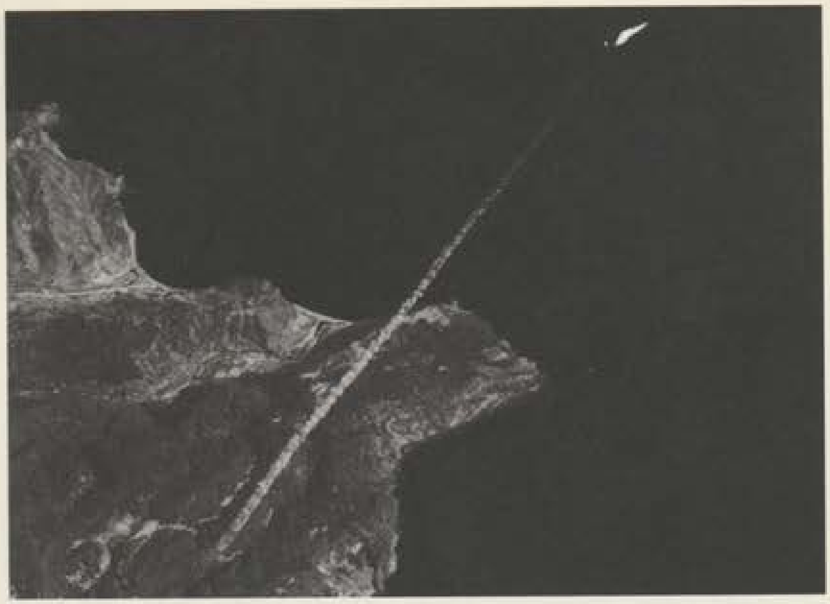
world in which it was not only a reasonable working assumption that major events could be monitored from outer space, but that the traces of that surveillance would appear in the public sphere.

In 2000, the *New York Times* for the first time used the newly available Ikonos satellite as a sort of alternative investigative journalist in Chechnya. On the front page of the Sunday "Week in Review" section, two comparable satellite images of the Chechen capital city of Grozny were published, bearing the title "Campaign Poster." The first image was dated December 16, 1999, and the second March 16, 2000, just ten days prior to their publication in the newspaper. The accompanying text remarked on the likely electoral victory that day of Russian President Vladimir Putin and explained: "The images above, commissioned by the New York Times and taken by a commercial satellite, hint at the cost of that victory, in the destruction of a residential area near Minutka Square in the Chechen capital, Grozny."[21] As Lara Nettelfield has pointed out, "unlike other images of destruction in the post-Communist world, the Grozny pictures failed to arouse public sympathy or outrage for the plight of civilians in Chechnya."[22] But since then, this genre

The *New York Times* first used before-and-after satellite imagery, directly obtained from a commercial provider, in an analysis of the role of the Chechen war in the Russian presidential campaign of March 2000.

of before-and-after images has become commonplace in much news gathering and reporting from zones of conflict and mass destruction.

Fast forward almost another decade. In April 2009, *The Lede* blog at the *New York Times* reported on what might be considered a satellite photo opportunity. "In what was either a remarkable coincidence or a bit of precision timing," wrote Robert Mackey, the North Korean government had launched a rocket "just as a commercial satellite, owned by a company which provides images of the earth to the Pentagon, DigitalGlobe, was passing over North Korea."[23] The *Guardian*'s science correspondent, Ian Sample, reported that at least one British defense analyst



"A satellite image showing what is believed to be the exhaust trail and part of a North Korean rocket launched on April 5. The company that took the photograph, DigitalGlobe, describes it as 'a panchromatic, 50 centimeter (1.6 foot) high-resolution WorldView-1 satellite image showing the rocket launch from the Musudan Ri launch facility, formerly known as Taepo-dong.'" CAPTION: *NEW YORK TIMES*; IMAGE: DIGITALGLOBE

"suspects Pyongyang had timed the controversial launch to coincide with the satellite's arrival, in the hope of maximizing publicity of the launch."[24]

Google Earth is only the latest step in the public availability or democratization of high-resolution satellite imagery. Many military technologies have gone from classified to omnipresent, from expensive to free, and from centralized to distributed, downloadable on our desktops anywhere on Earth with access to the Internet.[25] That much seems certain. Policy analysts have dubbed this a "growing global transparency."[26] However, because what is involved is the appearance in the public sphere of a way of viewing things close up at a distance in which there is no absolute scale, no anchor, no center, evaluating this new visibility and negotiating its reality is a lot less obvious.

THE OPACITY OF TRANSPARENCY

In September 1999, Space Imaging successfully launched Ikonos, the first satellite to make high-resolution image data publicly available. John Pike, who pioneered the civilian use of aerial and satellite imagery at the Federation of American Scientists and today directs GlobalSecurity.org, called it "one of the most significant events in the history of the space age."[27] Earlier, Pike had suggested that a new kind of deterrence was enabled when news organizations and civilians could test, with meaningful certainty, the authority of official claims about, for example, the presence or absence of nuclear facilities in other states. And likewise, "it provides an independent check," he said, "on what the government is saying, for example about mass graves and other wartime atrocities in the Balkans."[28] Ann Florini, of the Carnegie Endowment for International Peace, argued that "on the plus side, governments and nongovernmental organizations may find it easier to respond quickly to sudden refugee movements, to document and publicize large-scale humanitarian atrocities, to monitor environmental degradation, or to manage international disputes before they escalate.... But, there is no way to guarantee benevolent uses."[29]

When U.S. Secretary of State Colin Powell made his infamous February 2003 presentation to the United Nations Security Council claiming to demonstrate that the government of Iraq was in possession of weapons of mass destruction, he presented a PowerPoint slide show that included a lot of satellite images, annotated to support his claims. "The facts speak for themselves," he said. "My colleagues, every statement I make today is backed up by sources, solid sources. These are not assertions. What we are giving you are facts and conclusions based on solid intelligence." And later he repeated, "Ladies and gentlemen, these are not assertions. These are facts corroborated by many sources, some of them sources of the intelligence services of other countries."

Later, he clarified his epistemology. He explained that the images, in fact, did *not* speak for themselves and were indeed hard to understand, but insisted that he was confident in his own ability, backed by the work of experts, to say what they meant:

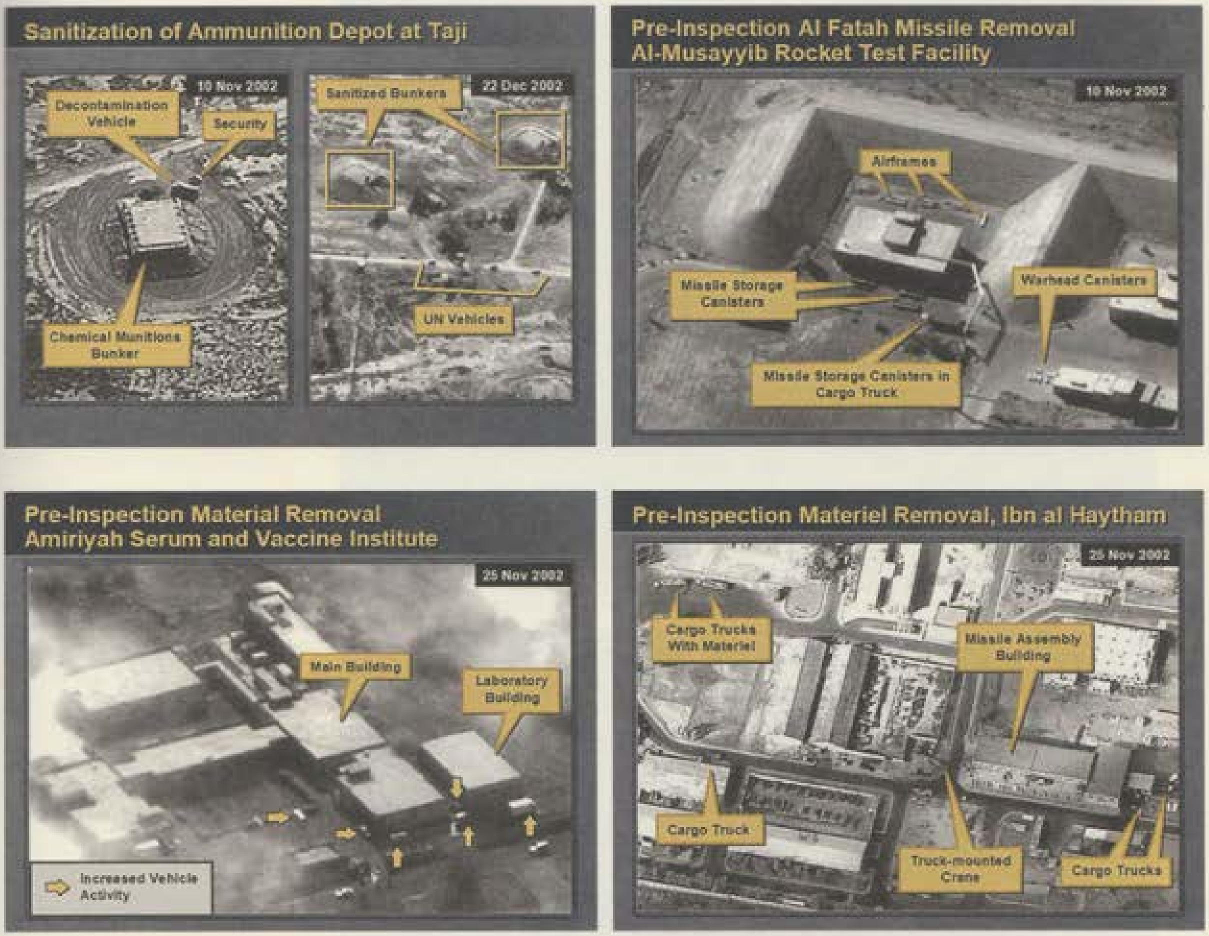
> Let me say a word about satellite images before I show a couple. The photos that I am about to show you are sometimes hard for the average person to interpret, hard for me. The painstaking work of photo analysis takes experts with years and years of experience, poring for hours and hours over light tables. But as I show you these images, I will try to capture and explain what they mean, what they indicate, to our imagery specialists.[30]

The images he presented had been artfully interpreted, which is not to say that they were fake or forged or even that the images distorted the truth. Simply and more importantly, they were not objective photographs, but were presented as such. They were interpretations presented as facts and in a way that prevented anyone else from examining the uninterpreted data. The presentation and its catastrophic results remind us that we need to be alert to what is being highlighted and pointed toward, to the ways in which satellite evidence is used in making assertions and arguments. We need to learn how to agree and disagree with those arguments, to challenge the interpretations made of images that are anything but objective or self-evident. For every image, we should be able to inquire about its technology, its location data, its ownership, its legibility, and its source. To facilitate that inquiry, an image and its associated data should remain closely linked. But we are seldom given access to the data or the tools with which to interpret it, because the satellite images have been stripped of their data and presented to us as pictures already interpreted by experts.

We know now that there were no weapons of mass destruction found in Iraq. We also know that there was a videotape made by a jihadist militia, the Islamic Army in Iraq, that showed the group using satellite images from Google Earth to plan an attack.[31] And we have witnessed the "benevolent" stand taken by the Satellite Sentinel Project at Harvard, which makes use of DigitalGlobe satellite imagery to "identify chilling warning signs [of mass atrocities]—elevated roads for moving heavy armor, lengthened airstrips for landing attack aircraft, build-ups of troops, tanks, and artillery preparing for invasion—and sound the alarm."[32] Michael Van Rooyen, director of the Harvard Humanitarian Initiative, which houses the project, says that it's "a clear example of how technology transforms the way we think about and prepare for crises. In the hands of well-trained and experienced analysts guided by humanitarian principles, satellite technology provides a potent new way of ensuring that the world witnesses threats to civilians."[33]

Is the globe transparent? Yes, sort of. High-resolution satellites seem to signify global transparency, to realize effectively the dream that pretty much anyone could be able to see pretty much anything, anywhere. Because a visual regime that is inherently decentering, that disorients under the banner of orientation, can be used for all sorts of purposes, understanding how the images thus generated are produced and used is a civic responsibility and a political obligation. And the ways in which these satellite views are for the most part presented to the public—which is to say, in the news or in the public announcements of private companies, NGOs, or government agencies—are as misleading as they are revelatory: they come to us as already interpreted images, and in a way that obscures the data that has built them. As apparently self-evident images, pictures stripped of their data, they generally lack, omit, or erase the fact, quite simply, that they have been interpreted.

In such a situation, Lisa Parks worries that any satellite image, even on Google Earth, implies a military view, which is to say, "knowledge practices of intelligence gathering and Earth observation…satellites…encircling the Earth on planetary



Four slides from U.S. Secretary of State Colin Powell's PowerPoint presentation on Iraq to the United Nations Security Council, February 5, 2003. These are some of the many annotated satellite images displayed that day, without access to the original satellite data.
IMAGES: U.S. DEPARTMENT OF STATE

"The Satellite Sentinel Project (SSP) has published new imagery indicating that as Sudan and South Sudan clashed over an oil field near the disputed border town of Heglig, a key part of the pipeline infrastructure was destroyed. The damage appears to be so severe, and in such a critical part of the oil infrastructure, that it would likely stop oil flow in the area, according to SSP."

FROM PRESS RELEASE, HTTP://WWW.SATSENTINEL.ORG; SATELLITE IMAGERY FROM DIGITALGLOBE patrols" and "treat[ing] the surface of the Earth as a domain of unobstructed Western vision, knowledge, and control." She says, "I define remote sensing as a televisual practice that has been articulated with military and scientific use of satellites to monitor, historicize and visualize events on Earth."[34]

Parks spends a long time analyzing the same images of Srebrenica mentioned above, the ones Madeline Albright showed to the Security Council. Some of her analysis may seem apologetic now, for instance, her protests against the ways "the Western media tended to demonize the Serbs" and her suggestion that the Bosnian Army "must take partial responsibility for conditions leading to the massacre" at Srebrenica.[35] Her response is complicated by her almost automatic suspicion whenever agencies of the U.S. government appear to be the main interpreters of events by way of a satellite image. However, she is right that we were simply given images and interpretations by Albright, and more importantly, that we were also and unexpectedly seeing high-resolution intelligence imagery used for the first time as evidence of genocide. But today it is clear that Albright's imagery was in fact essential evidence of a crime and its cover-up.

Parks devotes a good part of her analysis to the "passive-aggressive voyeurism" of the U.S. government, "idly recording" the attack on Srebrenica while failing to do anything to stop it. She concludes that because of its "remoteness and abstraction," the satellite view functioned merely as an "overview of the war, draw[ing] on the discursive authority of meteorology, photography, cartography and state intelligence to produce its reality and truth effects."[36] The combination of passivity (just watching) and aggressivity (the militarized view) is most troubling to her. The problem is not just that the image comes from the state, though, and bears its codes; she seems troubled by its ontology, as well.

> Since it is digital, however, the satellite image is only an *approximation* of the event, not a mechanical reproduction of it or live immersion in it.... Because it is digital, its ontological status differs from that of the electronic image. The satellite image is encoded with time coordinates that index the moment of its acquisition, but since most satellite image data is simply archived in huge supercomputers, *its tense is one of latency*.... The satellite image is not really produced, then, until it is sorted, rendered, and put into circulation.[37]

This latency or approximation, for Parks, leaves the satellite image open to all sorts of exploitation, most notably that operated by a military-diplomatic machine promoting its own omniscience and objectivity. Critical of that, she endorses the engagement of journalist David Rohde, who traveled to the scene in the immediate aftermath of Albright's revelations to see whether he could confirm what the images seemed to show. She admires his success in "witness[ing] the minutiae that the satellite could not pick up," his eyewitness account of the body parts, clothes, shell casings, and documents left behind in the mass murders. She is tempted by the notion that, because the eye sees at a higher resolution than the satellite, it sees more, and more clearly. Parks praises Rohde's "refusal to accept the satellite image as evident"—"instead of accepting the state's attempt to anchor the meaning of the satellite image, [he] seizes its emptiness and abstraction as impetus to infuse it with partiality, situated knowledge, and local tales."[38]

She leaves unstated the fact that Rohde in fact did confirm the interpretation that Albright had offered, but that is less important than her commitment to what is called "ground truthing." The ultimate test of the image, it seems, is what can be found, seen, heard, and sensed on the ground itself. In fact, she makes the trip herself some years later, but confesses to not really being able to see very much. Srebrenica was still largely populated by those who had killed and expelled its Muslim population and neighbors: "at Cafe Kum I encountered a former Serbian military officer who, I was told, had recently been indicted by the War Crimes Tribunal." So it was hard to learn much. "There is a code of silence in Srebrenica that is difficult to penetrate, especially for an outsider like me," she says. She concludes from this persistence of unreality—"the site was as abstract to me up close as when I first saw it on television"—that "witnessing became *a fantasy of proximity*."[39]

This conclusion seems more reliable than the premise that generated it. The view up close can be just as blurred as the one from overhead, and the difference between the image as a "site of activity" and a "memorial" more difficult to tell than it might at first seem.[40] What is most valuable here is the caution she invites: no satellite image presents a simple, unambiguous picture of the Earth, and a visit to the site itself can often raise more questions than it answers, reaffirming rather than reducing the openness of the image to interpretation. In the end, it seems, embedded in the very structure of the techno-scientific, militarized, "objective" image is something more disorienting, an "emptiness and abstraction" that resists sovereign control and opens itself to other sorts of interpretation.

INTERPRETATION AND "THE VIEW FROM NOWHERE"

What does the "emptiness and abstraction" of digital satellite images reveal? Although how such images are to be read and who is able to read them are of central importance, widespread understanding of satellite imagery and how to interpret it lags considerably behind its rate of production. We are often presented with images bereft of any data associated with them and subordinated to the interpretations that guard that data behind a shield of security and expertise. The projects in this book aim to challenge that.

What digital satellite images can show is certainly derived from a military or logistical worldview and deeply indebted to the institutions committed to seeing the world in military or logistical terms. The publicly available images in Google Earth come largely from DigitalGlobe and GeoEye, both major contractors for the U.S. government in the development and deployment of high-resolution satellites. By allowing transparency and openness—or rather, by funneling these images to the public via Google Earth—the United States has remained, thus far, in the forefront of viewing at high resolution across borders. And because what is at issue here is interpretation, other interpretations are possible.

What is largely missing from Parks's argument is the positive reading of what "image interpretation" implies. It is both an art and a science, especially with satellite image data, and the relation between the two is not an easy one to negotiate, even for "experts" whose expertise is at the service of governments and commercial institutions. John Pike, interviewed on National Public Radio about satellite imagery of destroyed villages in Darfur, responded to his host's claim that "the interpretation of these images is an art as well as a science" this way:

> Well, it's a discipline that the military intelligence community has spent a long time training people to do. One of the big challenges with this type of imagery is in finding things that it's readily understandable what you're looking at, and doesn't require any great leap of imagination, you're not dependent on somebody else captioning it. In the case of the Chinese nuclear submarine, well, that was pretty straightforward. In the case of Darfur, frankly, I've been very frustrated that the satellite imagery has not had the sort of impact on the public imagination that we had hoped it would in the past.[41]

Pike is telling us about the leaps of imagination that image interpreters must take when they look at an image, and longing for images that require fewer and shorter leaps. We continue, though, to defer to experts and to privilege the view that designates itself as scientific and objective.

But because the interpretation of such images is an art, as well as a science—because it inherently involves imaginative leaps—the putatively scientific and objective interpretations at the service of governments and commercial institutions tell only *a* story, not *the* story, of what is going on in these images. Views of the globe, which is to say, maps, have always combined the science of spatial description and documentation with a certain art, as well. J.B. Harley argued famously that maps should be understood as multidisciplinary artifacts, ones that reveal social and political forces, as well as representations of power. He worried, in 1989, about the ways in which "the scientific rhetoric of map makers [was] becoming more strident." "Many may find it surprising," he wrote, "that 'art' no longer exists in 'professional' cartography." He asks that we question the by now naturalized conventions through which maps have in fact standardized our images and knowledge of the world. He also asks us "to search for the social forces that have structured cartography and to locate the presence of power—and its effects—in all map knowledge." Although Harley's article was aimed at historians, *against* "what cartographers tell us maps are supposed to be," his questions are equally important for professional cartographers and the users of maps.[42]

He asks about the legends and frames of ancient maps, whose creators could only imagine what the globe looked like, as well as the symbols and legends in contemporary maps, which claim the status of objective description of reality. He treats both as texts that need to be read closely so we can start to understand the bias in any map projection. He reminds us that even something as simple and innocent as the mathematical translation of a sphere projected as a so-called undistorted flat plane has a "politics." "In our cartographic workshops we standardize our images of the world," he writes, and the process is complex: "the way maps are compiled and the categories of information selected; the way they are generalized, a set of rules for the abstraction of the landscape; the way the elements in the landscape are formed into hierarchies; and the way various rhetorical styles that also reproduce power are employed to represent the landscape." The standardized cartographic images to which we have grown so accustomed that most of us don't know them as a particular interpretive decision—the Mercator projection—are distinguished from others because they project the spherical globe as a series of apparently undistorted square shapes. This formal, but not only formal, gesture, he points out, "helped to confirm a new myth of Europe's ideological centrality."[43]

Svetlana Alpers attributes these standardized images of the world, or the flattening of the Earth into the mathematical uniformity of longitude and latitude, to a certain disappearance of the subject, or what, following Thomas Nagel, she calls "the view from nowhere."[44] As an art historian, she opposes this flat surface to the equally mathematical formula of the perspectival grid, which is viewed from somewhere—the point of view of the subject who both constructs and is constructed by that view. Perspective, it is well known, freezes a subject in a particular place and time.

Maps do not employ perspective. Although the grid that the Mercator and other such projections impose on the sphere of the Earth may share with perspectival paintings the mathematical uniformity of the frame and the definition of the picture as a window through which an external viewer looks, they do not share the positioning of the viewer. The cartographic projection is, in that sense, viewed from nowhere.[45]

Maps construct a spatial interpretation through their techniques of representation, the "normalized" views that Harley decries.[46] A cartographic projection transforms, mathematically, a sphere into plane.

Yve-Alain Bois arrives at maps, although he does not quite specify that this is where his argument leads, from another type of constructed, measured, and projected view: the "axonometric" projection. An axonometric drawing shows an object in ways that cannot be seen simply by looking at it. To do so, it rotates the object along one or more of its axes such that the surfaces of the top and two sides are in view simultaneously. The horizontal and vertical dimensions are projected to scale, so that their planes are parallel to each other. Unlike in a perspectival drawing, there is no single fixed position from which the object is viewed.

Axonometric drawing originated, argues Bois, in techniques developed by engineers in 1822 to draw carefully the joints of a new material, iron. What distinguishes this technique is that the top and the side views are both drawn to scale, as if one were flying over the joint, but no perspective is generated to distort the scale. The engineers, Bois writes in "Metamorphosis of Axonometry," derived their drawings from French military artists a century and a half earlier, who had used the technique to simulate the trajectory of a cannonball making its way over the walls of a medieval city, in order to compensate for the blindness imposed on them by the walls.[47]

Modern architects reinvented this drawing technique another hundred years later, in 1923, showing an object from the top and the side view in equal measures in order deliberately to generate a decentered modernist aesthetic of ambiguity. "All treatises which precede this event…regardless of their concern with architecture, military art, technical drawing or geometry, emphasize the convenience and accuracy of axonometry, whereas modern artists celebrated its perceptive ambiguity…. The axonometric image is reversible; it tears free of the ground (Malevich's term), facilitating aerial views." After chronicling the various ways in which more and more architects, from Herbert Bayer to the New York Five, used the axonometric view to focus on ambiguous spaces, rather than to reproduce the scientific or factual vision of the engineer, Bois pushes the argument further to propose that the "history of axonometry should include a chapter on aerial views and photogrammetry." And there is no reason to stop there: the history should extend to remote sensing in all its forms…a history precisely, as Bois insists, not only of the logistically and pragmatically military, but also at the same time of instability, abstraction, "ambiguities," and the "vertiginously ambivalent."[48]

"The axonometric drawing hovers or flies above its object," concludes Bois.[49] Denis Cosgrove has written some of the history of this flying image, focusing on Oskar Messter's 1915 invention of the airborne automatic camera, which "allowed pilots to film a 60-by-2.4 kilometer strip of land surface in a sequence of frames at the scale of conventional topographic maps." With it, he says, "a new mode of geographical representation was created: 'a flattened and cubist map of the earth,' which demanded new skills to relate the image to the ground": "Composite photographic images demanded a different way of looking than the still photograph did. The eye moves over the virtual space of the image as across a map, parodying in some measure the kinetic vision of the flyer.... Over time the aerial photograph and, more recently, remote-sensed images have become codependent with the map."[50]

Although high-resolution satellite images are by now naturalized as authoritative and maplike, the rigor (and we could even say the truth) of their embeddedness into the coordinates of longitude and latitude, the digital grid of navigational lines, should not be allowed to efface their military-political origins, or the technologies that have produced them, or the "relativity" and "ambivalence" that can render them so profoundly opaque and disorienting—and demanding of interpretation.[51]

PARA-EMPIRICISM

Not only is the physical surface of the Earth being mapped—*we* are also part of the transformation effected by digital mapping technologies. Anything that is listed, counted, and linked to a physical or digital address can potentially become spatial data and be mapped as well. Mounds of social, financial, and mobile data are collected on a daily basis by private and public entities, and we are being counted and translated into data each time we interact with electronic networks. Maps are being generated and updated constantly with this data. All of us—crossing a border, talking to a census taker, swiping a credit card, riding the London Underground, entering a luxury building in Dubai or a public housing project in Seattle, withdrawing cash at an ATM, driving through a highway toll booth—can become, and are regularly becoming, points on all sorts of maps. The social city is inscribed repeatedly onto the physical city.

The projects in this book use advanced digital technology and data. I have each time taken a leap and not left the data it to speak for itself, but have tried instead to offer a reflection on what can be done with it. When working with data, things are not as obvious as they might seem. So while others call working with data "quantitative," "empirical," or "objective" analysis, I prefer the somewhat more modest notion of "para-empiricism."

The English prefix "para" comes from the Greek word meaning "by the side of, beside," hence "alongside of, by, past, or beyond." It has come to denote, in words such as "paramedic" and "paramilitary," the sense of auxiliary, almost, not quite, functional but not really a substitute. It is with this double sense of alongsideness and incompleteness that I employ this neologism.

Usually when we appeal to *data*, we mean by this nothing less than reality itself, the concrete facts of the world, the real things. We ask for data points, we collect them in data sets and databases, and we treat them as indexical traces of the very phenomena we wish to understand or manipulate. Data are, in their etymological sense, the givens with which we can operate on the world. When empirical social scientists want to explore the hard facts of a situation, it is to data in this sense that they turn.

Instead, the word "data," in this book, means nothing more or less than representations, delegates or emissaries of reality, to be sure, but only that: not presentations of the things themselves, but representations, figures, mediations—subject, then, to all the conventions and aesthetics and rhetorics that we have come to expect of our images and narratives. All data, then, are not empirical, not irreducible facts about the world, but exist as not quite or almost, alongside the world: they are para-empirical.

To put it another way, there is no such thing as raw data. Data are always translated such that they might be presented. The images, lists, graphs, and maps that represent those data are all interpretations. And there is no such thing as neutral data. Data are always collected for a specific purpose, by a combination of people, technology, money, commerce, and government. The phrase "data visualization," in that sense, is a bit redundant: data are already a visualization.

My claim is not that this plunges us into some abyss of uncertainty, though, or makes it impossible to function in the real world. On the contrary, it is only on the condition of accepting this condition of data, in *para*-empirical condition, that we have any chance of operating responsibly in or on the world. It is because we admit that our data are not the same as reality, that there are disputes about data and that they can be decided only in debates with others, that the realms of politics and ethics open up for us.

Here I share the position of Bruno Latour, who argued in his introduction to the catalog of his ZKM show, *Making Things Public*, that the time has come for a thorough reevaluation of the so-called "crisis of representation." It might be, he says, and he means that this is in fact the case, that

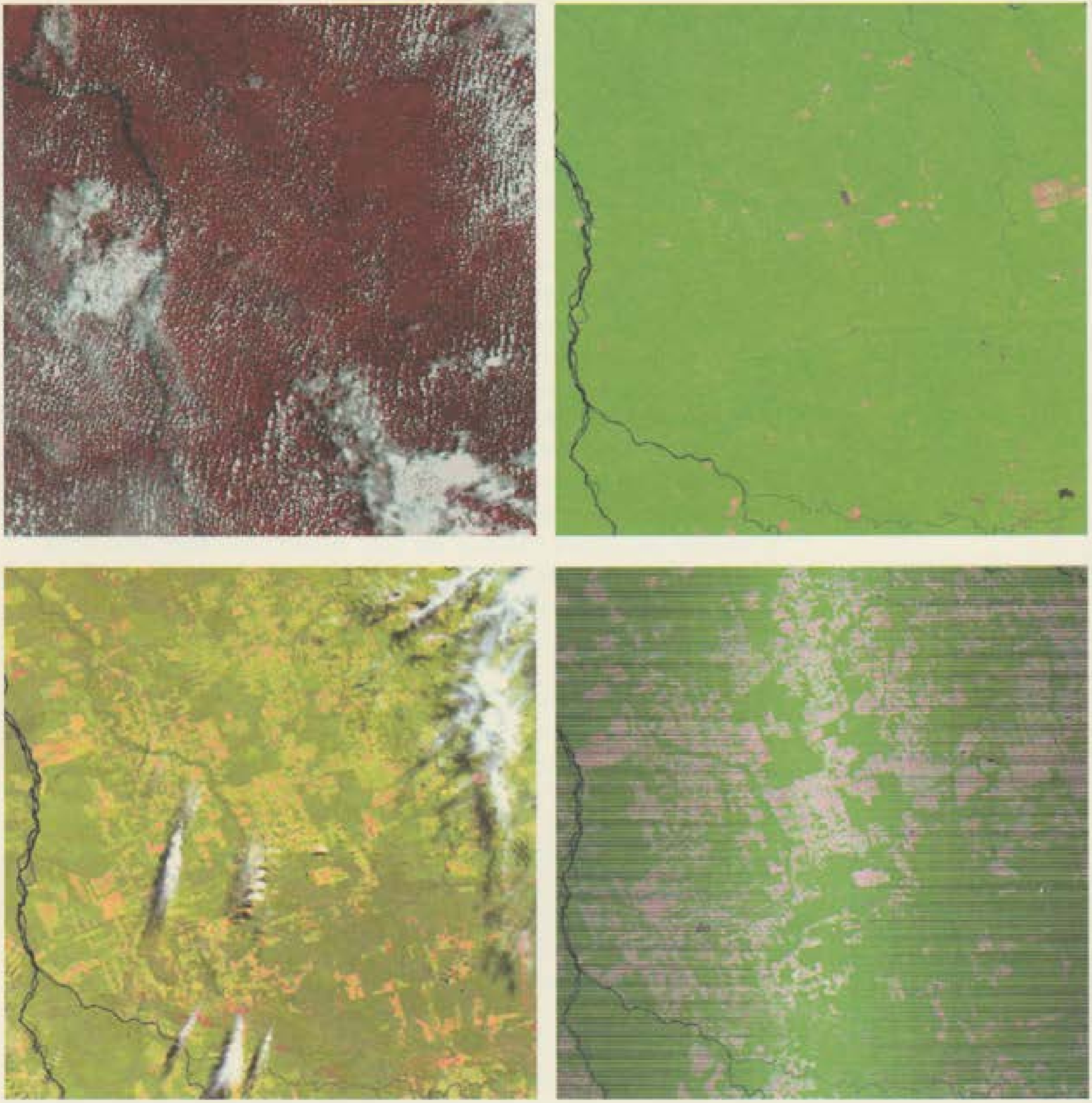
> half of such a crisis is due to what has been sold to the general public under the name of a faithful, transparent and accurate representation. We are asking from representation something it cannot possibly give, namely representation without any re-presentation, without any provisional assertions, without any imperfect

> proof, without any opaque layers of translations, transmissions, betrayals, without any complicated machinery of assembly, delegation, proof, argumentation, negotiation and conclusion.[52]

"Para-empiricism" names for me this effort at once to reclaim a sense of reality, and not to imagine that this requires doing away with representations, narratives, and images.

The projects included here don't only talk *about* maps, images, data. They seek to talk *with* them—to put them to use in ways that are critical of or that enlarge our conceptions of where we are and might be in the world. From the facts on the ground to the exhilaration of disorientation, the projects and writing, the images and data, collected here all aim to open spaces for discussion and action. They affirm the necessity of critique, and they reject the idea that critique requires "critical distance," at least in the ordinary sense. That is, they aim to make more space in the public sphere for the participation of everyone, not just governments, their militaries, and the experts tasked with making interpretations of global imagery to serve those constituencies. They aim to make it possible for everyone at least to understand how to participate actively, and by necessity politically, within the new territories constituted by these technologies of representation.

LEXICON



Landsat's forty-year archive gives researchers the ability to investigate changes at the same location over time. These images, acquired by Landsat 1, 4, 5, and 7, show an area near Nova Monte Verde, a municipality in the Brazilian state of Mato Grosso, just south of the Amazon, where rain forest is being replaced by ranching and monocropping. Top left: November 30, 1972; top right: August 5, 1986; bottom left: May 5, 2006; bottom right: August 4, 2012. The striping in the last image is due to failure of Landsat 7's scan line corrector.

From Military Surveillance to the Public Sphere

The discussions of the projects in this book refer to a number of technologies used in the process of mapping—GPS, remote-sensing satellites, and GIS. The projects make use of them in order to create new images or repurpose existing ones. But the history and politics of these technologies are at once obscure and important for understanding what's at stake in working with them. The following lexicon attempts to sketch the stories of the development of these technologies, their technical language, and their political and historical contexts. This chapter, which largely eschews explicit theoretical reflection, is designed both to document the increasing public access to these technologies and to lay the groundwork for the discussions of how they have been put to use in the chapters that follow. The list is not a complete one, but touches on most of the technologies with which I have engaged.

GLOBAL POSITIONING SYSTEM (GPS)

The GPS is a network of twenty-four satellites and five ground stations designed to provide to anyone carrying a portable receiver a highly specific determination of his or her location, anywhere, anytime, and in any weather.[1] The satellites, launched and operated by the U.S. military, are arranged in six circular orbits at an altitude of 11,000 miles, which makes it possible for at least four of them to be "seen" at one time by a receiver anywhere on Earth, and they constantly emit signals specifying their time and their own positions. A GPS receiver measures the time that the different signals take to reach it, and by comparing that with what it learns about where the satellite is, the receiver can calculate its own position. GPS location and time signals are freely available to anyone with a GPS receiver, including those embedded in other devices, such as mobile phones and cameras.

The research and launch period for the Global Positioning System began in 1973 and ended in 1991, when the program became operational just in time for the first Gulf War. The first experimental satellite was launched in 1978, the first satellite in the system was launched in 1989, and the full constellation of twenty-four satellites, also known as NAVSTAR by the Department of Defense, was completed in 1993.[2] GPS is now not only a household word, but a ubiquitous technology—what the official GPS website calls a "U.S.-owned utility"—used for everything from directing missiles to their target, to tracking elephants, to locating mobile phones and their users, to everyday navigating on land and sea, to hiking in the mountains, to recording the precise time of a financial transaction, to playing urban games using geotagging devices, and beyond.

Originally designed to provide accurate measurements of positions to within 100 meters, GPS is now capable of locating a position within 5 meters of accuracy. Not everyone, however, has always been permitted to make use of this degree of accuracy. When the system was launched by the U.S. military, it was designated a "dual-use technology," which meant that its features were also available for civilian use—but in an intentionally downgraded way. Originally it was governed by a policy known as "Selective Availability," which intentionally scrambled the highly accurate signals so as to reduce accuracy readings to 100 meters for civilian users. It was possible for civilians to improve the accuracy using a technique called "differential correction," which involved gathering additional readings from base stations at known locations within roughly three hundred miles (the area covered by one group of four satellites) and correcting the errors by measuring against the location of the base stations. This allowed, even in the early days of the system, position readings between 2 and 5 meters of accuracy.

Over time, the accuracy and availability of the GPS system has been affected less by the limitations or capacities of the technology than by a series of U.S. government policy decisions.[4] The first was the decision to activate the system in a two-tier manner, with different quality readings available to military and civilian users.

Only five years later, in 1996, President Clinton committed the United States to the continued maintenance and upgrade of the system and announced that it was his "intention to discontinue the use of GPS Selective Availability (SA) within a decade, in a manner that allows adequate time and resources for our military forces to prepare fully for operations without SA."[5] In May 2000, the SA program was abandoned, and fully accurate GPS readings are now publicly and freely available.

Today, according to the U.S. government's online GPS information page:

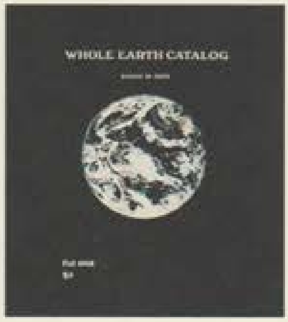
The GPS signal in space will provide a "worst case" pseudorange accuracy of 7.8 meters at a 95% confidence level. The actual accuracy users attain depends on factors outside the government's control, including atmospheric effects and receiver quality. Real-world data collected by the FAA show that some high-quality GPS SPS receivers currently provide better than 3 meter horizontal accuracy. [FAA data from early 2011 shows GPS SPS was often accurate to ~1 meter.] Higher accuracy is available today by using GPS in combination with augmentation systems. These enable real-time positioning to within a few centimeters, and post-mission measurements at the millimeter level.... The accuracy of the GPS signal in space is actually the same for both the civilian GPS service (SPS) and the military GPS service (PPS). However, SPS broadcasts on only one frequency, while PPS uses two. This means military users can perform *ionospheric correction*, a technique that reduces radio degradation caused by the Earth's atmosphere. With less degradation, PPS provides better accuracy than the basic SPS. Many users enhance the basic SPS with local or regional augmentations. Such systems boost civilian GPS accuracy beyond that of PPS.[3]

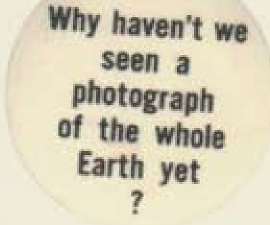
In 2004, President Bush created the National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT) and adopted a new national policy committed to modernization, sustainability, and maintenance of GPS as a free worldwide utility.

Over the past decade, the Global Positioning System has grown into a global utility whose multi-use services are integral to U.S. national security, economic growth, transportation safety, and homeland security, and are an essential element of the worldwide economic infrastructure. In the year 2000, the United States recognized the increasing importance of the Global Positioning System to civil and commercial users by discontinuing the deliberate degradation of accuracy for non-military signals, known as Selective Availability.[6]

The policy acknowledges the development of European-based PNT systems and supports standards of interoperability and compatibility so that they might rely on each other's infrastructure. The policy also endorses a more accurate version of the system for military use, but without SA. In 2010, President Obama reaffirmed these policies.

Other nations have begun putting their own PNT systems into place. In Russia, the system is called GLONASS and has been in operation since 1995. Galileo is a system being developed by the European Union and other partner countries and is planned to be operational by 2014. There are other regional systems being planned by China, India, and Japan.





In 1966, Stewart Brand printed and sold buttons which asked the question, "Why haven't we seen a photograph of the whole Earth yet?" As his colleague Robert Horvitz wrote later, "Stewart wanted NASA to release a photo of the whole Earth because he believed it would have significant psychological impact: it would be visual proof of our unity and specialness, as our luminous blue ball-of-a-home contrasted dramatically with the dead black emptiness of space. Differences in skin color, religion, nationality and wealth, which can seem so important down here on Earth, shrink to nothing when viewed from afar." No spy satellite images were declassified. But a year later, NASA and a team of weather scientists at the universities of Wisconsin and Chicago released a film made of images taken by the newly launched ATS-III satellite in November 1967, titled "The First Color Movie of the Planet Earth: Viewed from 22,300 Miles over Brazil." And in the fall of 1968, the first issue of Brand's *Whole Earth Catalog* told readers how to buy a 16mm print of the film, and featured another image, also from the ATS-III spin-scan camera, taken over Brazil on November 10, 1967, on its cover. SATELLITE IMAGE: NASA

REMOTE-SENSING SATELLITES

The *Oxford English Dictionary* defines "remote sensing" as the sensing "of something not immediately adjacent to the sensor; *spec.* the automatic acquisition of information about the surface of the earth or another planet from a distance, as carried out from satellites and high-flying aircraft." Remote sensing implies the collection of knowledge from an array of distances and methods, from human sight and sound to seeing and hearing from hundreds of miles in the sky or deep down in the ocean from the water's surface. What follows, however, focuses only on remote-sensing satellites and the technologies that allow us to see very closely from a distance.

Remote-sensing satellites have been launched since the 1960s, generally to an altitude of between 400 and 900 kilometers (249 and 559 miles) above the Earth, first by the United States and the Soviet Union (later Russia) and then by other states, including France, Israel, and India.[7] Remotely sensed images are generated either by the telescopic lenses of cameras or by sensors on the satellites. Older satellites captured what they sensed as analog images on physical storage surfaces, such as film, while later satellites have transmitted their data as digital information that is converted to images by ground stations. With either method, what remote-sensing satellites sense and record is reflected radiation: the ordinary visible light spectrum that allows us to see colors, and, since the 1970s, the nonvisible infrared spectrum that allows, for example, for types of vegetation to be differentiated from each other by more than color.

This is all that each remote sensing satellite has in common. What follows outlines a series of satellites used for remote sensing from 1960 until 2010. It is by no means a complete list, but can serve as an introduction to the satellites used here. The orbiting platforms range from spy satellites launched by the U.S. military and intelligence agencies (for instance, Corona), to those launched with public funds to monitor the Earth's resources (Landsat and SPOT), to privately launched satellites that today make very high-resolution imagery publicly available (for instance, Ikonos and GeoEye). This sequence tells the story of the technopolitical transformation of access to remote-sensing imagery, a progression in both access and resolution that today makes very detailed images of the Earth from outer spac;e almost commonplace. The history is one of a tension between secrets and spying, on the one hand, and access and commerce, on the other, finally enabling nonprofessionals and civilians to make use of these powerful information resources.[8]

In my work, the satellites I have made use of are mostly those launched by the United States and operated by a combination of private corporations and U.S. government agencies. This is not an accident. Aside from the French SPOT satellites, launched in 1986, the United States has always had the highest-resolution imagery available and has maintained a set of policies designed to guarantee its global dominance in the field of satellite imagery.[9] This may change in the future. As with GPS satellites, other countries have launched high-resolution Earth-imaging satellites, including India, China, Japan, and Israel, and this list will expand to include Turkey, South Africa, and the Gulf Cooperation Council in the next decade.[10]

CORONA (UNITED STATES, 1959–1972)

Begun under the Eisenhower administration in reaction to the Soviet Union's Sputnik project, the Corona program focused primarily on photographing the Soviet Union and the People's Republic of China. The series of six classified satellites—dubbed KH-1 through KH-4B in a series of secret documents titled *Talent Keyhole*—produced high-resolution images for intelligence, reconnaissance, and mapping purposes. Today, Corona negatives and accompanying documents are available in the public sphere, prominently featuring the crossed-out words "TOP SECRET."

Over time, the ground resolution of Corona imagery improved from 40 feet to 5 feet.[11] Individual Corona images are film negatives, each recording 10 miles by 120 miles of ground space. The imagery was exposed on a newly designed physical polyester film, now known as Mylar. It was collected onboard the satellite in rolls and ejected or "de-orbited" in canisters inside a capsule with small parachutes, to be picked up in midair by aircraft at a location near Hawaii. "The capsules were designed to float, so that if the plane missed, Navy boats could retrieve them. In case the boats missed, the capsules were fitted with salt plugs that would dissolve after two days in the ocean, causing the capsule to sink beneath the waves, so the film could never fall into enemy hands."[12]

Rather than orbiting the earth for long periods of time, Corona satellites were "tasked" on missions to specific sites and territories. Corona was alternately used to spy on and to map certain locations. On its first successful one-day mission, August 18, 1960, KH-1 orbited the Earth only three times, taking pictures of 1.65 million square miles of the Soviet Union and Eastern Bloc countries on three thousand feet of film. Later missions lasted up to nineteen days, and the KH-4 satellites were equipped with two cameras—for both intelligence and mapping purposes. The last imagery was acquired by the KH-4B satellite on May 31, 1972. According to historian Keith Clarke, "The systems worked so well that in short order the CIA was using Corona to map the world, remap the U.S., and to evaluate all 1:24,000 topographic maps for revision."[13]

The archive of over eight hundred thousand Corona images—2.1 million feet of film in thirty-nine thousand canisters[14]—was declassified on February 22, 1995 with President Clinton's Executive Order 12951. The archive became available to the public three months later.[15]

LANDSAT (UNITED STATES, 1972–)

Appearing concurrently with the nascent environmental movement of the 1970s and dubbed the ERTS-1 (Earth Resources Technology Satellite), Landsat names a series of seven satellites launched by the National Aeronautics and Space Administration (NASA). The first was launched in July 1972. Together, they comprise the first publicly accessible remote-sensing program. Of these seven satellites, only Landsat 5 and Landsat 7 are currently functioning. A further satellite, known as the Landsat Data Continuity Mission, is scheduled for launch in 2013.[16]

Over time, ground resolution of the Landsat images has increased from 80 meters to 15 meters, which is officially described as "moderate." Each Landsat scene measures 170 by 185 kilometers (106 by 115 miles) of ground space. At its highest resolution, Landsat can picture large buildings and airstrips. According to a NASA presentation on Landsat, "this is an important spatial resolution because it is coarse enough for global coverage, yet detailed enough to characterize human-scale processes such as urban growth."[17] Landsat satellites orbit the Earth on predictable paths. The same coordinates are imaged at nearly the same time of day, every fourteen to eighteen days.

Because Landsat imagery is inexpensive and readily available, it is used frequently by researchers to investigate and highlight large-scale patterns related to climate change, natural resource management, land development, or disaster recovery. However, Landsat was not always so accessible. In the early 1980s, the program was privatized, and the National Oceanic and Atmospheric Administration (NOAA) selected the Earth Observation Satellite Company (EOSAT), later known as Space Imaging, to archive, collect, and distribute Landsat data as well as to build, launch, and operate the next two Landsat satellites (with government subsidies). As NASA tells the story today, "commercialization proved troublesome, with NOAA and EOSAT raising the cost of images by 600%, effectively "pric[ing] out many data users." Faced with competition from the newly launched French SPOT satellite and with coverage collapsing because EOSAT acquired imagery only when there were customers to buy it, Landsat images nearly disappeared by the end of the decade. "By 1989," reports the NASA Landsat history, the program was in such shambles that "NOAA directed EOSAT to turn off the satellites (no government agency was willing to commit augmentation funding for continued satellite operations, and data users were unwilling to make the hefty investments in computer processing hardware if future data collection was uncertain)."[18]

Over the course of the 1990s, control of Landsat's satellites and its imagery output was gradually returned to the U.S. government.[19] The pivotal role of Landsat imagery in the planning and implementation of the Gulf War,coupled with competition from the newer and cheaper SPOT, led to the Land Remote Sensing Policy Act, signed into law by President Clinton on October 28, 1992. It bolstered the Landsat program, stating that "continuous collection and utilization of land remote sensing data from space are of major benefit in studying and understanding human impacts on the global environment, in managing the Earth's resources, in carrying out national security functions, and in planning and conducting many other activities of scientific, economic and social importance."[20] The latest satellite, Landsat 7, was launched in 1999, and on July 1, 2001, operational control of the entire system and its archive was officially returned to the federal government, with EOSAT/Space Imaging giving up their commercial right to Landsat data. The program appears to be set to continue with the Landsat Data Continuity Program. Landsat images can be obtained from http://landsat.gsfc.nasa.gov.

SPOT (FRANCE, 1986–)

SPOT, an acronym for Système Probatoire d'Observation de la Terre, is a series of five satellites launched between 1986 and 2002 by the French national space agency, the Centre National d'Études Spatiales (CNES), in collaboration with Swedish and Belgian scientific agencies. At the time of its initial launch, SPOT 1 posed a serious challenge to the U.S. and Soviet monopoly on satellite imagery by offering 20-meter and 10-meter spatial resolution, significantly better than Landsat. Of the five satellites, SPOT 4 and SPOT 5 are currently functioning, and Astrium GEO Information Services (the private owners of the system) planned to launch two new satellites in 2012 and 2013 (SPOT 6 and 7) with ground resolution as high as 1.5 meters, as well as a successor pair of satellites called Plêiades, offering half-meter resolution (the first was launched in September 2012).[21]

Over time, SPOT image data has improved from 20 meters to 2.5 meters ground resolution at an altitude of 832 kilometers (517 miles). This resolution is able to capture small buildings, but not their details. SPOT orbits around the polar axis, capable of returning to the same place on Earth every twenty-six days.

In June 2010, the company announced a data-purchase agreement with the U.S. government allowing access to all image data collected by SPOT 4 and SPOT 5 over the United States. As with Landsat imagery (in partnership with NASA), the U.S. Geological Survey can distribute these images for free.[22] SPOT announced that its image data will therefore be the "most widely used medium resolution commercial sources of Earth observation data in the U.S. government."[23] This purchase may be the U.S. government's response to the pending danger in the Landsat data gap should a new Landsat satellite not be launched. Archival and recent can be purchased online through the SPOT catalogue at Astrium.[24]

IKONOS (UNITED STATES, 1999–)

Launched by the private company Space Imaging (the transformed EOSAT, now known as GeoEye) in September 1999, Ikonos-2 was the first satellite to make high-resolution satellite imagery available to civilian users, leading the *New York Times* to describe it some weeks later as "the world's first private spy camera."[25]

John Pike, then in charge of space policy at the Federation of American Scientists, told the *Times* that high-resolution imagery "was revolutionary when it was available to the nuclear powers, and one expects it to have similar potential now that it is commercial."[26] Robert Wright, writing in the *New York Times Magazine*, called it "a geopolitical milestone. Able to discern objects only a few feet wide—to see at 'one-meter resolution'—it will give presidents, generals and assorted political actors around the globe a kind of power once confined to elite nations."[27]

Ikonos was launched with the capability of providing image data with 1-meter ground resolution in a swath 11.3 kilometers (7 miles) wide from an altitude of 681 kilometers (423 miles). It functions by combining 82-centimeter (32.28-inch) resolution black-and-white ("panchromatic") images with 4-meter (13.12-foot) resolution multispectral images to create 1-meter (3.28-foot) color imagery (pan-sharpened).[28] At 1-meter resolution, Ikonos can distinguish a tank from a truck. Every point on Earth can be revisited by Ikonos every three to five days. Although its lifespan was a proposed seven years, Ikonos is still functioning.

Ikonos does not collect a steady stream of images. Its sensors are turned on only to record image data when tasked. Once the satellite is assigned an objective and the image data is received by a purchaser, it becomes available for repurchase and can be ordered and received through a website that includes the image data's longitude, latitude, and date stamp, but not the identity of the tasking agency or individual. Between its launch in 1999 and mid-2011, Ikonos had imaged more than 280 million square kilometers (over 100 million square miles) of the Earth's surface.[29]

The simultaneous provision of high-resolution image data to civilians, the U.S. military, and other governments globally was made possible by President Clinton's March 10, 1994, Presidential Decision Directive, which "among other things, loosened restrictions on the sale of high resolution imagery to foreign entities."[30]

According to the European Space Agency, "the spacecraft operations of Ikonos-2 are unique among the current commercial imaging satellites in that they allow each international affiliate to operate its own ground station(s). These ground stations are assigned blocks of time on the satellite during which they can directly task

On the front page of the *Washington Post* on March 3, 2005, Dana Priest revealed the existence of a secret CIA prison, code-named the Salt Pit, near Kabul, Afghanistan. Eight months later, she reported that the Salt Pit had been an early part of a "hidden global internment network," a series of so-called "black sites," in which the CIA housed and interrogated terror suspects. Her first article had offered enough detail to send GlobalSecurity.org looking for earlier satellite images of the Salt Pit, and so the second article included a high-resolution Ikonos satellite image of the building.

Top: Salt Pit, as seen by Ikonos satellite, January 25, 2001. COURTESY GEOEYE

Bottom: Salt Pit, as seen by Ikonos satellite, July 17, 2003. COURTESY SPACE IMAGING MIDDLE EAST

Ikonos, and immediately receive the downlinked imagery for which they tasked."[31]

The launch of Ikonos allowed the United States to retain its position as the primary provider of highest-resolution image data globally, but in so doing, it introduced sensitive issues of "shutter control," which, in the words of former Space Imaging vice president Mark Brender, "provides a lever by which the U.S. government can interrupt service when there is a 'threat to national security or foreign policy concern.'"[32] Rather than exercising shutter control, however, the U.S. government has deployed other means of controlling imagery during sensitive times: for example, purchasing the rights to all Ikonos image data over Afghanistan and Pakistan for the two months directly following the September 11, 2001 attacks on the United States. Images from the Ikonos archive, as well as new (tasked) acquisitions, are available for purchase worldwide through GeoEye.

QUICKBIRD-2 (UNITED STATES, 2001–)

QuickBird-2 was launched in October 2001, less than a year after the loss at launch of its predecessor, QuickBird-1. It is a high-resolution Earth-observation satellite owned by DigitalGlobe. It operates in a polar orbit, 482 kilometers (299.5 miles) above the Earth, with a swath width of 18 kilometers (11 miles). It is capable of sub-1-meter resolution, as high as 65 centimeters (25.6 inches).[33] Like Ikonos, QuickBird does not collect image data unless tasked to do so. It can revisit some sites beneath its orbit as frequently as every two and a half days, others within no more than six days. QuickBird-2 is also subject to shutter control, although the U.S. government has never implemented it.

QuickBird-2 and the other satellites in what DigitalGlobe calls its "constellation of sub-meter spacecraft" have emerged as major providers of overhead image data to the U.S. government. In a 2002 memo to the director of the National Imagery and Mapping Agency (NIMA), then–CIA Director George Tenet specified that "it is the policy of the Intelligence Community to use U.S. commercial space imagery to the greatest extent possible" and that the U.S. government should use commercial satellites unless military ones provide better resolution with classified image data.[34] DigitalGlobe has since been awarded two contracts by the U.S. government: $500 million from the NextView program in September 2004 and $3.5 billion over ten years from an EnhancedView contract in August 2010.[35]

The "sub-meter constellation" also does nongovernmental work. DigitalGlobe has agreements with humanitarian and human rights initiatives, among them the Satellite Sentinel Project at Harvard University, to provide QuickBird-2 and other images of zones of conflict in nearly real time. In March 2011, for instance, a DigitalGlobe vice president announced, on the company's blog, the release of satellite images of burned and destroyed villages in the Abyei region of Sudan. He wrote: "We've collected, processed, analyzed and delivered imagery and information in record time, given the urgency of the situation and the need to demonstrate to both sides that the world is watching." He added, for context, that this was simply part of the satellite business:

> we do keep a constant eye on the planet, to gain early insights into the business, market, environmental and political changes that impact people around the world. That's why we are keeping such a close eye on Sudan. It may be hard to watch, to look at an image and know someone's home is gone, a livelihood destroyed, that many lives have been lost. All involved are seeking the truth in pictures, and delivering valuable information and insight to both sides of the country. We certainly hope that one day, peace will come to this nation.[36]

QuickBird-2 image data can be purchased at digitalglobe.com, along with that of its fellow DigitalGlobe satellites WorldView-1 (50-centimeter/19.7-inch resolution) and WorldView-2 (46-centimeter/18.1-inch resolution).

GEOEYE-1 (UNITED STATES, 2008–)

The revolution in the privatization of high-resolution imagery from outer space that is exemplified by the generation of satellites from Ikonos on stems both from the declassification efforts of the 1990s and a series of U.S. government decisions to "support the continued development of the commercial satellite imagery industry by sharing the costs for the engineering, construction and launch of the next generation of commercial imagery satellites."[37] One result was the September 2008 launch of GeoEye-1, a private satellite owned by GeoEye with resolution below a half meter (41 centimeters, 16.41 inches). Its swath width is just over 15 kilometers (9 miles), and from its sun-synchronous polar orbit 681 kilometers high (423 miles), it can revisit anywhere on Earth once every three days, passing overhead, like other imaging satellites, at 10:30 a.m., local time. Like Ikonos, also owned by GeoEye, and QuickBird-2, it is subject to shutter control and does not collect imagery unless tasked to do so.

According to GeoEye, "While the satellite collects imagery at 0.41-meters, GeoEye's operating license from the U.S. Government requires re-sampling the imagery to 0.5-meter for all customers not explicitly granted a waiver by the U.S. Government."[38] Nevertheless, at this reduced 50-centimeter resolution, the home plate of a baseball diamond is visible from space.

GeoEye's CEO wrote in January 2010:

> The defense and intelligence communities have developed a huge appetite for unclassified, high-resolution, map-accurate satellite imagery. One leading reason is that our government can freely share unclassified images with allies, coalition

partners and disaster relief workers, thus speeding collaboration and time-critical decision-making. Another reason is that commercial imagery is highly cost-effective because we can resell excess capacity and imagery to commercial customers.

As a result, the use of satellite imagery by analysts and mapmakers at military headquarters is the norm.[39]

After the U.S. government, GeoEye's second major customer is Google. Since mid-2009, a lot of GeoEye-1 imagery has been freely available to Google Earth users. Although the Google logo was prominently displayed on the launch rocket—such that *Wired* magazine could title an article "Google's Super Satellite Captures First Image"[40]—Google does not own the satellite. Instead, through its Google Earth interface, it distributes and makes accessible imagery produced and tasked by others. (There is of course a possibility that Google has commissioned GeoEye imagery collection for its own purposes, but if so, it's a closely held secret.) It is unclear whether Google displays the GeoEye imagery at its full resolution, and since one cannot download images from Google Earth in the same way as one can from GeoEye itself—where each pixel has a size of one square meter and a longitude, latitude, and spectral signature—it's rather difficult to find out. For its full resolution and data, GeoEye-1 image data can be purchased at www.GeoEye.com.

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

The Global Positioning System and remote-sensing satellites simply generate data. GIS is the generic name for software that allows users to locate data spatially. Any line on a spreadsheet, item on a list, or field in a database that records a physical address has the potential, once linked to its geographic coordinates, to become a point on a digital map. Once that point is recorded, it can be linked to or labeled with any other sort of data: the address can be connected to the name of a road, a dollar amount, a color or a shade, something a person said, a crime committed or thwarted, an encounter with an animal or a deity, or almost anything else that can be stored in a database—and that includes nonquantitative data.

Environmental Systems Research Institute (ESRI) is the Microsoft Word of GIS software and has the generic Web domain name www.GIS.com. GIS is described by ESRI as a system that "integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information."[41]

The most popular textbook on GIS, *Geographic Information Systems and Science*, describes the "field of GIS as concerned with the description, explanation, and prediction of patterns and processes at geographic scales. GIS is a science, a technology, a discipline and an applied problem solving methodology."[42] The textbook description says nothing about hardware and software, and rightly so, because it focuses on how GIS has radicalized and transformed the methodologies and processes of cartography, geography, urban planning, urban design, data management, archeology, sociology, and public health, among many other fields and practices. Although these are very different disciplines, they all have a stake in using maps as a basis for research and analysis.

Over the course of its short history, GIS has been commonly talked about as having transformed cartography into spatial data management. GIS has become a metaphor for the role that data now play in the drawing of new maps of the world, especially its cities and its resources. Often, the data is newly created for the map. What GIS does well is to layer diverse sets of information onto a single digital file or map.

Both these things—data displayed on maps and a layering of data onto maps—have long histories. Depending on where one starts the historical trajectory, one will end up with a very different interpretation of the meaning and uses of GIS. For example, some urbanists and public health researchers put the origin of GIS in John Snow's 1854 map of cholera in London. For them, the social data and statistical methods embedded in GIS are critical to the ways in which they define it.[43] These methods, which were developed later by Charles Booth in his poverty maps of London in 1898–99 and then by the Chicago School of sociological research in the first half of the twentieth century, constitute in effect the history of the modern city and define the modern history of cartography.[44]

But there are other genealogies. Some cite Ian McHarg's 1969 *Design with Nature* as the origin of GIS.[45] McHarg famously produced manually layered topographical maps with multiple sources of information in order to suggest ecologically smarter layouts for highways.[46] Slope, surface drainage, scenic value, residential values, forests, institutions, erosion, and so on were layered together into what McHarg called a "composite," an image in which one could see the effects of the layers on one another. The overlays bore titles such as "Composite: All Social Values" or "Composite: Physiographic Obstructions." McHarg's maps featured proposals such as "Recommended Minimum-Social-Cost Alignment" for a highway construction project. McHargian users of GIS have an expanded and design-oriented view of the built environment, one that incorporates ecological, landscape, and urban patterns, as well as the social forces that might affect those patterns.

The dominant history of GIS traces only the hardware and software that make up the GIS we know today on our computer desktops. The history section of *Geographic Information Systems and Science* begins in the mid-1960s in Canada, where the first "real GIS" was a "computerized map measuring system."[47] It was produced to create the Canada Land Inventory System, a project—classically cartographic—to identify resources and their potential uses.[48] A second phase of rapid development, they write, came from the U.S. Census Bureau, which, planning for the 1970 census, created the DIME (Dual Independent Map Encoding) program, allowing the creation of digital records of every street in the United States such that the population could be referred and aggregated to specific geographies. From the perspective of emerging GIS software development, these two programs responded to the "same basic needs in many different application areas, from resource management to the census."[49]

These narratives and genealogies are important as examples (and this is not the full scope of genealogical narratives of GIS) because neither data collection nor software are neutral in the uses of GIS. Sociologists, urban planners, advocacy groups, and other users of GIS software often tend to downplay the art of mapping and can unknowingly, or knowingly, as Mark Monmonier has argued, "lie with maps."[50] GIS software, which hides from the viewer or user of the map the statistical operations that the maker of the map utilizes, can make this traditional possibility a great deal easier. A more polite term for this, which acknowledges the explicitly aesthetic operations of some GIS users and recognizes the deployment of maps for persuasive purposes, as well as for the management of people and things, would be that of Dennis Wood, "the power of maps."[51]

Obviously, the design of the data and the reasons for its collection have an effect on the biases of the map. Now that many specialists other than cartographers can make maps, it is especially important to understand the sources of data they rely on, the products of which are maps and images that are having an effect on policy, cities, landscapes, privacy, and beyond.

Remote sensing had an enormous influence on the data and imagery in GIS. Aerial exploration of the Earth's surface not only generated the image bases for all sorts of maps, but also allowed interpreters to discover new things about everything from land use to population density to changes in landscapes and landforms. The Corona program was already using satellite imagery to map large parts of the United States and elsewhere by coordinating its measurable images with mapping reference grids (longitude and latitude). And as the 1990s dawned, GPS emerged as an unprecedented and inexhaustible source of new data points.

However, no one, really, would be using GIS were it not for the emergence of desktop and then portable computers and the World Wide Web, which dramatically democratized the availability of data-processing power in the late 1980s and early 1990s and effectively put GIS–like data and software into mass circulation.

With the ubiquity of personal computers and the increased availability of GIS software and geospatial data—whether from GPS, remote-sensing satellites, or public and private libraries and archives—the ability to access, interpret, and put to use digital images of events occurring anywhere in the world, on any scale, from the local to the global, is no longer the sole property of governments, militaries, and large corporations. What the dissemination of these technologies has enabled is the democratization of what I have called "para-empirical" investigations. What follows here are nine such investigations, together with reflections on the ways in which they can help us understand better how the images generated by this hardware and software are used, how the rest of us can explore their unintended consequences and unexpected byproducts—and how sometimes we can make such images ourselves.