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8

Satellites and Sovereign Knowledge: Remote Sensing of the Global Environment

Karen T. Litfin

Introduction[1]

Environmental problems are not just physical occurrences; they are informational phenomena which are socially constructed through multiple struggles among contested knowledge claims. Access to and control over information, therefore, are crucial and controversial elements in environmental decision making. The gathering of environmental data is almost never a simple empirical exercise in sense observation, but is mediated by technologies of varying scale, scope, and sophistication. Those technologies, like any other, are more than simply neutral tools: They may be seen as "artifact/ideas" which embody political cultures.[2] Technologies only appear to be neutral because people generally assign a functional meaning to tools, rather than grasping the less visible logic of power, authority, and control that permeates them from their inception to their everyday usage. Artifacts should be viewed contextually, with different uses and meanings for different social groups, and should not be treated as objective facts.

Increasingly, the information that guides international environmental policy-making, both directly through treaties and regulations and indirectly through its impact on development activities, is being obtained through space-based instruments orbiting Earth on satellites. Earth remote sensing (ERS) can generate data on an enormous range of issues, including forest cover, the health of crops, atmospheric concentrations of many pollutants, drought conditions, crisis monitoring, resettlement of refugees, storm warnings, and the locations of resources ranging from drinking water, to petroleum and mineral deposits, to endangered species.[3] During the 1990s, approximately fifty Earth observation satellites will be launched by the space-faring nations of the world.[4] Although earth remote sensing (ERS) is indisputably a useful tool, it is also an artifact/idea whose political and social dimensions have been largely unexamined. Ironically, the very ubiquity of ERS capabilities, which gives it the semblance of the ultimate all-purpose neutral tool, may also impede serious analysis of the political culture embodied in it.

The implications of ERS for sovereignty are not straightforward; it is not a technology that can universally be said to either reinforce or erode modern practices associated with sovereignty as an institution. On the one hand, as a manifestation of "Big Science" and a supplier of information as a public good, ERS simulateously relies upon and supports the role of the state. As both Anthony Giddens and Michel Foucault have argued, although in different ways, surveillance technologies have been the basis for the state's administrative power throughout the modern era.[5] Indeed, surveillance provides the informational dimension of sovereignty, a dimension that is typically neglected in discussions of the state power and authority. Not surprisingly, the first (and, until recently, sole) users of satellite technology were the militaries of the two superpowers.

As the range of applications and the number of users has increased exponentially, in the past two decades, the relationship between satellite technology and state sovereignty has grown more complex. Today, users include multinational corporations, scientists, policymakers, grass roots environmental groups, and indigenous peoples. The multibillion-dollar industries of satellite communications and geographical information services (GIS) have dwarfed the military uses of satellites.[6] The loosely coordinated international global change research program, which relies primarily on satellite observations for its data, is likely to become the largest research project in human history, even with the current budget-cutting mood of many governments.[7] Information gathered through ERS will be applied by diverse sets of actors to some highly politicized purposes, including assigning responsibility for environmental degradation.

Is there a logic to satellite technology in general, and ERS in specific, with respect to sovereignty as a political institution? This chapter argues that, while the relationship is characterized by multiple, cross-cutting logics, certain traits and applications of ERS technologies are contributing to the reconfiguration of sovereignty. This is not to draw any grandiose conclusions about the abililty of satellite technology, in and of itself, to abrade or fundamentally alter the nation-state system. Rather, I focus on three attributes of ERS—transparency, globality, and its "high-tech" nature—and seek to grapple both inductively and deductively with their implications for some of the "bundles" that constitute the political institution of sovereignty. In particular, I examine the relationship of ERS to each of the following: the principle of territorial exclusivity, sovereignty bargains and international cooperation, popular sovereignty, and, the epistemic dimensions of sovereignty.

I argue that the relationship between ERS and sovereignty is multidimensional, in part because ERS technology seems to have emerged at the intersection between modernity and postmodernity. Although the term is hotly contested, the political meaning of *postmodernism* is usually taken to embrace two related tendencies: the diffusion of power along multiple capillaries and the proliferation of images and information.[8] If sovereignty is understood in terms of control and authority, the diffusion of satellite-generated data appears to be fostering multiple channels of control and authority, and therefore multiple sovereignties or micropowers, even as the technology owes its existence to large-scale state endeavors. Without making any sweeping predictions about the demise of sovereignty, one may infer that Earth remote sensing is a participant in the unfoldment of both of these apparently contradictory tendencies, and that the practices of sovereignty are undergoing revision in the late modern period, catalyzed by artifact/ideas manifested in specific technological forms.

Territoriality

Space Espionage and Extraterritoriality

As John Ruggie has argued, the principle of territorial exclusivity, an epochal development marking the end of the medieval era, has been the defining feature of the modern system of states. With the recent globalization of human activities, he claims, we are now witnessing the "unbundling of territoriality" and the "rearticulation of political space."[9] There is perhaps no form of technology better suited to exemplify these trends than ERS, which inherently erases territorial boundaries by virtue of the global scope of both its observations and its diffusion of information. While the transparency afforded by ERS no doubt undercuts the principle of territorial exclusivity, which is probably its greatest effect, ERS technology can also reinforce the modern practices of sovereignty in some interesting ways.

It is important to recall that the early space age, which gave birth to ERS technologies, was characterized by fierce competition. For the superpowers, and to a lesser extent for subsequent space powers, large-scale space programs were symbols of national prestige. These autonomous programs were viewed as means of strengthening national security and were seen as necessarily under state control.[10] Military reconnaissance, the direct progenitor of ERS technologies, came to be viewed as a staple in the superpowers' exercise of territorial sovereignty; knowing the adversary's military and industrial capabilities was seen as essential to preventing foreign intervention. Paradoxically, just as the mutual acquisition of nuclear weapons by the superpowers rendered those weapons effectively unusable, the mutual acquisition of satellite reconnaissance technology rendered their territorial space utterly transparent. While satellites may have offered some protection against military intervention, they opened the door to visual intervention.

With the advent of nonmilitary applications of satellite-based remote sensing, concerns about sovereignty and intervention were in some ways heightened. The United States pioneered the use of ERS technologies, launching the moderate-resolution Landsat in 1972; the French-led SPOT (Systeme Probatoire d'Observation de la Terre) began returning higher-resolution data to Earth in 1985; and a Russian consortium entered the market with even higher-resolution images a few years later. Each of these developments raised new sets of issues with respect to sovereignty.

Even today, with international cooperation and the proliferation of commercial and scientific satellite data, the technology's military roots are continually evident. Military agencies still control the lion's share of high-resolution satellite imagery and are reluctant to share it with others. As the militaries of the Cold War superpowers come under pressure to redefine their mission in a post–Cold War era, they have become involved in environmental research.[11] For decades, the security forces of both superpowers did a good deal of inadvertent environmental

research, which scientists are now eager to acquire.[12] Yet, in a profound clash of cultures, the highly secretive nature of military technologies and procedures is often at odds with the expectations and conventions of both commercial and research partners—even in the relatively open United States.[13] There is a certain irony in the fact that the Russian consortium, Soyuzkarta, made formerly top-secret, high-resolution imagery from Soviet military satellites available on the mass market while the United States has been reluctant to do so for reasons of national security.[14] At stake is the principle of territorial exclusivity in a world rendered transparent by satellite technology.

This tension reflects the discrepancy between the nonterritorial nature of outer space and the principle of state sovereignty. While the air space above a state's territory falls under that state's jurisdiction, the space above the Earth's atmosphere (outer space) was declared in the 1967 Outer Space Treaty to be a *res communis*, or the common province of humanity.[15] The prohibition of territorial claims in outer space stands in a tense relationship with the efforts of states to enhance their own security through the use of satellites stationed in nonterritorial space. Given the military's leadership role and the resources required to conduct space activities, space issues would seem to reinforce the state-centric model of international relations. Yet the nonterritorial character of space activities poses certain challenges to traditional notions and practices of sovereignty.[16]

Developing Countries, Satellites, and Territorial Sovereignty

Questions of territorial sovereignty were hotly debated during the two sets of negotiations on the use of geosynchronous orbits and on the principles governing the use of satellites in television broadcasting. In both cases, the principle of nonterritoriality prevailed, with implications for environmental remote sensing. In the 1976 Bogota Declaration, the equatorial nations argued that their sovereignty extended 22,300 miles upward to the prized geosynchronous orbits over their territories. They argued that because the existence of the orbit depended upon the Earth's gravity, it was therefore a "physical fact linked" to the planet and thus subject to national sovereignty.[17] However a majority of the UN General Assembly, including most developing countries which preferred a "common heritage of mankind" reading, rejected this interpretation.

The coveted geostationary orbits became part of outer space, although they have, in practice, been more or less governed by a first-come, first-served policy.[18]

In a similar debate over the territorial status of outer space, the former Soviet bloc, and most developing countries held that lack of control over direct broadcasting within their territories would amount to cultural imperialism. The U.S. freedom-of-information perspective, however, which was premised upon the nonterritorial nature of outer space, ultimately prevailed.[19] These two outcomes, each upholding the nonterritorial nature of outer space, entail some important implications for ERS. If states may not claim territorial jurisdiction over the orbits overhead, then claims to sovereignty over the images and data gathered from the satellites stationed in those orbits are substantially weakened.

Beginning in the 1970s, countries without access to satellite technology suspected that an "open skies" policy with respect to ERS might violate their territorial sovereignty. Although they may have harbored such fears earlier with respect to military reconnaissance satellites, the fact that superpower images were not available on the commercial market was a source of comfort. The military secrecy of the superpowers, at least in this case, was an apparent blessing for the Third World. But when NASA espoused an open skies policy with its first launch of the Earth Resources Technology Satellite (later renamed Landsat), some Latin American countries countered that their sovereignty over natural resources extended to the dissemination of information about them. Mexico, for instance, announced that "no data would be collected over Mexican territory from air or space without prior permission."[20]

NASA's response was threefold. First, it argued from international law that there were no legal restrictions on the use of ERS for peaceful purposes. Second, it labeled Landsat an "experimental," rather than an "operational," project until the 1980s. Third, and most effectively, it held out the enticing promise to developing countries that the open dissemination of satellite data would extend, not reduce, their ability to control the development of their resources. In other words, earth-sensing satellites would *amplify* their sovereignty. To add credence to that promise, NASA established an educational program to train scientists from developing countries to use ERS data.[21]

Indeed, many countries came to the counterintuitive conclusion that transparency and the global diffusion of data actually reinforced their territorial sovereignty. By 1980, ten countries had built ground stations and were committed to paying NASA an annual fee of two hundred thousand dollars for data transmission; dozens more were purchasing Landsat images and data tapes. For example, Brazil reported that the first Landsat images resulted in the discovery of several large islands within its territory and a major rectification of Amazon tributaries on its maps. The U.S. Embassy in Mali reported that "the U.S. government has gained a million dollars worth of Malian political mileage" from Landsat.[22]

Satellite data, then, may actually help to prepare a given territory for the exercise of sovereignty. As Thom Kuehls argues in chapter 2, nature is not inherently constituted so as to become subject to state sovereignty, but is rather socially constructed as "territory." Mapping is a crucial element in this social construction. There are no lines of latitude and longitude in nature; overlying the globe with this symbolic organization imposes an artificial order and serves specific political purposes. For this reason, cartography has been labelled "the science of princes."[23] The burgeoning use of geographical information systems (GIS), which use space as a common key between sets of satellite data, can strengthen claims to territorial sovereignty in countries with isolated areas. Thus, the utility of ERS data for mapping and locating resources suggests that the logic of satellites does not always run contrary to the principle of territorial exclusivity.

Nonetheless, developing countries have not always been satisfied with their roles in the emerging ERS regime. By the early 1980s, developing countries were concerned with preserving open and nondiscriminatory distribution of Landsat data, which they felt was threatened by the Reagan administration's proposal to privatize Landsat.[24] Many observers believed that Landsat data should remain a public service, analogous to census, cartographic, and meteorological data, and several studies concluded that Landsat could not be successfully commericialized. Nonetheless, control over Landsat's data was given to EOSAT, a joint venture of Hughes Aircraft and General Electric, under the Land Remote Sensing Commercialization Act of 1984.[25] One of EOSAT's first acts, which was greatly resented by scientists as well as developing countries, was to quadruple the price of each Landsat image.[26]

Cost is just one of the factors limiting the utility of ERS data, from both Landsat and SPOT, in developing countries. Commercial ERS programs tend to be designed with the informational needs of paying customers in mind—primarily multinational agricultural, mining, and oil exploration companies. Because ERS is fundamentally a "high-tech" endeavor based in the industrialized countries, its use elsewhere entails a host of complex technology transfer issues. The use of ERS data requires skills in photogrammetry and computers which are scarce in most developing countries. As a first step in overcoming this problem, the United Nations has initiated Centres for Space Science and Technology Education on a regional basis in developing countries.[27] Yet ERS data continue to remain inaccessible to potential beneficiaries.[28] Nor do the large global change research programs that rely upon ERS data emphasize the kinds of information on land use and ecological change that are most urgently needed in developing countries.[29] The tensions in U.S.-Brazilian environmental research, for instance, have motivated Brazil to launch remote sensing satellites of its own in the 1990s and to broaden its international sources of data.[30]

With the exception of India, China, and Brazil, which have built their own ERS systems, all other developing countries have depended on imagery from Landsat, NOAA, SPOT, and now Russian satellites.[31] But they have not always been satisfied with this arrangement. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has emerged as a champion for the interests of developing countries. In 1991, several developing countries submitted a working paper to the Legal Subcommittee of COPUOS arguing for a kind of affirmative action program, expressed in a new treaty, for developing countries with respect to space technology.[32] They based their position on Article I of the 1966 Outer Space Treaty, which states that the use of outer space "shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind." Developing countries insisted that, in order for all countries to share equitably in the benefits of space technology, including ERS programs, international cooperation must be based on a system of preferential treatment for developing countries.

They also referred to the Principles on Remote Sensing of the Earth from Outer Space, adopted by the United Nations in 1986, which call for international cooperation in the use of ERS technologies.[33] Thus, taking a notably different tack from that of the equatorial states in the earlier debate on geosynchronous orbits, developing countries cite the common property status of outer space as a rationale for preferential treatment in the emerging ERS regime.

The United States and the United Kingdom, however, countered the developing countries on the basis of traditional sovereignty claims. Attempting to appease them, on the one hand, they cited many examples of bilateral and multilateral programs in space technology. On the other hand, however, they claimed that any attempt to impose legal obligations for cooperation would undercut states' sovereign right to decide the sorts of joint programs in which they would participate. The developing countries split ranks when Brazil and Nigeria concurred with this line of argument, scuttling efforts to negotiate a new treaty. Their effort to promote preferential treatment may have been successful, though, in serving notice to the space powers that they should work harder to ensure that ERS and other forms of space technology are beneficial to developing countries.

Developing countries have apparently embraced ERS, but not without some reservations about the technology's impact on their territorial sovereignty. One feature of ERS is its dual role in providing an information base and as a technology for monitoring. Sovereignty has traditionally been invoked to shield states from external intrusion, yet satellites render territory effectively naked.[34] While the transparency afforded by satellite observations can aid in the monitoring of international law, it can also be interpreted as a tool for foreign intervention. Compliance with international environmental agreements, for instance, has tended to be voluntary, with nongovernmental organizations frequently functioning in a watchdog capacity. When mandated, verification of compliance has generally proceeded through self-reporting. Thus, certain developing countries have expressed the concern that ERS could foster "green conditionality" and other types of "eco-imperialism." Just as satellites can be used to monitor treaty compliance, so too can they be used for industrial espionage. Many observers believe that "in the future, commercial remote sensors will not only be able to detect pollutants leaving a factory, but determine what a factory is producing."[36] For these reasons, developing countries insisted that the Earth Summit documents adopted at Rio de Janiero in 1992 contain no references to the use of ERS for "monitoring," but only for "observation."[36] Whether the semantical distinction between surveillance and observation will translate into practice remains to be seen.

Commercial Satellites and Reconfigured Sovereignty

Ironically, it has been primarily the United States, not the developing countries, which has sought to place restrictions on ERS data and technology in the name of territorial sovereignty. The U.S. restrictions harken back to the technology's roots in military reconnaissance. In 1978, President Carter upheld the Pentagon's interests over NASA's by signing a presidential directive that set ten meters as the resolution limit for, nonmilitary remote sensing.[37] But the entry into the international market of SPOT, with a resolution of ten meters, and Soviet satellite photographs of roughly five-meter resolution, soon made this rule essentially obsolete. The Reagan administration deleted the rule in 1988 after being persuaded that it put American satellite operators, especially the now-privatized Landsat data marketing firm, at a distinct disadvantage. In an effort to uphold traditional national security interests, the new directive granted veto power to the secretaries of defense and state over the licensing of U.S. commercial remote sensing satellites.[38] But U.S. officials were at a loss to describe how they would enforce a ban on the dissemination of pictures from space, since the United States no longer enjoyed a monopoly on Earth-scanning satellites—even in the West. And, of course, the most likely beneficiaries of American regulations would be foreign satellite operators. As a SPOT spokesperson observed, "Open skies, open access is a precondition of commercial success in the remote-sensing industry."[39] The Clinton administration went beyond the Reagan rule with its commitment to consider favorably licensing applications for ERS systems whose capabilities are already available or are in the planning stages.[40]

The emergence of high-resolution satellite imagery on the world market provides an interesting example of how the practices of sovereignty can be driven by technological developments and globalization. It makes little sense to place domestic restrictions on high-resolution data which are easily accessible from foreign suppliers. A technology that cannot be controlled by a single government is impossible to contain; satellite images can only be suppressed if the data are sent to a ground station under the control of the censoring government. In a classic sovereignty bargain, the United States has been forced to revise its conceptions of national security in order to promote its own industrial competitiveness.

It might be an overstatement to declare, as some have, that satellites have "abolished the concept of distance,"[41] but it is certainly the case that the practices associated with territorial sovereignty are being revised. There is no single, straightforward logic to ERS technology. Certainly, it still bears the imprint of its origins in military reconnaissance, the root purpose of which was to protect the superpowers' territorial integrity. Moreover, ERS is being used by some developing countries to expand and reinforce their claims to sovereignty within their borders. Yet the emergence of ERS data on the world market has dramatically eroded the ability of states to control information about the resources within their borders. The almost universal availability of ERS data has rendered much of the world transparent; its global nature appears to be undercutting the characteristically modern conceptualization of Earth as territorially demarcated. If, as David Harvey suggests, modernity located "the other" in a specific place "in a spatial order that was ethnocentrically conceived to have homogenous and absolute qualities,"[42] then ERS, by virtue of its globality and its transparency, challenges this spatial order, and thus stands at the cusp of the modern and the postmodern.

Sovereignty Bargains

Just as it would be an oversimplification to say that transboundary environmental degradation necessarily subverts state sovereignty, so too would it be simplistic to say that international cooperation axiomatically subverts state sovereignty. Paradoxically, in an interdependent world, cooperation may help to sustain the institution of sovereignty. Sovereignty may be disaggregated, with autonomy, control, or authority in one area being traded for greater autonomy, control, or authority in another area. While such sovereignty bargains may not destroy sovereignty, they do alter it. While there is nothing new in the fact that states often make such trade-offs, the contemporary logic of ERS seems to be pushing states to sacrifice autonomy in exchange for greater collective problem-solving capacity.

The multiple-use character of ERS data has compelled states to try to strike a balance among competing military, economic, and environmental interests. As a corollary, international sovereignty bargains manifest domestically as bureaucratic competition among state agencies. The huge economies of scale to be gained through pooling ERS resources have encouraged states to sacrifice some autonomy and control in exchange for better access to information. The end of the Cold War has made a whole range of new sovereignty bargains feasible.

Consider the incremental relaxation of restrictions on ERS technology by the U.S. government since the late 1970s. The apparent contradiction between U.S. industrial competitiveness and perceived military interests is gradually being resolved in favor of the former, an uneasy settlement driven by the globalization of technological change. Whereas resolutions finer than ten meters were once deemed a serious security risk, even domestically, the United States is now licensing commercial ERS systems with a resolution of only one meter.[43] This does not mean that security is no longer a top concern for states, but it does suggest that the meaning of security, like that of sovereignty, is being revised. Nonetheless, traditional security arguments have also been used to promote industrial competitiveness. For instance, proponents of easing restrictions on high-resolution ERS technology argued that, "Failure to allow the (U.S.) remote sensing industry to grow aggressively will only encourage the development of suppliers that may be impossible to control in a time of crisis."[44] Apparently, a parallel debate has been occurring in Russia.[45]

The relationship of military agencies to commercial and scientific ERS has always been a tense one.[46] Yet the military does a good deal of inadvertent earth science. Because military and civilian ERS systems often duplicate each other's work, a merger of some programs would be more efficient. National security concerns, however, may pose a critical obstacle.[47] Even though the U.S. military has been actively promoting access to formerly classified data and facilities in order to justify its post–Cold War budget, cultural barriers often prevent researchers from obtaining usable military data. Again, global technological change

provides the impetus for new sovereignty bargains. Consider, for instance, the fact that once Europe's Earth Resources Satellite-1 (ERS-1) began returning the same kind of gravity data as the U.S. Navy's Geosat system, the U.S. military suddenly became more responsive to civilian researchers.[48]

In the long run, the most important types of ERS-related sovereignty bargains are likely to be those embodied in international cooperative endeavors. At the most general level, the Outer Space Treaty hinges upon a sovereignty bargain in which states accept responsibility for all activities of their nationals in outer space in exchange for the recognition of their right to use outer space for peaceful purposes.[49] On a more instrumental level, the efficiency of cooperative programs provides a powerful incentive for states to collaborate on a wide range of space programs, including ERS.[50]

Before the end of the Cold War, there was a political consensus on both sides of the Iron Curtain linking space to national security objectives—not only for projects with an obvious military value, but also for civilian prestige projects. Since the end of the Cold War, the alliance of space with narrowly defined national interests has deteriorated, as the proliferation of U.S.-Russian space programs demonstrates.[51] That development, combined with a general mood of fiscal conservatism, has sparked a major increase in the number and scope of cooperative space programs. In the words of one observer, "Now that the Cold War is over, we can afford to be efficient."[52] Sovereignty has not been "eroded," but the range of acceptable sovereignty bargains on space projects has dramatically increased with the end of the Cold War, prompting the proliferation of international ERS programs.

Just as important for international cooperation in ERS have been the new exigencies of global environmental research. A patchwork of transnational scientific research programs has sprung up in the last decade, including: the Man and the Biosphere Programme, the International Biosphere-Geosphere Programme, and the World Climate Research Programme. To a very great extent, these programs, spearheaded by international organizations and nongovernmental scientific organizations, rely upon satellite data provided through national space agencies. These international programs seek to achieve a "worldwide synergy of local research" by bringing together the financial and organizational capabilities of governments with the intellectual capacity of the world's scientific community.[53]

Though NASA is undoubtedly the major player in most of these programs, virtually every ERS project has an international component. Most of the satellites launched under NASA's Mission to Planet Earth program have carried instruments from other countries, or else have transmitted data to other countries. Likewise, Japan's new Advanced Earth Observing Satellite (ADEOS) carries two U.S. and one French instruments.[54] The principle international coordinating body for Earth observations is the Committee on Earth Observations Satellites (CEOS), which was created in 1984 in connection with the annual G-7 Economic Summit, and whose membership includes all national and supranational space agencies. A smaller body, the Earth Observations International Coordination Working Group (EO-ICWG), provides a more restricted forum for Canada, Europe, Japan, and the United States to plan the International Earth Observing System (IEOS) for the 1990s and beyond.[55]

The kinds of voluntary arrangements represented by CEOS and EO-ICWG are emblematic of a particular kind of sovereignty bargain whereby states sacrifice some degree of autonomy and control over technological and informational resources in exchange for the benefits of collaboration, which include cost savings and intellectual synergy. But these bargains are not without their drawbacks. Once states become dependent upon a continued supply of Earth observation data that they do not themselves control, they are faced with the dilemma that their access to data is perpetually at the mercy of other states' budgetary processes. For instance, while the European Space Agency (ESA), having been once burned by NASA in the Spacelab project, insisted upon effective sovereignty over the elements it contributed to the space station, it nonetheless remains hostage to NASA's budgetary roller coaster. According to a clause in the 1988 ESA-NASA agreement, which is standard fare in joint international space ventures, states' obligations are "subject to availability of funds."[56] Given that NASA's Earth Observation System (EOS) program has already been scaled back twice, there is a strong likelihood that budgetary politics will interfere with other cooperative ERS endeavors.

Various proposals have been introduced for an international regime that would promote the efficient and systematic use of ERS technologies.

One proposal, initiated by the Society of Japanese Aerospace Companies, is for a World Environment and Disaster Satellite Observation System (WEDOS) that would monitor natural and man-made disasters on all time scales.[57] A more comprehensive proposal, under discussion since the mid-1980s, is for ENVIROSAT, a regime analogous to INTELSAT and INMARSAT, to provide climate, meteorological, ocean, and land observations. Regime members would contribute to the capital expenses of the system by paying in proportion to use, and users would pay commercial fees for services.[58] This sort of sovereignty bargain would simultaneously increase states' mutual dependence on ERS technology and data, while making it more difficult for states to renege on prior commitments for budgetary reasons. In spite of the obvious benefits, an international ERS regime, whose users would include government agencies, academic researchers, multinational corporations, local communities, and nongovernmental orgnanizations, would be far more difficult to negotiate than a regime like INTELSAT, which serves only the communications industry. At stake would be critical questions about the ownership of knowledge.

The sorts of sovereignty bargains embodied in international cooperative arrangements involving ERS technology do not necessarily signify "the erosion of sovereignty." Rather, they represent concrete choices by states to sacrifice some elements of authority, autonomy, and control for others. Those choices, which are never free choices but are constrained and largely driven by the dynamics of technological globalization, engender the reconfiguration of political space and the renegotiation of sovereignty.

The View from Space: Sovereign Knowledge?

Because of its central role in the dissemination of knowledge about the Earth, the most interesting political questions involving ERS technology pertain to the control of knowledge and information and the purposes to which they are applied, bringing us back to the neglected informational dimension of sovereignty.[59] Knowledge and sovereignty are conceptual kin; both sorts of claims are fundamentally about whose voice is to be regarded as authoritative. And because the quest for scientific knowledge is a cornerstone of modernity, these issues inevitably return us to the larger question of the relationship of ERS to modernity.

Information has inherent public-goods attributes, so that governments are likely to continue to play a significant role in ERS funding and application.[60] And although information is "slippery" by nature, its production and dissemination are costly and its close relationship to power can kindle conflicts over its control and possession. Consider the following disputes over access to satellite-derived information. Developing countries' lack of confidence in an uninterrupted supply of ERS data from the United States, particularly after the privatization of Landsat, prompted the largest of them to build their own remote sensing satellites.[61] Researchers harbored similar sentiments, but they lack the option of building their own satellites. According to one scientist, the tenfold increase over the 1970s price in the cost of Landsat data after privatization effectively impeded a good deal of scientific research.[62] Both government agencies and scientific researchers feel that commercialization threatens their access to data. SPOT, for instance, implemented a policy in 1989 of giving preferential service to its largest customers, the oil and mining industries, potentially placing certain government agencies at a disadvantage in obtaining urgently needed data.[63] More recently, European governments have threatened to launch a "data war" by attempting to restrict commercial access to ERS data from weather satellites. Their moves have inflamed researchers, who claim that scientific and commercial data are not easily distinguishable.[64] In a similar vein, ensuring data consistency is a central concern for researchers, whereas commercial competitiveness entails exactly the opposite: capabilities, image size, and hardware are differentiated as much as possible to prevent commercial users from switching systems.[65] In June 1995, the World Meteorological Organization voted to restrict the availability of some kinds of weather data, "in effect creating a new commodity which can be encrypted, bought and sold, licensed, and controlled in a way that such data had not been before."[66] All of these points of dissension have implications for issues of control and authority in an information age, issues that include but are not limited to state sovereignty.

New technologies do not emerge as neutral tools; rather, they arise in a context of ongoing struggles for control and authority, amplifying certain voices and inhibiting others. Any technology as useful as ERS

inevitably becomes the object of great contention. Is there, then, a distinctive logic to ERS as an artifact/idea that tends to legitimize or empower certain voices over others? If knowledge and information are preeminent sources of power in late modernity, then what do the globality, the transparency, and the high-tech nature of ERS entail for the distribution of social and political power?

At first glance, the logic underlying ERS appears to be profoundly technocratic. The skills required to operate satellites and sensors, and to decipher ERS data and, imagery, are concentrated in an elite group of technicians and scientists from industrialized countries.[67] At times, ERS experts exhibit an almost missionary zeal reminiscent of the Baconian technocratic ideal. Space technology is said to offer "unlimited perspectives on ourselves, the world, and the cosmos around us."[68] One champion of ERS technology, Thomas Becker, even suggests that human survival depends upon it: "The great opportunity for progress in the world in the 20th century was physics, which built the world we live in. The great opportunity for creative progress in the next century will be Earth Science. It will determine if humankind is in the universe to stay."[69] As the capabilities of ERS technology expand, such sentiments may become even more prevalent. Already, a marine biologist can sit at his computer and "get information from a free-ranging whale anywhere on Earth."[70]

While the technocratic potential of ERS appears to be evident, other forces could compel the architects of ERS technology to become more accountable to its users. The very multiplicity of ERS users—ranging from research scientists in many fields to the extractive industries to environmentalists—suggests the potential for a diffusion of power along multiple channels. The state may be an important channel, but it is neither the only one nor is it a univocal one. As "Big Science" projects lose their appeal in a time of budgetary conservatism, and as their prestige value is diminished with the end of the Cold War, space agencies must increasingly justify ERS programs in terms of their users' requirements. One space scientist calls this a "thoroughly postmodern approach," stating that, "No longer will the development of new technology be driven by an elite of scientists and engineers, but a broader base of consultation will be required with the many user constituencies."[71]

ERS is a multifaceted artifact/idea incorporating sometimes contradictory tendencies. On the one hand, the global view afforded from the vantage point of space seems especially conducive to notions of "planetary management" and the centralization of power. Indeed, in the discourse surrounding ERS, terms like "managing the planet" and "global management" abound.[72] Yet global science is inherently decentralized, depending upon "countless loosely knit and continually shifting networks of individual researchers—most of whom resist outside intervention—in communication that crisscrosses the borders of well over a hundred sovereign nations."[73] The decentralized nature of global science is likely to have important social and political implications for efforts to cope with ecological interdependence, implications which are beyond the scope of this chapter.

While the global science based upon ERS data has many of the earmarks of a mammoth technocratic enterprise, it is not immune to public opinion; nor are its fruits available only to the elite. NASA's Mission to Planet Earth program, for instance, was conceived as a vehicle for restoring the confidence of Americans, newly concerned about the environment, in the space agency after the Challenger disaster.[74] Even in Japan, popular environmental concern shifted the emphasis of its new Earth resources spacecraft, ADEOS, away from pure research objectives.[75] In the future, ERS satellite systems could provide citizen groups with the means to verify compliance not only with, environmental treaties, but with arms control treaties as well, with potentially interesting ramifications for the tension between state sovereignty and popular sovereignty.[76]

ERS data can facilitate the localization of control in some surprising ways. Perhaps most interesting is the use of satellite data by indigenous peoples for mapping their customary land rights and documenting the role of the state and multinational corporations in environmental destruction. Environmental advocacy groups and indigenous rights groups in Indonesia, Nepal, Thailand, and the Pacific Northwest are using satellite-generated data to reterritorialize their political practices to an extent previously inconceivable.[77] While ERS data may deterritorialize political practice at the level of the nation-state, it seems to be having exactly the opposite effect at the local level. Thus, ERS technologies may facilitate challenges to state sovereignty from below, a promising development for groups trying to assert local control.

Because the use of ERS data in developing countries raises a host of complex cultural, political, and ethical issues, not all observers see this sort of technology transfer in a positive light. For instance, Masahide Kato is critical of nonprofit groups based in industrialized countries who supply satellite-generated information to remote areas of developing countries. He believes they are representives of a "globalist technosubjectivity" which renders the territories of indigenous peoples as resources.[78] Indeed, satellites seem to offer the tantalizing prospect of "sovereign knowledge," or knowledge with supreme authority. As one early enthusiast proclaims, they "show vast terrains in correct perspective, from one viewpoint, and at one moment in time."[79] But, that "one viewpoint" is generally located in the North and that "one moment in time" cannot capture centuries of past environmental abuse, a fact that may prove profoundly disadvantageous for developing countries when ERS data are used to assign responsibility for ecological degradation.[80]

While Kato perhaps too quickly condemns ERS technology, which we have seen can be used to promote the interests of indigenous peoples, his critique reveals two interrelated issues of political culture implicit in ERS as an artifact/idea: the control of knowledge (who controls it and for what purposes) and the constitution of knowledge (what counts as knowledge). By employing ERS dâta, environmental and indigenous rights groups demonstrate that it can be translated into usable knowledge for purposes of cultural and ecological preservation, but they simultaneously legitimize it as a source of credible knowledge. The mantle of scientific objectivity that is gained when traditional practices are transposed into the language of GIS is not cost-free. As one scientist cautions,

> [While] spatial information technology may enable local people to make claims against the state, this power comes with a price—it destroys the fluid and flexible nature of their traditional perimeters.... While maps can be an empowering tool, helping a local community define itself in relationship to the landscape and to the political forces that shape and influence it, maps can also be used to disinherit them.[81]

Moreover, the voyeuristic nature of photography, including satellite imagery, may promote a view of nature that is antithetical to the long-term ecological goals of grass roots groups. In her famous essay, *On Photography*, Susan Sontag argued that, "cameras implement the instrumental view of reality. [They] arm vision in the service of power—of the state, of industry, of science."[82] Some grass roots groups are wagering that ERS can also "arm vision in the service of power" at the local level, and thus serve the cause of resistance. Their efforts, however, are too recent to draw any conclusions at this point.

Users of satellite-generated Earth data have powerful cultural and rhetorical tools on their side—specifically Enlightenment ideals about the liberating power of knowledge. According to one viewpoint programs employing ERS information should be based on the premise that "greater knowledge leads to greater wisdom,"[83] a premise that deserves scrutiny. If the link between knowledge and wisdom is weak, the link between knowledge and power is more palpable. Indeed, a core assumption of the architects of ERS systems is that they offer "a whole new tool with which to understand our own world, and once we understand it, we can manage it."[84] Such statements seem to presuppose a specifically modern conception of agency and responsiblity, with a rational autonomous self capable of knowing (and thereby controlling) the Other embodied in the natural "environment." This is exactly the form of Western subjectivity which Franke Wilmer critiques in chapter 3 of this book. If this hallmark of modernity is actually at the root of the global environmental crisis, then the faith in ERS technology may be fundamentally misplaced.

Given the deep entrenchment of the knowledge/power nexus as a cultural cornerstone of modernity, to question the need for more information approaches heresy. Yet, given the stakes, we must ask whether ERS data will tell us what we need to learn. NASA's Earth Observing System (EOS) will produce an unprecedented quantity of data, at a cost of perhaps twenty billion dollars; its data information system (EOSDIS) will be the largest data-handling system ever constructed, with a capacity of fourteen petabytes (a petabyte is 10^{15} bytes).[85] A global ERS system is expected to provide "the long-term measurements to determine the habitability of the Earth" and guide policy makers in addressing global environmental change.[86] With less than 5 percent of Landsat's data having ever been used,[87] it is quite possible that ERS technologies will generate more information overload than usable knowledge. According to the World Meteorological Organization, a satellite-based Global Climate Observing System, with EOS as its core, "will require substantial resources, but the costs to society from continuing the present level of uncertainty about climate change are very much larger."[88] What those costs are, who bears them, and how ERS data will decrease them, are not discussed.

Will the knowledge gained through ERS technology tell us how to live sustainably? The answer to the question will depend largely upon who uses the information and to what purposes it is applied.

Conclusion

The transparency, globality, and technological sophistication associated with ERS technologies entails multiple, and sometimes contradictory, implications for the institution of sovereignty. As we have seen, there is no single political logic for ERS as an artifact/idea, which is partly because technologies tend not to be monolithic cultural constructs. But, more importantly, the cross-cutting logic stems, in many ways, from the fact that ERS stands at the intersection between modernity and postmodernity. First, ERS is fundamentally an information age technology, with all the concomitant implications for the power/knowledge nexus that arise when data make up the currency of power and materialist conceptions of power are not fully applicable.

Second, ERS contributes to the unbundling, but not the abolition, of territoriality. While the transparency and globality associated with ERS technologies very often deterritorialize state practices, they are also capable of bolstering territorial sovereignty for developing countries with remote regions. More surprising, however, are the ways in which they are helping local environmental and indigenous groups to reterritorialize their political practices.

Third, while ERS programs have their roots in the balance-of-power politics characteristic of the modern nation-state system, since the end of the Cold War they tend to exemplify the sorts of sovereignty bargains required by scientific and environmental (and, to a lesser extent, commercial) cooperation. If modernity is interpreted as the enclosure of the globe via the twin institutions of state sovereignty and private property, then ERS technologies at once epitomize and challenge that trend. On the one hand, by making visible the invisible, satellite imagery renders nature subject to claims of ownership and control. On the other hand, in light of the globality and transparency inherent in ERS technologies and the emphasis on environmental cooperation, ERS has the potential to become a tool in the revisioning of nature as a global commons. Indeed, this is the thrust of much of the discourse surrounding environmental ERS.

Finally, there is the tension between the universal, totalizing perspective of the sovereign gaze, and the application of ERS technologies to popular sovereignty through the decentralization of scientific and political control. According to John Ruggie, the transformative potential of global ecology as a basis for a postmodern social episteme lies in "the underlying structural premise of ecology [of] holism and mutual dependence of parts." He also suggests that the study of the emergence of "multiperspectival institutional forms" is key to understanding the transition to postmodernity.[90] By itself, holism could legitimate and reinforce the uniperspectival attitude of the sovereign gaze. While this distorted interpretation of ecological principles is at times evident among proponents of ERS programs, it is countered by a contrary tendency toward pluralism and the proliferation of voices among users of ERS technologies and data. Thus, the relationship of ERS to sovereignty can be problematized and analyzed in terms of how, as an artifact/idea, it operates at the crossroads between modernity and postmodernity.

Notes

1. I am grateful to Ronald Mitchell, Lisa Schafer, Janice Thompson, and Mark Zacher for their helpful comments on earlier versions of this paper.
2. Langdon Winner, "Artifact/Ideas and Political Culture," in Albert H. Teich, ed., *Technology and the Future*, 6th ed. (New York: St. Martin's Press, 1993): 283–92.
3. Committee on Earth Observation Satellites (CEOS), "The Relevance of Satellite Missions to the Study of the Global Environment," produced for the UNCED conference at Rio de Janeiro (Washington, D.C.: CEOS, 1992). On the multitude of uses for ERS, see Doug Stewart, "Eyes in Orbit Keep Tabs on the World in Unexpected Ways," *Smithsonian* 19 (December 1988): 70–76.
4. John H. McElroy, "INTELSAT, INMARSAT, and CEOS: Is ENVIROSAT Next?" in Gordon MacDonald, ed., *Proceedings of the Conference on Space-Based Monitoring of the Global Environment* (La Jolla, Calif.: Institute on Global Conflict and Cooperation, 1992).
5. Anthony Giddens, *The Nation-State and Violence* (Berkeley and Los Angeles: University of California Press, 1987), 52, 309; Michel Foucault, *Discipline and Punish: The Birth of the Prison* (New York: Vintage, 1979).
6. Joseph N. Pelton, "Organizing Large-Scale Space Activities: Why the Private Sector Model Usually Wins," *Space Policy* 8 no. 3 (August 1992): 234.
7. "A Problem as Big as a Planet," *Economist* (5 November 1994): 83–85.
8. Michel Foucault, *Power/Knowledge: Selected Interviews and Other Writings*, C. Gordon, ed., and trans. C. Gordon, L. Marshall, J. Mepham, and K. Soper (New York: Pantheon, 1980); Mark Poster, *Foucault, Marxism, and History: Mode of Production vs. Mode of Information* (Cambridge: Polity, 1984); Frederic Jameson, "Postmodernism, or the Cultural Logic of Late Capitalism," *New Left Review* 146 (July-August 1984): 53–92.
9. John Gerard Ruggie, "Territoriality and Beyond: Problematizing Modernity in International Relations," *International Organization* 47, no. 1 (Winter 1993): 171.
10. Pelton, "Organizing Large-Scale Space Activities," 242.
11. While military agencies may be struggling to redefine their mission, the end of the Cold War does not spell the obsolescence of military reconnaissance. See Jeffrey T. Richelson, "The Future of Space Reconnaissance," *Scientific American* 264, no. 1 (January 1991): 38–44; and John Trux, "Desert Storm: A Space Age War," *New Scientist* 27 (July 1991), pp. 30–34. On NASA's Mission to Planet Earth program, and the conversion of missiles to environmental purposes, see Ann Florini and William Potter, "Goodwill Missions for Castoff Missiles," *Bulletin of the Atomic Scientists* (November 1990): 25–31.
12. Robert Dreyfuss, "Spying on the Environment," *Earth Action* 6, no. 1 (February 1995): 28–36.
13. On the disadvantages of involving the military in ERS, see Ronald Diebert, "Out of Focus: "U.S. Military Satellites to the Environmental Rescue," in Daniel Deudney and Richard Matthews, eds., *Contested Grounds: Security and Conflict in the New Environmental Politics* (Albany: State University of New York Press, forthcoming).
14. Leonard S. Spector, "Keep the Skies Open," *Bulletin of the Atomic Scientists* (September 1989): 16. A 1988 image, apparently bought from Soyuzkarta, of an air base in Nevada which the Pentagon does not admit exists, has turned up in instructions for a Testor model airplane and on the cover of *Popular Science*. See "Get Satellite Imagery Policy in Focus," *Aviation Week and Space Technology* (February 21, 1994): 124.
15. "Legislating the 'Last Frontier,'" *UN Chronicle* 29 (December 1992): 54; "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies," *United Nations Treaty Series* 610: 205 (1967). The question of remote

sensing satellites and territorial sovereignty had been partially resolved when President Kennedy promised the world free access to weather data in exchange for an implicit recognition of outer space as a global commons.

16. David Green, "The Reassertion of Social Aspects of Science and Technology," *Space Policy* 10, no. 3 (August 1994): 242.
17. Carl Q. Christol, *The Modern International Law of Outer Space* (Oxford: Pergamon, 1982): 468, quoted in Joanne Irene Gabrynowicz, "Bringing Space Policy into the Information Age," *Space Policy* 8, no. 2 (May 1992): 168.
18. See Stephen A. Doyle, "Space Law and the Geostationary Orbit: The ITU's WARC-ORB-85088 Concluded," *Journal of Space Law* 17 (1989): 13–21; Report of the Committee on Peaceful Uses of Outer Space, UN Doc. A/49/20 (1994).
19. M.J. Peterson argues that the nonterritorial perspective won out not just for reasons of power and interests, but because the analogical reasoning linking outer space to the high seas and Antarctica had become so firmly entrenched. See "Extending International Law to New Fields of Endeavor: Developing Outer Space Law," unpublished manuscript, 1995. See also "Legislating the 'Last Frontier.'"
20. Quoted in Pamela Mack, *Viewing the Earth: The Social Construction of the Landsat Satellite System* (Cambridge, Mass.: MIT Press, 1990): 187.
21. David T. Lindgren, "Commercial Satellites Open Skies," *Bulletin of the Atomic Scientists* (April 1988): 34.
22. Mack, *Viewing the Earth*, 189–92.
23. J.B. Harley, "Maps, Knowledge, and Power," in Denis Cosgrove and Stephen Daniels, eds., *The Iconography of Landscape: Essays on the Symbolic Representation, Design, and Use of Past Environments* (Cambridge: Cambridge University Press, 1988): 227–312.
24. Mack, *Viewing the Earth*, 188.
25. "Report Criticizes Landsat Commercialization," *Aviation Week and Space Technology* 118 (May 9, 1983): 18; Mack, ibid., 206.
26. Eliot Marshall, "Landsats: Drifting toward Oblivion?" *Science* 243 (February 24, 1989): 24.
27. Adgun Ade Abiodun, "An International Remote Sensing System," *Space Policy* 9, no. 3 (August 1993): 183.
28. For instance, the public health sector, which could employ ERS technology to combat many diseases, had yet to become a user as of 1989. Peter Jovanovic, "Satellite Medicine: Space Technology in Primary Health Care," *World Health* (January 1989): 18.
29. Committee on Earth Studies, Space Studies Board, National Research Council, *Earth Observations from Space: History, Promise, and Reality* (Washington, D.C.: National Academy Press, 1994): II–5.

30. Frederic Golden, "A Catbird's Seat on Amazon Destruction," *Science* 246, no. 4927 (October 13, 1989): 201.
31. "Chinese Developing Satellites for Earth Resources Exploration," *Aviation Week and Space Technology* (July 22, 1985): 81–84.
32. UN document A/AC.105/C.2/L.182, April 9, 1991, submitted by Argentina, Brazil, China, Mexico, Nigeria, Pakistan, the Philippines, Uruguay, and Venezuela.
34. N. Jasentuliyana, "Ensuring Equal Access to the Benefits of Space Technologies for All Countries," *Space Policy* 10, no. 1 (February 1994): 11.
34. Molly K. Macauley, "Collective Goods and National Sovereignty: Conflicting Values in Global Information Acquisition," in *Proceedings of the Conference on Space Monitoring of Global Change* (San Diego: Institute on Global Conflict and Cooperation, 1992): 31–55.
35. Rheem, 16.
36. Dreyfuss, "Spying on the Environment," 36.
37. Peter D. Zimmerman, "Photos from Space: Why Restrictions Won't Work," *Technology Review* 91 (May-June 1988): 48. The resolution of Landsat images at the time was thirty meters, while military reconnaissance satellites had a resolution of less than half a meter. See Nicholas Daniloff, "How We Spy on the Russians," *World Politics Magazine* (December 9, 1979): 24–34.
38. Theresa M. Foley, "Pentagon, State Department Granted Veto over U.S. Remote Sensing Satellites," *Aviation Week and Space Technology* (July 20, 1987): 20–21. In an interesting twist, the Pentagon became a paying customer of SPOT for images of Soviet military installations; while it had millions of its own images, these were classified and so could not be published in its reports. See William M. Arkin, "Long on Data, Short on Intelligence," *Bulletin of the Atomic Scientists* 43, no. 5 (June 1987): 5.
39. Daniel Charles, "U.S. Draws a Veil over 'Open Skies,'" *New Scientist* 116, no. 1585 (November 5, 1987): 29. Many space experts have argued that commercial ERS can promote peace by lessening military secrets and by promoting the independent verification of arms control treaties. See William J. Broad, "Private Cameras in Space Stir U.S. Security Fears," *New York Times* (August 25, 1987): Michael Krepon, ed., *Commercial Observation Satellites and International Security* (New York: St. Martin's, 1990).
40. Office of the Press Secretary, the White House, "Foreign Access to Remote Sensing Capabilities," *Space Policy* 10, no. 3 (August 1994): 243–44.
41. Kiran Karnik, "Remote Sensing: The Indian Experience," *UNESCO Courier* 46 (January 1993): 17.
42. David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Cambridge: Blackwell, 1989): 252.
43. The Clinton adminstration's policy is outlined in the White House, "Foreign Access to Remote Sensing Space Capabilities." The controversy preceding this policy is discussed in John Morrocco, "Lawmakers Warn Clinton on

Satellite Imagery Sales," *Aviation Week and Space Technology* (November 22, 1993): 38.

44. "Get Satellite Imagery Policy in Focus."
45. James Asker, "High-Resolution Imagery Seen as Threat, Opportunity," *Aviation Week and Space Technology* (May 23, 1994): 51–53.
46. Interestingly, the political roots of NASA's earth science programs lie partly in the Reagan administration's desire to dispel the popular impression that it was only interested in space research for its military applications. "NASA Floats a Global Plan," *Science* 217 (September 3, 1982): 916.
47. Committee on Earth Studies, *Earth Observations from Space*, ix, 9–10.
48. Richard Kerr, "The Defense Department Declassifies the Earth—Slowly," *Science* 263 (February 4, 1994): 625–26.
49. In a sense, this can be viewed as a consolidation of sovereignty. Just as states became responsible for their nationals at sea, thereby effectively eliminating mercenarism and piracy, states are now responsible for their citizens' activities in outer space. See Janice Thomson, *Mercenaries, Pirates, and Sovereigns: State-Building and Extraterritorial Violence in Early Modern Europe* (Princeton, N.J.: Princeton University Press, 1994).
50. Thus, the market for launching satellites is a global one for the simple reason that demand in any one country is insufficient to support that country's launch capacity. See Jack Scarborough, "Free Trade and the Commercial Launch Industry," *Space Policy* 8, no. 2 (May 1992): 109.
51. The unique relationship of the United States to its NATO allies during the Cold War made certain arrangements acceptable that would be virtually unthinkable today. Europe, for instance, agreed in the 1970s to give full "jurisdiction and control" of its Spacelab to the commander of NASA's space shuttle. A recent ESA-NASA agreement, however, gives Europe full sovereignty over the elements of the space station that it contributes. See George van Reeth and Kevin Madders, "Reflections on the Quest for International Cooperation," *Space Policy* 8, no. 3 (August 1992): 221–22.
52. Pelton, "Organizing Large-Scale Space Activities," 244.
53. Rene Lefort, "A Worldwide Synergy," *UNESCO Courier* 45 (July-August 1992): 42; Eugene Bierly, "The World Climate Program: Collaboration and Communication on a Global Scale," *Annals of the American Academy Political and Social Science* 495 (January 1988): 110.
54. Hatoyama-Machi, "Japanese Earth Satellites Spawn Multiple User Groups," *Aviation Week and Space Technology* 133 (August 13, 1990): 70–72.
55. Committee on Earth Studies, *Earth Observations from Space*, 27–31.
56. Van Reeth and Madders, "Reflections on the Quest, "226.
57. Joan Johnson-Freese, "Development of a Global EDOS: Political Support and Constraints," *Space Policy* 10, no. 1 (February 1994): 45–55. One of the strongest opponents of the Japanese proposal has been NASA, which views EDOS as a potential competitor with its own EOS program.

58. John L. McLucas and Paul M. Maughan, "The Case for ENVIROSAT," *Space Policy* 4, no. 3 (August 1988): 229–39; Stephen Day, "Is the Next Step, InRemSat?" *Satellite Communications* 15, no. 4 (April 1991): 22; Abiodun, "An International Remote Sensing System: A Possibility," 179–84.
59. *Data* is not the same thing as *knowledge*. Data are generated from simple empirical observation, while knowledge entails causal understandings and typically involves some degree of generalizability. Creating knowledge out of data requires analytical abilities that go beyond the observational capacities of instruments such as those found on earth-orbiting satellites.
60. Molly K. Macauley and Michael A. Toman, "Supplying Earth-Observation Data from Space," *Space Policy* 8, no. 1 (February 1992): 17.
61. Frederic Golden, "A Catbird's Seat on Amazon Destruction: Brazil's Space Agency Is Playing. an Expanded Role in Monitoring the Nation's Environment," *Science* 246, no. 4927 (October 13, 1989): 201.
62. Christopher Fotos, "Commercial Remote Sensing Satellites Generate Debate, Foreign Competition," *Aviation Week and Space Technology* 129 (December 19, 1988): 49–50.
63. Spector, "Keep the Skies Open," 16; Group of Experts, UNISPACE 82 Conference, "International Remote Sensing System Proposed by Experts," *UN Chronicle* 22, no. 2 (February 1985): 20.
64. Andrew Lawler, "U.S., Europe Clash over Plan to Set Policy on Data Access," *Science* 268 (April 28, 1995): 493.
65. Gabrynowicz, "Bringing Space Policy into the Information Age," 174.
66. Renee Marlin-Bennett, "Who Owns the Weather? A Case of Commodification in the Global Political Economy." Paper presented at the 1996 meeting of the International Studies Association, 17–21 April 1996, San Diego, 2. (cited with permission of author).
67. David Rhind, "Geographical Information Systems and Environmental Problems," *International Social Science Journal* 43 (November 1991): 662.
68. L.A. Fisk, L.K. Berman, R. Brescia, A.S. McGee, and F.C. Owens, "NASA Takes Lead Role in Earth Observation," *IEEE Technology and Society Magazine* (Spring 1992): 11.
69. Thomas W. Becker, "Mission to Planet Earth and Global Space Education Policy," *Space Policy* 8, no. 2 (May 1992): 158. Many ERS enthusiasts also advocate a crash program in the developing countries aimed at "creating a scientific outlook." See U.R. Rao, chairman of India's Space Commission, "Space Technology in Developing Nations: An Assessment," *Space Policy* 9, no. 2 (May 1993): 169.
70. Stewart, "Eyes in Orbit Keep Tabs," 71.

71. Graham Harris, "Global Remote Sensing Programmes, Global Science, Global Change: An Australian Perspective," *Space Policy* 9, no. 2 (May 1993): 131. A current example is the struggle that the new one-meter systems face in winning customers who currently use airplanes for mapping or monitoring. Aerial remote sensing involves "well-ensconced relationships with a local pilot, a local customer, [and] local analytical people." See Joseph Anselmo, "High-Resolution Satellite Competiton Heats Up," *Aviation Week and Space Technology* 140 (July 11, 1994): 56.

72. For instance, see Scientific American, *Managing Planet Earth* (New York: W.H. Freeman and Co., 1990).

73. James R. Beniger, "Information Society and Global Science," *Annals of the American Association of Political and Social Scientists* 495 (January 1988): 23.

74. Daniel Clery and William Bown, "Sensing Satellites: Who Calls the Tune?" *New Scientist* 130, 1767 (May 4, 1991): 17.

75. Hatoyama-Machi, "Japanese Earth Satellites," 71.

76. Lindgren, "Commercial Satellites Open Skies," 36.

77. Martua Sirait, et al., "Mapping Customary Land in East Kalimantan, Indonesia: A Tool for Forest Management," *Ambio* 23, no. 7 (November 1994): 411–17; Cultural Survival, *Geomatics: Who Needs It?* 18, no. 4 (Spring 1995); Jefferson Fox, ed., "Spatial Information and Ethnoecology: Case Studies from Indonesia, Nepal, and Thailand," an unpublished manuscript available from the East-West Center in Honolulu, Hawaii. I am grateful to Judith Mayer for her insight into the reterritorializing of political practice at the grass roots level.

78. Masahide Kato, "Nuclear Globalism: Traversing Rockets, Satellites, and Nuclear War via the Strategic Gaze," *Alternatives* 18 (1993): 344–45.

79. Beaumont Newhall, *Airborne Camera: The World from the Air and Outer Space* (New York: Hasting House, 1969): 121.

80. This is exactly the kind of issue that bedevils efforts to measure responsibility by formulating a "greenhouse index." See Peter Hayes and Kirk Smith, eds., *The Global Greenhouse Regime: Who Pays? Science, Economics, and North-South Politics in the Climate Change Convention* (Tokyo: Earthscan, 1993).

81. Jefferson Fox, "Spatial Information Technology and Human-Nature Relationships," East-West Center Working Paper No. 43, (Honolulu: East-West Center, 1995).

82. Susan Sontag, *On Photography* (New York: Farrar, Straus, and Giroux, 1977): 176–77.

83. P.M. Banks and C.C. Ison, "A New Role for Freedom," *Aerospace America* (September 1989): 30.

84. Carol Matlack, "Landsat's Slow Death," *National Journal* (July 25, 1987): 1903.

85. E. David Hinkley and Gary T. Rosiak, "Instrumenting Space Platforms for Earth Observations," in *Proceedings of the Pacific Rim Environmental Research Meeting* (World Scientific Publishing Co. PTE, 1992).

86. Fisk, "NASA Takes Lead Role," 14.

87. Christine Nielsen and Dirk Werle, "Do Long-Term Space Plans Meet the Needs of Mission to Planet Earth?," *Space Policy* 9, no. 1 (February 1993): 15.

88. World Meteorological Organization, *Global Climate Observation System: Responding to the Need for Climate Observations* (Geneva: WMO, 1992): 12.

89. Ruggie's notion of a new social episteme entails "a new set of spatial, metaphysical, and doctrinal constructs through which the visualization of collective existence on the planet is shaped." Ruggie, "Territoriality and Beyond," 173–74.