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Paper Title: Shooting (from) the Moon: NASA, Nature, and the New Left during the Vietnam War
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Note to Colloquium Participants:

The attached paper is a draft of a chapter from my next book project, which is tentatively titled *Ground Control: How Apollo Scrubbed the Age of Aquarius*. The overall book project explores the technological and environmental history of the space race to better understand the interplay between federal efforts to place humans on the Moon and the more grassroots political and social struggles of the 1960s and 1970s. The project is basically a history of how the space race and the political movements of the "long 1960s" influenced one another.

I approach this through five case studies (chapters), each of which explores how the space race influenced, and was influenced by, one of the political movements of the era. There will be chapters on the space race and civil rights, women's equality, environmentalism, the anti-war movement, and the rise of the conservative right. I will also include an introductory chapter that places this history within its broader Cold War context. What you are reading now is a draft (please do not cite) of the Vietnam War chapter.

Thanks in advance for reading my work and for your feedback.

Neil Maher

Shooting (from) the Moon:
NASA, Nature, and the New Left during the Vietnam War

Neil M. Maher

Just before midnight on July 23, 1980, in the high desert of Kazakhstan, the Soviet Union launched Soyuz 37 from the Baikonur Cosmodrome. Lifting off from "Russia's Cape Canaveral" were Colonel Victor Gorbatko, a seasoned Soviet cosmonaut, and Colonel Pham Tuan, who, on this mission, became the first Asian to travel into outer space. Six days later, after docking in Earth's orbit with the Soviets' Salyut 6 space station, cosmonaut Tuan proudly addressed his fellow countrymen and women on Vietnamese national television. "The Vietnamese revolution has always enjoyed the great assistance of the Soviet Union," he explained while floating 200 miles straight up. Tuan then became quite specific regarding the type of aid bestowed on Vietnam by the Russians. "I would like to convey my heartfelt thanks," he stated, to the Soviet "scientists [and] engineers . . . who have taken part in preparation for our flight." Asia's first cosmonaut then ended his televised broadcast from space by holding up a scale model of the Salyut 6-Soyuz 37 orbital space complex for all of Vietnam to see.[1]

The deployment of space science and technology as Cold War propaganda did not take off with the Soyuz 37 mission during the summer of 1980. Beginning with the launch of Sputnik in 1957 up through the Apollo 11 landing more than a decade later, both the U.S. and the Soviet Union continually publicized space feats as a means of promoting their competing political systems.[2] This practice of linking a country's scientific and technological prowess to its national identity and international prestige was also not new; it harked back at least to the seventeenth century, was reinforced in the

European context by the Enlightenment, and became even more widespread during the Industrial Revolution.[3] Yet it was during the Cold War that this relationship between a nation's scientific and technological capabilities on the one hand, and its political ideology on the other, became most interconnected.[4] By holding up a scale model of the Salyut—Soyuz space complex on Vietnamese national television, Pham Tuan was in effect broadcasting the benefits of Soviet-style communism to the Vietnamese public.

During Colonel Tuan's television broadcast from space his thoughts also returned to Vietnam, which he passed over more than 142 times during his nearly eight days in orbit. "I was deeply moved each time I flew over Vietnam and saw our beautiful homeland," he beamed from space after watching the lush green landscape race by below.[5] Vietnamese on the ground also experienced this historic spaceflight through the nature all around them. "Everyone in our country — on the rivers, in the mountains, on the seas, in the forests, in the rice fields," explained Radio Hanoi in a national broadcast on the day of the liftoff, "is happy."[6] While such joy was obviously related to national pride, Tuan and his fellow Vietnamese were also excited by the prospects this space technology posed for their country's natural environment. Experiments conducted during the mission, announced the Vietnamese government to the public just days before the launch, "include some very important and interesting ones to study natural resources of the country from space."[7] The Vietnamese people thus understood, perhaps more than their Russian counterparts, that although superpower technologies such as spaceships were difficult if not impossible to develop from the ground up *within* the developing world, they might nevertheless be put to good use on the ground *across* it.[8]

Pham Tuan's historic ride aboard Soyuz 37 raises historical questions as well.

How does our understanding of the Cold War's political history change when we analyze not only science and technology, such as that hurtling through space during the summer of 1980, but also the natural environment, in this case passing by two hundred miles below? Where does this Cold War history lead us when we trace the impact of science and technology not just between the American and Soviet superpowers, but also across the political and environmental landscapes of developing countries such as Colonel Tuan's Vietnam? Finally, in what ways did the domestic politics surrounding the development and deployment of Cold War science and technology within these nations in turn influence the global politics of the Cold War era?

In seeking answers to such questions, outer space proves instructive. While domestic politics often determined the direction and scope of space exploration, the real, material, physical characteristics of space beyond Earth's orbit mean that its history is transnational at the least, if not truly global.[9] According to international law, for instance, no single country can own outer space, celestial bodies, or natural resources beyond planet Earth.[10] Viewing the Cold War from space thus repositions the era in two fundamental ways. First, it highlights the intertwined history of the Cold War space race and the domestic political movements of the late 1960s and 1970s, in this case involving the U.S. military's conflict in Vietnam. Second, it makes more global the history of an important transition from the 1960s when the U.S. and the Soviet Union used space science and technology to compete directly against one another for international attention, to the mid-1970s when the two superpowers embraced a softer détente that relied as well on nature to woo developing countries. To better understand such developments — linking domestic and global politics, as well as technoscience with the

natural environment — we must explore the roots of Pham Tuan's spaceflight, the seeds of which were sown not in the dry desert of Kazakhstan in 1980, but rather in the tropical jungles of Southeast Asia during the Vietnam War.

Both the Soviet Union and the Communist Party of Vietnam chose Colonel Pham Tuan for the Soyuz 37 spaceflight because on the evening of December 27, 1972, at the height of the Vietnam War, he became the first Vietnamese fighter pilot to shoot down an American B-52 bomber. As publicized worldwide during the Soyuz 37 mission by both TASS, the official Soviet press agency, and Quon Doi, the Vietnamese military newspaper, the deputy wing commander, who had received special training for flying at night, trailed his Soviet-made MiG-21 behind a squadron of U.S. Air Force B-52s, maneuvered one of the high-flying bombers into his sights, and fired. The American jet burst into flames and crashed. Although the U.S. military at the time denied the incident, for his aerial feat Tuan became a national hero, received Vietnam's highest military and civilian decoration, the Gold Star medal, and leap-frogged, eight years later, to the front of the line of Vietnamese cosmonauts.[11]

While Tuan's use of darkness in flight might seem extraordinary, it nevertheless reflected a more local Vietnamese practice of relying on the natural environment for advantage during military conflict. During the First Vietnam War, for instance, Vietnamese communists had turned to the Mekong Delta's water environment for military assistance by navigating along unmapped backcountry creeks, by scheduling the transportation of soldiers and materials in coordination with beneficial tides, and by setting ambushes along strategic bends in channels and canals where French vessels

would be most vulnerable.[12] In 1965 when French gunboats in Vietnam gave way to U.S. airplanes and helicopters, Vietnamese communists, now under the banner of the National Liberation Front (NLF), began relying to an even greater extent on local nature for military advantage. Now it was the dense Vietnamese jungle, rather than the country's winding waterways, that were the NLF's primary weapon against the U.S. military's increasingly sophisticated war technology. "The woods were being used to conceal armed bands of Viet Cong," lamented an *Air Force Times* journalist in May of 1966. Trees, grasses, and especially the thick jungle canopy were all employed to "camouflage" their positions.[13]

In many instances Vietnamese communists hid in plain sight, directly underneath dense jungle foliage. The extremely thick canopy of the Boi Loi forest, for instance, located approximately 26 miles northwest of Saigon and extending to within a few miles of the Cambodian border, hid communist guerillas from aerial view so well that these fighters were able, over the course of a decade, to develop the 48-square mile area into one of the NLF's most important military operations centers in South Vietnam.[14] When the jungle itself proved inadequate the NLF's military, the People's Liberation Armed Forces (PLAF), burrowed beneath it by constructing thousands of miles of caves, tunnels, trenches, and other underground passageways for the surreptitious transportation of troops and munitions. The most elaborate of these underground networks was the Cu Chi tunnels, which ran from the outskirts of Saigon for approximately 75 miles to the Cambodian border.[15] Finally, in an effort to augment the jungle's cloaking capabilities, many guerillas moving through the Vietnamese forest did so after dusk, using the night much as Pham Tuan had done during his flight in December of 1972. "Enemy battalions

that break into small units to escape discovery in the daylight," wrote Pulitzer Prize-winning photojournalist Horst Faas from Saigon in 1966, "come together under the concealment of the night and strike in force." The Ho Chi Minh Trail was a case in point; since daylight afforded U.S. bomber pilots better visibility deep within the jungle, nearly all PLAF movement along the Trail occurred after sundown.[16] "The night," Faas concluded, "is an ally" of the Vietnamese communists.[17]

The Vietnamese communists' practice of using their country's jungle as a wartime defense made it increasingly difficult for the U.S. military to "see" clearly in Southeast Asia.[18] Magazine and newspaper articles from the early-to-mid 1960s with titles such as "Uncovering Charlie," "The Invisible Foe," and "U.S. Airborne Device Sniffs For Foe Under Jungle Canopy" all speak to this growing visibility problem as well as to an increasingly desperate reliance on other senses to pinpoint PLAF soldiers.[19] "The key to defeating the guerillas is finding them," explained Lieutenant Colonel Stanley D. Fair in a September 1963 issue of *Army* magazine. Fair went on to lament the U.S. military's inability to do just this — see and locate the enemy. "They move by stealth," he wrote of Vietnamese guerillas. "If only there were some magic way to clear away the trees and brush," he concluded, "there would be less difficulty in finding the VC and defeating them."[20]

Although the American government's efforts to make communists in Vietnam more visible involved spending hundreds of millions of dollars on technologies including "jungle-eating" bulldozers that cleared the Boi Loi forest, carpet bombing campaigns that destroyed the Cu Chi tunnels, and the use of herbicides to defoliate the Ho Chi Minh

Trail, the U.S. military admitted publicly and frequently that such efforts proved ineffective.[21] "In spite of the advantages of mobility, manpower, equipment, and firepower," warned one U.S. military advisor, "the Viet Cong are able to move, strike and disperse with a freedom which seems inconsistent with the imbalance of combat power."[22] Concerned scientists visiting Vietnam to assess the ecological impact of U.S. military efforts agreed. "Despite the lavish application of great wealth and superior technology," wrote one biologist in 1971, "the U.S. has made surprisingly little headway over the years against the national Liberation Front and its North Vietnamese allies."[23] The American military, it seemed, needed a new kind of "magic" to combat Vietnam's "trees and brush," and during the mid-to-late 1960s no other entity worldwide seemed more magical than the National Aeronautics and Space Administration (NASA).

The U.S. Air Force first asked NASA for technological help with the war in Vietnam on November 2, 1965. At a meeting convened at NASA Headquarters in Washington, D.C., General James Ferguson and other members of the Air Force Systems Command, which oversaw the branch's weaponry needs, briefed NASA officials on "the unique technological problems arising out of operations in Vietnam," after which NASA Administrator James Webb immediately indicated "that every effort would be made to uncover those NASA solutions to problems, devices, or techniques, that might be of assistance to our forces in Southeast Asia."[24] Within a month Webb had created a NASA Limited Warfare Committee to work more closely with the Department of Defense and by the end of following year had secured the cooperation of administrators at each NASA center, funded the program through a special account seeded with a half million dollars, and assigned thirty-five of the space agency's engineers to research projects for the

Vietnam War.[25] The goal of such efforts, explained one NASA Deputy Administrator, was to "assure that we miss no opportunity to assist the military forces in any and all ways that are available to us."[26]

Although President Eisenhower consciously established NASA in 1958 as a civilian agency, its ties to the military were deep and often clandestine.[27] The year after its creation, for instance, on February 28, 1959, NASA launched Discoverer 1, a supposed satellite technology experiment that was, in reality, cover for CORONA, the nation's first spy satellite. Developed cooperatively by the Department of Defense, the Central Intelligence Agency (CIA), and NASA, CORONA was a "film-return" satellite system that took photographs of Earth from polar orbit, packaged the exposed film into re-entry capsules, and then jettisoned the capsules into the upper atmosphere for retrieval by aircraft.[28] In 1960 NASA supplemented CORONA by launching TIROS-1, an Earth observation spacecraft that forecast weather patterns for military maneuvers.[29] By the mid-1960s CORONA and TIROS had not only heated up the Cold War, but had laid the foundation for similar cooperative ventures between the U.S. military and NASA during the conflict in Vietnam.

The space agency's authorization to undertake such military efforts was "fuzzy at best," as the *Washington Post* reported in 1967. While the 1958 act establishing NASA barred it from activities "primarily associated with the development of weapons systems, military operations or the defense of the United States," it permitted the space agency to make available to the Department of Defense "discoveries that have military value or significance."[30] "We are not developing anything that shoots a bullet or a missile at somebody," insisted a NASA official in 1967. Yet the space agency was developing

technologies that could guide bullets and missiles, and that, explained the *Washington Post,* made NASA administrators "nervous about its military role for several reasons."[31]

On the one hand, during a year when Congress was slashing the space agency's budget by more than ten percent to its lowest level in five years, NASA administrators such as James Webb were eager to highlight his agency's involvement in supporting the war effort in Southeast Asia.[32] Helping to end the war quickly, several internal NASA studies concluded, would also free up federal funds intended for the military and allow them to flow back to space exploration.[33] Yet Webb and his fellow administrators were equally nervous that over-promoting NASA's military research for Vietnam might cause international consternation, which was especially troubling since the space agency relied heavily on foreign countries such as Great Britain, France, and West Germany for joint space research and on others around the world including Australia, South Africa, and Peru as hosts for ground-based tracking stations and communications outposts.[34] Webb's solution in 1966 played it both ways; an internal NASA memorandum explained that the space agency would admit, and even publicly promote, its technological contributions to the war effort in Southeast Asia overall, but would classify as top secret the specifics of such contributions. The public in the United States and around the world, in other words, would know that NASA was aiding the U.S. military in Vietnam but not know exactly how.[35]

Webb's approach succeeded. By the end of 1967 NASA's Limited Warfare Committee had expanded its work significantly; its budget had skyrocketed to four million dollars annually and its personnel had grown to approximately one hundred NASA scientists and engineers working at the Jet Propulsion Laboratory (JPL) and the

Ames Research Center in California, as well as at the Langley Research Center in Virginia, on what one NASA administrator described as "techniques and hardware that may be of direct application to the current problems of tactical warfare in Vietnam."[36] While the work of these NASA technicians was diverse, involving research on eighty-nine different projects including a small beacon for locating downed fighter pilots that was powered by longer-lasting batteries spun off from the space agency's Surveyor, Mariner, and Ranger missions to the Moon and Mars, the great majority of these efforts shared a common goal.[37] They were all intended to help the U.S. military see better into, underneath, and around the jungles of Vietnam.

One of the earliest of such research efforts by NASA involved an attempt to increase the visibility of fighter pilots through the use of satellites that would forecast inclement weather over Vietnam. Members of NASA's Committee on Limited Warfare first discussed meteorology as a military aid in Southeast Asia in late 1965, and the following year assigned engineers at JPL in southern California to research the possibility of retooling NASA's Applications Technology Satellites (ATS) to provide real-time weather reports to U.S. pilots stationed in Southeast Asia. The new technology, which built upon the CORONA and TIROS reconnaissance systems of the late 1950s, would entail the deployment into synchronous orbit over Vietnam of an ATS satellite equipped with a so-called "Cloud Camera." Because the satellite would not be visible from the United States, and in order to ensure real-time data regarding Vietnam's weather, the meteorological system would necessitate a pair of ground stations in Toowoomba, Australia and Japan to control the satellite, and a third on the ground in Vietnam that would receive real-time reports and then forward them to fighter pilots at nearby air

bases. “It would be highly desirable,” explained the NASA Limited Warfare Committee, “to be able to obtain accurate and current information as to weather conditions over the target areas.”[38] Internal studies throughout 1966 indicated that a prototype of the “Cloud Camera” could be launched as early as March of 1967 for between 100 and 200 million dollars.[39]

An even more elaborate scheme by NASA and the U.S. military to make the communist enemy more legible involved artificially illuminating the night environment of Vietnam. Known publicly by various names including Project Moonlight, Project Reflector, and, perhaps most unfortunately, Project Moonshine, what became Project Able began in 1965 as a classified research project of the Limited Warfare Committee involving NASA and the U.S. Army and Air Force. The proposed project entailed the deployment of a giant aluminized Mylar mirror, 2,000 feet in diameter, into synchronous orbit 22,000 miles above Earth. By positioning the mirror directly over Southeast Asia at night, NASA engineers envisioned the device capturing sunlight from the bright side of the Earth and reflecting it downward, where it would illuminate a 200 mile-wide swath of Vietnamese jungle with an intensity approximately 1.7 times that of the full moon.[40] Such a satellite could “limit enemy activity at night,” explained George E. Meuller, NASA’s Associate Administrator for Manned Space Flight, to Congress soon after the project became declassified in 1966.[41] By the end of that year NASA had budgeted nearly a half million dollars for Project Able, assigned responsibility for it to the Manned Space Flight Center in Huntsville, Alabama, and contracted out five technical feasibility studies with space industry leaders such as Boeing, Westinghouse, and Grumman, the last of which planned to retool the technology it had developed to stabilize and control the Apollo

Lunar Module (LEM) to guide the giant reflector through space.[42]

Along with researching space technology that could peer around cloudy weather and turn the Vietnamese night into a dimmed-down version of day, NASA's Limited Warfare Committee also developed highly sensitive seismometers that would help the U.S. military peer deeper into jungles of Southeast Asia. In the early 1960s the space agency had developed similar highly sensitive seismometers for its Ranger and Surveyor Moon missions to assess the lunar surface for future Apollo landings, and also as part of its Apollo Lunar Surface Experiments Package (ASLEP), which each Apollo mission left behind on the Moon to measure the seismic activity of the lunar crust.[43] In December of 1965 NASA engineers at JPL in southern California began working with the Air Force to refashion these lunar seismometers for use in Operation Igloo White, a covert mission that involved airplanes dropping 20,000 of these updated "seismic detectors" to create a so-called "electronic battlefield" along the Ho Chi Minh Trail.[44] One of these sensors, called the "Air-Delivered Seismic Intrusion Detector," or ADSID, resembled a lawn dart whose antenna poked above ground disguised as a tropical plant's stalk. When the ADSIDs detected vibrations from passing military convoys they immediately transmitted "hits" to Air Force planes circling continuously overhead, which in turn relayed the data to the Infiltration Surveillance Center located on a U.S. military base in nearby Thailand. Inside the Surveillance Center, which at the time was the largest building in Southeast Asia, two IBM 360-65 computers, identical to those being used by NASA for the Apollo program, quickly analyzed the data and within five minutes conveyed bombing target coordinates to the closest available armed aircraft.[45] "We wired the Ho Chi Minh Trail like a drugstore pinball machine," bragged one Air Force officer of the U.S. military's

electronic battlefield, "and plugged it in every night."[46]

Although NASA's "Cloud Camera," giant space mirror, and electronic battlefield were initially top secret, the Soviet Union was well aware of the U.S. military's use of space technology to see more clearly into the jungles of Vietnam, and retaliated in kind. In many ways, Soviet developments in space during the height of the Cold War echoed, note for note, those of the United States. For instance, during the summer of 1962, just two years after the Air Force and NASA placed the first CORONA spy satellite into orbit, the USSR successfully launched its own version called Zenit, which, like its U.S. counterpart, took high resolution photographs from space and returned them by means of a re-entry capsule that parachuted onto Soviet territory. Again in 1975, less than a decade after the U.S. military researched the possibility of using NASA's ATS satellites over Vietnam to track cloudy weather, the USSR deployed its own satellites over Southeast Asia to monitor communist advances into South Vietnam and Cambodia as well as arm supplies from the United States into the region.[47] In the early 1980s the Soviets even developed and successfully deployed their own mammoth space mirror, initially called "Star Electricity," which one American space engineer admitted "could light up a battlefield at night."[48]

Although studies by NASA concluded that deploying real-time weather satellites, a giant space mirror, and jungle seismometers in Vietnam were all technologically feasible, the space agency scrapped both its "Cloud Camera" and Project Able during the winter of 1967. While this decision was due, in part, to opposition from American astronomers who feared that the giant mirror's brighter night would interfere with their

ground-based science, it was the New Left's anti-war activism that ultimately disabled Project Able, rained on NASA's "Cloud Camera," and eventually unplugged the space agency's electronic battlefield.[49]

The New Left's opposition to NASA's military efforts in Southeast Asia had its roots in the counterculture's open disdain for science and technology.[50] While a small minority represented by the likes of Stewart Brand and his *Whole Earth Catalogue* embraced technoscience as a possible solution to a host of problems from pollution to overpopulation, a shared opposition to what social commentators at the time were calling "technocracy" helped weave together the diverse strands of the mid-1960s counterculture, which included hippies, yippies, utopian communalists, and New Leftists, among other groups.[51] The New Left in particular located much of the blame for this expanding technocracy in the American research university.[52] Student leader Mario Savio, for instance, during the December 2, 1964 protest that launched the Berkeley Free Speech Movement, compared the University of California to an "odious machine" and implored his fellow students to "put your bodies upon the gears and upon the wheels" in order to "make it stop."[53] By the end of the decade New Leftists had pushed their critique beyond analogy; they began publicly condemning universities for actively participating in the rise of what many were calling "the military-industrial-academic complex."[54] In 1967, for example, Savio led another sit-in, not to promote free speech on campus but rather against Navy recruitment at Berkeley, which ended with students mocking the military with a heartfelt rendition of the Beatles' "Yellow Submarine."[55] Just two years later, students at approximately thirty universities nationwide, including Cornell and Princeton on the east coast, Stanford out west, and at the University of Michigan in

between, were similarly employing anti-technology rhetoric to further their anti-war activism.[56]

The National Aeronautics and Space Administration was not immune to such student opposition, which was sparked, in part, by the belief that the development of NASA science and technology was siphoning federal funds away from more pressing problems on Earth. A College Poll survey conducted on more than one hundred college campuses nationwide just days after the July 20, 1969 Apollo 11 lunar landing found that "most students feel space budgets should be largely diverted to domestic problems in the future." The same survey singled out campus activists such as those involved in the New Left as being strongly opposed to "continuing space investments."[57] This anxiety regarding NASA technology quickly migrated from students to their parents by means of political cartoons in newspapers. In 1968, for instance, the *St. Louis Globe* ran a cartoon titled "Could I Interest You in Some Earthly Problems?" that depicted a small everyman named "The Rest of Us" tugging on a lab coattail labeled "Technology" being worn by what appears to be a giant scientist carrying the moon. (See Appendix Image 1: "Could I Interest You in Some Earthly Problems?").[58]

Along with censuring the space agency for funneling funds away from problems on Earth, the New Left was equally critical of NASA for causing problems of its own, particularly when its space technology was deployed for military purposes. In 1962 Students for a Democratic Society (SDS) had initiated this suspicion in the Port Huron Statement, which criticized the Kennedy administration for making "outer space a region subject to militarization," and the student group continued publicizing this concern through organized campus activism well into the late 1960s.[59] The entire space program,

explained one SDS member from Columbia University days after Neil Armstrong stepped foot on the Moon, was a "weapon of the military establishment which is draining our resources."[60] Here again, popular political cartoons translated New Left sentiment to those residing far from college campuses. In late-July of 1969, for example, the *Washington Daily News* ran a cartoon titled "What Have They Been Feeding You?," which juxtaposed a pint-sized, tippy-toed civilian labeled "Domestic Needs" against an oversized and aloof NASA astronaut with "U.S. Space and Military Technology" written across his chest. (See Appendix Image 2: "What Have They Been Feeding You?").[61] The implication was all too clear; in the late 1960s, coinciding with the Apollo 11 lunar landing, Americans on and off campus were becoming increasingly concerned that NASA and the U.S. military were becoming dangerous bedfellows.

This conflation of space and military technology stemmed from a growing awareness among college students regarding NASA's increasing involvement in the Vietnam War. Not only were New Left activists alarmed by newspaper articles with titles such as "NASA's Role in War Grows" and "NASA to Study Military Satellites," the latter of which argued that such research "would place the agency squarely and irrevocably in the U.S. defense establishment," but these students also witnessed the expansion of NASA's military research for the Vietnam War quite literally across their campuses.[62] Whereas in 1960 the Department of Defense had contracted 1.2 billion dollars to universities for military research, just seven years later in 1967 the allocation had skyrocketed to more than 1.8 billion dollars, an increase after adjusting for inflation of more than thirty percent.[63] Research and development of space technology helped drive this growth; in 1968 NASA awarded U.S. universities approximately 130 million

dollars for military-related research, much of it used to develop technologies for the war in Vietnam.[64] "Space is a great turner-offer of college people these days," reported a special July 1969 edition of *Newsweek* magazine titled "The Moon Age." "To many of them the astronauts, NASA and Mission Control seem part and parcel of the Pentagon, the munitions industry and the war in Vietnam."[65]

Students and faculty at the Massachusetts Institute of Technology (MIT) were just one example of "college people" who were turned off by the space race during the late 1960s because of NASA's Department of Defense research for the Vietnam War. Such concern at MIT centered around the university's famed Instrumentation Laboratory, run by Dr. Charles Draper, which in 1969 alone received more than fifty-million dollars in nearly equal parts from NASA and the Department of Defense to build, among other technologies, guidance systems that, as the *Washington Post* explained on its front page, "get missiles and spacecraft where they're headed."[66] To protest this increasingly fuzzy boundary between space and war-related research on their campus, in the spring of 1969 MIT students, with the support of left-leaning linguist professor Noam Chomsky, formed a Science Action Coordinating Committee, modeled on the Student Non-Violent Coordinating Committee of the civil rights era, that initiated a nearly year-long campaign involving work stoppages, teach-ins, sit-ins, and campus shutdowns. This activism culminated in a November 4th rally involving more than eight hundred students from MIT and other Boston-area colleges including Harvard, Boston University, and Northeastern, who picketed Building 5 of the "I-Lab" in order to disrupt war-related work taking place inside. The demonstration, which was covered by 118 off-campus newsmen, along with similar protests ultimately forced MIT to dissociate Draper's laboratory from the

university the following year.[67] "Among the New Left's numerous assaults," complained conservative columnist Joseph Alsop in the *Washington Post* in 1969, "the most successful has been the attempted strangulation of MIT's great Instrumentation Laboratory."[68]

The New Left's success in linking NASA technology with the war in Vietnam, along with the political pressure it sparked in Congress, were partly responsible for the space agency's decision late in 1967 to halt research on both its Cloud Camera and Project Able.[69] Such political pressure was also responsible for a major policy change at NASA. Whereas during the mid-1960s James Webb had decided to publicize NASA's overall cooperation with the U.S. military in developing technologies for the War in Vietnam while simultaneously keeping classified the particulars of such research, during the fall of 1969, just months after students began protesting against NASA on college campuses from coast to coast, the space agency's administrators instituted a stricter public relations policy intended to eliminate all official statements concerning NASA's role in the Vietnam. "We are now requiring that *no* [emphasis in the original] statements concerning our support of the Vietnam effort, even those verifying [NASA's involvement in the conflict in general], be given," explained one memorandum from the space agency's Office of the Administrator.[70] Thus while the space agency provided New Left activists with fodder for their anti-war protests during the mid-1960s, by the late 1960s the New Left's efforts against the war in Southeast Asia were transforming policy within NASA itself.

By the early 1970s the New Left was also beginning to influence NASA technology in Vietnam. This process began on July 6, 1970 when Wisconsin Senator

William Proxmire leaked to the national media his own criticism of the then-classified electronic battlefield along the Ho Chi Minh Trail.[71] As news of the top-secret military project became public, along with notification that NASA engineers at JPL were retooling lunar seismometers for the operation, students again took action on their campuses against both the Department of Defense and the space agency. In March of 1971, for example, after learning from the Pentagon that the University of Michigan, which during the 1960s received more NASA contract funding than any other American university, was at the forefront of research on the electronic battlefield, students in Ann Arbor organized rallies, marches, and fasts to pressure administrators to ban all classified research from campus.[72] The following year University of Pennsylvania students took similar action, organizing a sit-in to protest their school's investments in companies doing research and development on the electronic battlefield. Such corporations included General Electric and IT&T, as well as Westinghouse, which had earlier conducted military research on NASA's Cloud Camera.[73]

Similar student activism against the space agency for its involvement in the Vietnam War intensified the following year, when in April of 1972 approximately fifty students and faculty members from more than fifteen New York metropolitan-area colleges took over the Pupin Physics Laboratory at Columbia University. Student demonstrators targeted the Pupin Lab because five faculty members conducting research inside the building belonged to the JASON Defense Advisory Group, an independent collection of scientists who in 1960 began counseling the federal government on matters involving science and technology. It was the JASONs who in 1967 originated the idea of an electronic battlefield in Vietnam, and subsequently promoted it to the U.S. Air Force

and NASA.[74] During the week-long protest, which involved the occupation of four other buildings at Columbia, students inside Pupin welcomed the support of several veterans of the 1968 Columbia campus uprising, leaders of the campus SDS chapter, and Chicago seven defendant Rennie Davis, who told supportive students gathered in a nearby auditorium that the "events at Columbia have been broadcast on North Vietnam radio."[75] Peace activist and poet Allen Ginsberg also joined the demonstration. Eventually, after ending their occupation, student protestors held a news conference announcing that they had found documents inside Pupin that directly linked Columbia "with the war machine" in Southeast Asia.[76]

Such student activism by New Leftists quickly spread beyond university campuses. "The so-called automated battlefield, where death strikes through a combination of sensors, computers and bombs," argued the Meriden, Connecticut *Morning Record* in December of 1971, "is coming into focus as a chief target for criticism in the fading Indochina war."[77] The space agency, because of its involvement with this technology, became a prime target of these civilian critiques. Earlier that year in San Francisco's South Bay anti-war protesters demonstrated outside the main gate of NASA's Ames Research Center, where engineers and scientists conducted many of the studies for the space agency's Limited Warfare Committee.[78] Similar civic protests in 1972 involved anti-war groups including the American Friends Service Committee, which created a slide presentation depicting the horrors of the electronic battlefield and showed it to local communities across the Northeast, as well as 275 members of the American Physical Society who, in response to Senator Proxmire's leak, proposed an amendment to the physics society's charter that would restrict military research by the

group's members. Even anti-war priest Philip Berrigan, who had been sentenced to eighteen months in prison for burning Vietnam draft cards, led eleven prisoners from the Federal Correctional Institution in Danbury, Connecticut in a fast, reminiscent of that undertaken by students at the University of Michigan, "to protest American atrocities in Indochina – our electronic battlefields, our mining of ports and rivers, our bombing of dikes and dams."[79] Local newspapers including the *Buffalo Evening News*, the *Chicago Daily News*, and the *Minneapolis Tribune* publicized, again through political cartoons, NASA's culpability in grounding the peace process in Vietnam. (See Appendix Images 3-7).[80] As a result of such widespread criticism, later that year the U.S. military terminated its electronic battlefield program and NASA's involvement in it.

New Left protests on college campuses were not only partly responsible for the cancellation of NASA's Cloud Camera, Project Able, and electronic battlefield. Such activism also represented just one example of what diplomatic historian Jeremi Suri has called a "global disruption" involving domestic uprisings not only in the United States but also in the Soviet Union, West Germany, France, and China. Cohering around opposition to the Vietnam War, these civil protests around the world culminated in 1968 as a direct challenge to the centralized power of the modern nation-state.[81] The world's "great powers" responded, Suri argues, by embracing détente as a means of both deflecting domestic political pressures and reasserting federal control through stronger international ties. Military treaties such as the Strategic Arms Limitation Agreement (SALT I), signed between the United States and the Soviet Union in 1972, was an example of such efforts aimed at easing superpower tensions. Terminating NASA's

military research for the electric battlefield, the Cloud Camera, and Project Able, the last of which the governments of Cambodia and Laos also criticized for being a "danger to both plant and human life," were other instances of an emerging détente intended to appease student anti-war protestors domestically while enhancing America's prestige on the international stage.[82]

Along with halting the development and implementation of space technology for military purposes, during the early 1970s the U.S. government also began using NASA technology in non-military ways to more proactively promote détente with the Soviet Union. The Apollo-Soyuz space mission was a prime example. First proposed by President Richard Nixon in 1972, the Apollo-Soyuz Test Project (ASTP), as it was known, culminated on July 15, 1975, when an Apollo command module from Cape Canaveral rendezvoused in Earth orbit with a Soviet Soyuz spacecraft launched from the Baikonur Cosmodrome in Kazakhstan. Although the experiments performed by the ASTP crew were, as the *Wall Street Journal* argued, "a costly space circus of almost no scientific significance," the project succeeded wonderfully as political spectacle.[83] Immediately after the two spaceships docked, for example, NASA's new four million dollar Apollo TV camera beamed images back to Earth of the international crews shaking hands, exchanging flags and gifts, eating a meal together, and trading indigenous tree seeds that were later planted in one another's home countries.[84] Such space theater not only improved political relations with the Soviet Union, but also aided the Nixon and Ford administrations politically on the domestic fronts by diverting, even for a few days, the New Left's attention from the conflict in Southeast Asia. "The Apollo program was conceived and executed," argued one anti-war writer, "to keep the people's mind off

Vietnam."[85]

Yet if détente in space succeeded domestically in taking the New Left's eye off the war in Southeast Asia, and proved fruitful internationally as well by raising America's standing throughout the developing world, it nevertheless raised a central dilemma for the United States. How could America continue its global competition with the Soviet Union, as it had done in Southeast Asia, without publicly stoking Cold War animosities? Additionally, what role would space technology and earthbound nature play in this process, within the parameter of a less openly confrontational détente? In other words, how could the U.S. government exchange tree seeds with communist Russians in space, but continue planting democracy firmly on the ground in developing countries like Vietnam?

One means was for the United States to redirect NASA's space technology, used during the late 1960s to make nature and communists more legible in Southeast Asia, towards more subtle Cold War ends in the 1970s across the developing world. Central to this effort were NASA's earth resources satellites, later known as Landsat, which the space agency first launched on July 23, 1972. Developed from both military hardware such as the CORONA spy satellite and civilian technology used clandestinely for war including the TIROS and ATS satellites, Landsat circled 560 miles above the Earth in near-polar orbit taking 13,000 square-mile "snapshots" of the planet's surface that when stitched together captured nearly the entire globe every 18 days.[86] These images derived from multispectral scanners that measured from space four different wavelengths of electromagnetic radiation reflecting off objects on the surface of the Earth. Landsat

satellites beamed these wavelength measurements back down to NASA's receiving stations where technicians converted the raw data into visual maps by assigning false colors to Earth-bound objects with different wavelengths. Landsat, in other words, made planet Earth's natural environment more readable by measuring the extremely slight temperature variations of the solar heat bouncing off rocks, trees, water, and even off animals.[87] As a result, the satellites could map crops and trees, identify plant diseases and insects, assess soil moisture, inventory fresh and salt water while forecasting droughts and floods, and even locate underground resources including oil, natural gas, and mineral deposits.[88] By radioing back "pictures" of Earth from space, the *New York Times* explained in mid-January of 1975, Landsat was "providing new insight into man's continuing effort to better manage earth's limited resources as well as aiding in the assessment and understanding of environmental changes."[89]

By helping to manage natural resources Landsat was also helping to manage NASA's public image, which during the early 1970s had sunk to an all-time low owing, in part, to student campus demonstrations against the space agency. "A long mental yawn will roll over America next Sunday when Apollo 16 spits fire from its tail and streaks skyward to the moon," explained the *Los Angeles Times* in April of 1972.[90] Partly because of such apathy, between the Moon landing of 1969 and the launch of Apollo-Soyuz in 1975 Congress cut the space agency's funding by more than forty percent, after accounting for inflation, to its lowest real-dollar level since 1962.[91] In a concerted effort to reverse this trend, NASA administrators not only cancelled several of the space agency's military projects but also began encouraging research and development of space technologies such as Landsat that would benefit the American public. "It is clear that if

we are to move forward with a strong space program, it, too, must be useful to the people here on Earth," argued NASA Deputy Administrator George Low in 1970. "This means that a space applications program and, specifically, an earth resources program should be the keystone for the space effort of the 1970s."[92] One result was NASA's Large Area Crop Inventory Experiment (LACIE), a joint venture by the space agency, the Department of Agriculture, and the National Oceanic and Atmospheric Administration (NOAA) that combined crop acreage measurements obtained from Landsat with meteorological information from NOAA satellites to forecast wheat production in an effort to stabilize the commodity's price for American consumers.[93] Such efforts by NASA succeeded; not only did Congress authorize two additional Landsat satellites in 1975 and 1978, but it also increased the space agency's budget by more than ten percent, after accounting for inflation, between 1975 and 1980.[94]

Both the federal government and the space agency quickly realized that Landsat could do for the United States internationally what it had done for NASA domestically. President Nixon, for instance, early on understood Landsat's promotional potential when he announced to the United Nation's General Assembly that his country's new earth observing satellites would "produce information not only for the U.S., but also for the world community."[95] Administrators from NASA were even more direct, focusing many of their public comments concerning productive uses of Landsat data specifically on the natural resources of poorer countries. The new space technology would "assist both the developed and developing areas of the world alike in providing maps and other important resource inventory data," explained a NASA position paper on remote sensing. In doing so, the report went on to argue, "the use of remote sensors in NASA spacecraft to aid

developing countries thus represents an important way for the United States to enhance its world image."[96] By giving poor nations access to scientific data that could help them develop their own natural resources, Landsat could raise the international standing of the United States.

There were just two problems with such a simple scenario. First, at least initially, several developing nations openly resisted NASA's remote sensing technology for fear that it would infringe upon their national sovereignty. While the Soviet Union was concerned that Landsat could be used for spying, countries across Latin America were more worried that developed countries would employ the technology to exploit natural resources located in the developing world; wealthy nations such as the United States could use satellite data not only to identify within poorer countries previously undiscovered resources, such as mineral and oil deposits, but also to forecast global crop production in an effort to manipulate agricultural commodity prices.[97] To protect against such actions, in 1975 several developing nations including Argentina, Chile, Venezuela, and Mexico co-sponsored a United Nations proposal that would have prohibited any remote sensing activity relating to natural resources under a country's national jurisdiction without prior consent of the nation being remotely "sensed" from space.[98]

The second problem hindering the U.S. government's ability to use Landsat to raise its international standing was that scientists in developing countries were wholly unprepared to receive, process, interpret, and utilize satellite data regarding their countries' natural resources. Such was the conclusion of an exasperated Verl Wilmarth, one of NASA's earth observation managers, who during the summer of 1971 lamented the abysmal quality of proposals submitted by foreign scientists interested in participating

in future Landsat experiments. The "poorly prepared proposals," he wrote, "indicate lack of knowledge of the program content and capabilities."[99] Administrators at NASA were equally concerned that even if foreign scientists did eventually understand Landsat's possibilities, they would nevertheless continue to lack the technological and scientific expertise necessary to take full advantage of the new space technology. Of particular concern was the dearth in developing countries of trained photointerpreters both to analyze the images obtained from satellites and to extract from them the types of data with economic value.[100] The space agency thus not only had to convince leaders of developing countries that Landsat did not pose a threat to their national sovereignty, but also needed to educate foreign scientists regarding the space technology's economic and ecological benefits.

Administrators from NASA began addressing such problems during the early 1970s by blanketing the international scientific community with press releases describing how Landsat technology worked, and which also requested from foreign scientists themselves proposals that would improve natural resources management specifically in developing countries.[101] The space agency augmented such efforts by teaming up with international institutions such as the United Nations, the World Bank, and the Inter-American Development Bank to sponsor conferences, symposiums, and workshops, some up to two weeks long, on the use of Landsat remote sensing data.[102] Initially, the space agency invited foreign scientists, engineers, and politicians to such events held in the United States both at academic institutions such as the University of Michigan, whose faculty excelled in remote sensing research, and also at NASA centers including the Johnson Spaceflight Center in Houston, which conducted a week-long "Earth Resources

Survey Symposium" during the summer of 1975. At the Houston Landsat conference some of NASA's heavy hitters, including Apollo astronaut Russell Schweickart, Marshall Space Flight Center Director Werhner von Braun, and Johnson Space Center Director Chris Kraft, addressed an audience of more than 1,200 scientists, engineers, politicians, and administrators from at least two dozen foreign countries on the practical applications of earth observing technology.[103]

Increasingly during the mid-1970s NASA also brought such gatherings directly to foreign scientists and government leaders within developing countries. During the summer of 1975, for instance, the space agency conducted two three-day symposiums on earth observing technology in West Africa in an effort both to educate scientists and government officials in the region about the capabilities of Landsat technology and to encourage them to submit scientific proposals aimed at better managing their countries' scarce natural resources. At the first conference, held in Ghana for English-speaking participants, scientists, engineers, and politicians from nearby nations including Nigeria, Liberia, and Togo listened, along with U.S. Ambassador to Ghana Shirley Temple Black, as the keynote speaker implored those present to make use of "accelerating tools" such as Landsat in order to bridge the "technological gap" between underdeveloped and developed nations. The second conference held later that summer took place in Mali, where French-speaking participants from Senegal, Chad, Zaire, Cameroon, Niger, and the Ivory Coast heard NASA scientist Bryan Erb describe how the space agency's LACIE experiments from the early 1970s could be applied to West Africa to lessen the severity of starvation then occurring across the drought-stricken Sahel region.[104] During the 1970s similar NASA conferences promoting the benefits of Landsat technology for

developing countries took place in Asia and throughout Latin America.[105]

While NASA's conferences, workshops, and symposiums succeeded in educating participants from developing nations regarding Landsat's scientific usefulness, the space agency alleviated concerns regarding the space technology's encroachment on national sovereignty by training foreign scientists to collect, analyze, and interpret earth observing data on their own. As with its Landsat conferences, such training took place both within the United States and abroad. In the early 1970s, for example, NASA expanded its international fellowship program to encourage foreign scientists to travel to American universities to take courses on the fundamentals of remote sensing.[106] The space agency also brought scientists from developing countries such as Brazil and Mexico to NASA centers including the Johnson Space Center to familiarize them with the acquisition, processing, and analysis of remote sensing data.[107] Finally, in an effort to institutionalize such training within less developed nations, NASA, along with the United States government, encouraged political leaders around the world to establish their own Landsat receiving stations to collect data on their country's natural resources. In South America this process began in 1974 when Brazil built its own receiving station, and continued three years later when Chile signed an agreement to build another and Venezuela formally expressed interest in doing the same. By early 1977 Egypt and Iran in the Middle East and Zaire in Africa had also established their own stations to receive and process Landsat data. Each of these host countries funded, owned, and operated their Landsat receiving stations, making their scientific experiments less dependent on the United States.[108]

Such efforts by NASA both to educate the international scientific community

about Landsat and to alleviate concerns of foreign government officials regarding the technology's impact on national sovereignty proved enormously successful. By the late 1970s, for instance, Landsat data was helping scientists from Latin American countries including Brazil, Bolivia, Venezuela, Costa Rica, and Mexico map their countries' soil, locate underground resources including iron, uranium, and oil, and monitor deforestation in threatened regions such as the Amazon rainforest.[109] In African countries such as Ethiopia, Mali, Libya, and Egypt, the space agency teamed up with local scientists and politicians to collect Landsat data that could help reverse the process of severe desertification, while in Asia NASA deployed its space technology for quite different purposes.[110] In 1973, for example, administrators redirected the orbit of Landsat 1 to pass over regions of Pakistan affected by flood to help that country assess agricultural damage, and in the mid-1970s NASA teamed up with the World Bank's Agricultural and Rural Development Department to use the same space technology to map land cover in parts of India, Bangladesh, and Burma. "Since for many parts of Burma there existed no recent, large scale maps," explained a 1977 study on earth observation in Asia, "the Landsat maps will significantly enhance that country's ability to plan its land-use and improve its food supply."[111] All totaled, by 1977 more than fifty countries worldwide, the great majority in the developing world, were relying on Landsat data to better manage their natural resources.[112]

By far the most surprising application of Landsat in the developing world, and undoubtedly the most politically beneficial to the United States, took place in Southeast Asia. Beginning in 1973 as the Vietnam War wound down, NASA, in cooperation with the United Nation's Mekong Committee, deployed Landsat satellites over the Lower

Mekong River to help the region's countries develop their natural resources more efficiently. Government officials, engineers, and scientists from Thailand, Cambodia, Laos, and Vietnam, whose countries encompass the more than 230,000 square mile Mekong River basin, teamed up with NASA scientists to analyze data collected from earth observation satellites.[113] The result was three natural resource maps. The first two, which included a hydrological survey of basin flooding during different times of the year and a land use map that differentiated agricultural from forest lands and identified different types of crops and tree species, were intended to help government officials from these developing countries better understand their present natural resource practices. The third map, which assessed the region's "land capabilities," was essentially a soil atlas aimed at improving planning for future natural resource management. The United States government and NASA intended all three maps to help Southeast Asia transition to a more developed peacetime existence. "Satellite imagery," explained NASA and the Mekong Committee in an April 1976 joint report, is "urgently needed, in order to finalize a realistic post-war development program for the basin."[114]

The Soviet Union responded to NASA's Landsat program with its own brand of space diplomacy that would similarly allow it to continue fighting the Cold War, but do so within the parameters of détente. The first step in this process was the creation in 1967 of the "Intercosmos Council" to promote cooperation in space among socialist countries including Bulgaria, Hungary, East Germany, Poland, Romania, and Czechoslovakia in Eastern Europe, Mongolia in Asia, and Cuba in Latin America. China, not surprisingly considering its troubled diplomatic relationship with the Soviet

Union during this period, was excluded from the program.[115] Within a decade the Council had launched sixteen "Intercosmos" satellites, five high-altitude research rockets, and dozens of weather satellites.[116] To support the Council's efforts, in 1971 the Soviet Union also launched the first of nine Salyut space stations, which would serve as working laboratories in Earth orbit for experiments on space science. The use of the Salyut space station by the Intercosmos Council, argued Intercosmos Council chairman Boris Petrov in the mid-1970s, "marks the transition to an important new state in the development of international cooperation in investigating and utilizing space."[117]

Just as NASA used Landsat to publicize its efforts across the United States, so too did the Soviet space agency employ the Intercosmos Council and its Salyut space station to increase its own prestige among developed socialist countries. It accomplished this not only by encouraging scientists from Eastern Europe to build research equipment for Intercosmos satellites and to create experiments for the Salyut space station, but also by literally taking cosmonauts from Warsaw Pact countries up into outer space. Between the winter of 1978 and the spring of 1980 alone, the Soviets launched Soyuz rockets filled with communist cosmonauts from Czechoslovakia, Poland, East Germany, Bulgaria, and Hungary, and then promoted each mission throughout the world as evidence of the superiority of Soviet-style communism. "A Soviet space program permitting cosmonauts from socialist countries to travel with Soviets into outer space looks more like a masterly piece of public relations," reported the *Associated Press* in the fall of 1980. "Everyone who has gone to date has been a friend of Moscow, not Washington." Such efforts by the USSR were perfectly timed, since NASA's Space Shuttle program was not scheduled for lift off until 1981. "People are proud of their cosmonauts who fly with the Russians,"

explained one space analyst of eastern Europeans. "There's no question about that."[118]

The Soviets understood as well that such pride could extend deep into the developing world, and made a concerted effort to involve poorer communist nations from beyond Eastern Europe in its Intercosmos program. The first of such efforts began in 1978, just three years after the fall of Saigon, when the Soviet space agency, in cooperation with government officials from the recently unified Socialist Republic of Vietnam, handpicked Pham Tuan to become an Intercosmos cosmonaut. The two governments immediately began publicizing Tuan's participation in the Intercosmos program as evidence of communism's benefits for the developing world.[119] Such promotion paid off. While politicians from Laos agreed that Colonel Tuan's mission into space illustrated "fruitful cooperation based on the spirit of proletarian internationalism," and the government of Sri Lanka described it as "a source of encouragement, strength and confidence to all people struggling for peace, freedom, social progress and international cooperation," Cuban politicians held a reception at the Vietnamese embassy in Havana to celebrate the flight.[120] Even American commentators understood the public relations coup scored by Pham Tuan's journey into orbit. "The United States shared its space triumphs with third-world allies by passing out moon rocks," worried the *New York Times* two days after Soyuz 37 returned to Earth. "But in terms of national pride, taking a third world friend along for the ride may reap bigger rewards for the Soviet Union."[121] In fact, so big were the political benefits that well into the 1980s the Intercosmos Council continued launching cosmonauts from developing countries including Cuba, Mongolia, and Afghanistan.

The political success of the Soyuz 37 mission throughout the developing world

did not depend solely on Soviet technology in space, but also rested on nature back on Earth. "Long-range analysis of the earth with the help of aerospace facilities to study our planet's natural resources has become one of the most important areas" for the Council, explained chairman Petrov in the late 1970s. These "aerospace facilities" were the Soviet equivalent of Landsat; the Russian version included an "MKF-6 multizone camera," a series of transmission satellites, and data receiving stations constructed on the ground in each of the countries participating in the Intercosmos space program. This multizone camera, which the Soviet space agency mounted on the Salyut space station, measured six different wavelengths of electromagnetic radiation bouncing off natural resources on Earth and transmitted the measurements to nearby orbiting satellites, which in turn relayed the data down to receiving stations on the ground. Such space technology, Petrov added, would "provide useful information for geology, agriculture, oceanology [sic] and other sectors of science and the national economy," especially the national economies of developing nations.[122]

While the U.S. had been using Landsat satellites for nearly a decade in Africa, Asia, and Latin America, the Soviets' first test case for this new space-based diplomacy involving natural resources in the developing world took place high above Vietnam during Pham Tuan's Soyuz 37-Salyut 6 mission. From 200 miles straight up, the Soviet's MKF-6 multizone camera undertook soil and forest surveys to improve crop and timber cultivation, made hydrological studies of flooding, erosion, and sedimentation to enhance fish breeding, assessed the atmosphere to forecast typhoons and hurricanes, and measured geological formations to identify mineral deposits for future prospecting.[123] Such space-based experiments involving the "study and precise assessment of the natural

resource potentials in Vietnam," explained deputy chairman of Vietnam's National Scientific Research Center Dr. Nguyen Van Hieu, "will serve as a basis for economic planning."[124] The Soviet space agency used its MKF-6 multizone camera to undertake similar measurements of natural resources in Cuba, Mongolia, and Afghanistan when it included cosmonauts from these countries on subsequent Intercosmos Soyuz-Salyut missions.[125]

The Soyuz 37 mission also used space technology both to assess the ecological damage caused by the U.S. military during the war and to formulate scientific plans for ecological restoration. According to the Soviet space agency, the Soyuz 37 experiments would focus especially on those areas of Vietnam "devastated by defoliants" during the Vietnam War. Two years earlier in 1978 a joint Soviet-Vietnamese biological expedition had initiated a study, in a few locations across Vietnam, of the severe environmental consequences of chemical spraying by the United States Air Force. "Dead jungles where nothing grows still remain in various areas," explained one scientist familiar with those land-based assessments.[126] Soyuz 37 would broaden this 1978 work by measuring from space the nation-wide extent of ecological damage caused by American defoliants. "From their height of 345 kilometers," explained one reporter, Pham Tuan and Victor Gorbatko "obtained photographs and spectral data of Vietnamese territory" that allowed scientists to study "the effects on the Vietnamese countryside, plants and forest of the enormous amounts of defoliants and fire bombs dropped during the Vietnam War." More important for the future of Vietnam, added this reporter, was that this data from space would also allow these same scientists to "develop effective methods to revive the soil."[127]

As with NASA's Landsat, the Soviet Union publicized Pham Tuan's scientific experiments from space to forward its own foreign policy goals in a new era of détente. Such goals included, on the one hand, the promotion of Soviet-style communism across the developing world through the promise of economic growth based on improved natural resources management. Yet the Soviets also used the Soyuz 37 experiments to publicize, worldwide, the environmental atrocities committed by their superpower rival during the Vietnam War as well as their own efforts to restore these damaged areas to ecological health. It was no coincidence, for instance, that Pham Tuan's mission, and its experiment to map defoliants sprayed during the war, were scheduled to coincide with the 1980 summer Olympics, which the U.S. boycotted on account of the Soviet invasion of Afghanistan.[128] The *Christian Science Monitor* was well aware of such tactics, reporting from the Moscow games that "the Vietnamese was preferred" for the Soyuz 37 flight because "one object of the Olympic games here is to cement Soviet influence in Asia, Africa, and Latin America."[129] Thus as they followed on radio or television the hundred-meter dash in Moscow's Lenin Stadium, citizens of the developing world were reminded, once again, of American ecocide in Vietnam.

At 8:15 in the evening on July 31, 1980, after one week in orbit, Victor Gorbatko and Pham Tuan undocked their Soyuz 37 space capsule from the Salyut 6 space station, re-entered Earth's atmosphere, and parachuted the capsule for a soft landing in the dry desert of Kazakhstan. After being carried from the Soyuz 37 landing module both cosmonauts followed Soviet tradition by signing their names on its side panel before Colonel Gorbatko exclaimed to the gathered reporters, "I am proud of having flown

together with the first cosmonaut of Asia."[130] Colonel Tuan was proud as well, and days later travelled home "with pictures of Vietnam taken from the air" that captured the country's lush green jungles from two hundred miles straight up.[131] Several years later the Soyuz 37 capsule became a gift of the Soviet people and followed Tuan to Vietnam, touring villages and cities throughout the countryside. Thus even after cosmonauts Tuan and Gorbatko had returned safely to Earth, Soviet space technology and Vietnamese nature continued to shape relations between the two countries.

Pham Tuan's historic flight also highlights important political changes taking place during the Cold War era on both the domestic and international fronts. Within the United States, the New Left drove such transformations by organizing rallies, sit-ins, fasts, building takeovers, and campus shut downs to protest the research and development of space technology for use in Vietnam. When such activism spread beyond college campuses and put pressure on Congress to reduce funding for the space program, NASA administrators responded by redirecting their technological efforts. The space agency cancelled covert military research on Cloud Cameras, giant space mirrors, and electronic battlefields intended to help the U.S. military see better into the dark jungles of Vietnam, and instead began launching Landsat satellites that helped scientists and government leaders from the developing world better manage their nations' natural resources. The Soviet Union followed suit with its Salyut space station and its MKF-6 multizone camera. In both cases, space technology that had been used during the late 1960s primarily to *seek and destroy* in the jungles of Vietnam, had become by the mid-1970s space technology deployed as well to *assess and restore* not only the environments of Southeast Asia but also those in Africa and Latin America.[132]

On the international stage, the result of this technological turnaround was a less dangerous space race for those back on Earth, but a more troubling political predicament for those living across in the developing world. Landsat measurements of natural resources from Botswana to Brazil to Burma depended on the cooperation of local scientists and politicians for success; biologists on the ground knew best which of their country's natural resources needed study from space, while native government officials had the political resources to build receiving stations and to train photointerpreters. Landsat's focus on local nature, in other words, left room for some local control over Landsat data.[133] The same could be said of Soviet remote sensing efforts in developing communist countries including Vietnam, Cuba, and Mongolia. Yet the U.S. government still fabricated and launched Landsat satellites, decided when they should be "turned on" over what geographic regions, approved or rejected proposed experiments, and determined which countries could and could not participate in the program.[134] The Soviet Union retained similar control over its own remote sensing technology. As a result, while developing countries co-produced this earth observing programs in part because they could influence them on the ground, the American and Soviet governments ultimately controlled this modernizing project from above in ways that almost always supported their own foreign policy agenda. "The earth resources survey satellite," explained one policy analyst, "if exploited in an optimum manner, could provide an ideal opportunity for the technologically advanced nations of the world to converge their interests with the aspirations of the many developed countries."[135] Stated less diplomatically, the space race allowed American and Soviet hegemony to become more subtle during the long 1960s, and therefore even more difficult to resist.[136]

In many ways this double-edged sword continues to hover over planet Earth. In 1983, for instance, in a nod to the Vietnam War, President Ronald Reagan asked NASA for technological assistance with his Strategic Defense Initiative (SDI), or Star Wars program, which would deploy space-based missiles in an attempt to protect the United States from nuclear attack.[137] Just four years later NASA also initiated its Mission to Planet Earth, aimed at increasing scientific understanding of both natural and human-induced changes to the world's environment.[138] While these two initiatives indicate that space technology continues to orbit dangerously between military aggression and environmental stewardship, the fact that SDI has been grounded while Mission to Planet Earth remains the largest federal program studying contemporary climate change suggests hope for our planet's future. Residents of the developing world would do well to remember, however, that while we all share the Earth, NASA's mission to the big blue planet is still directed from Washington, D.C.

APPENDIX

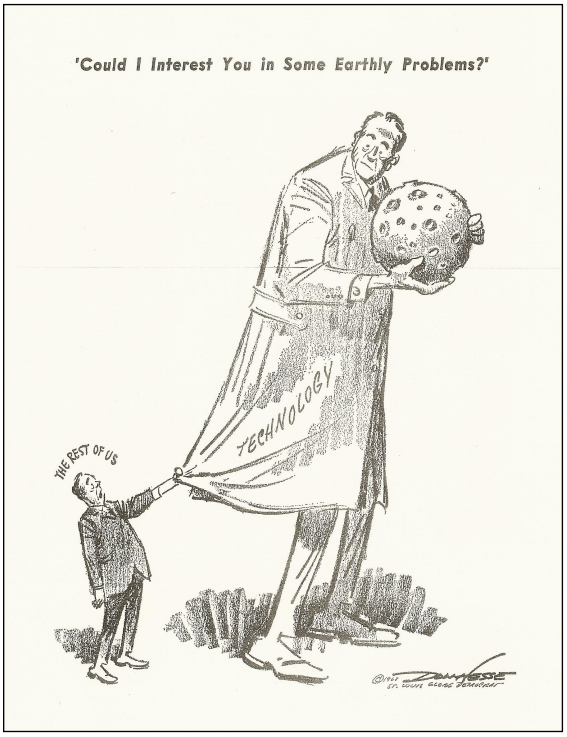


Image 1

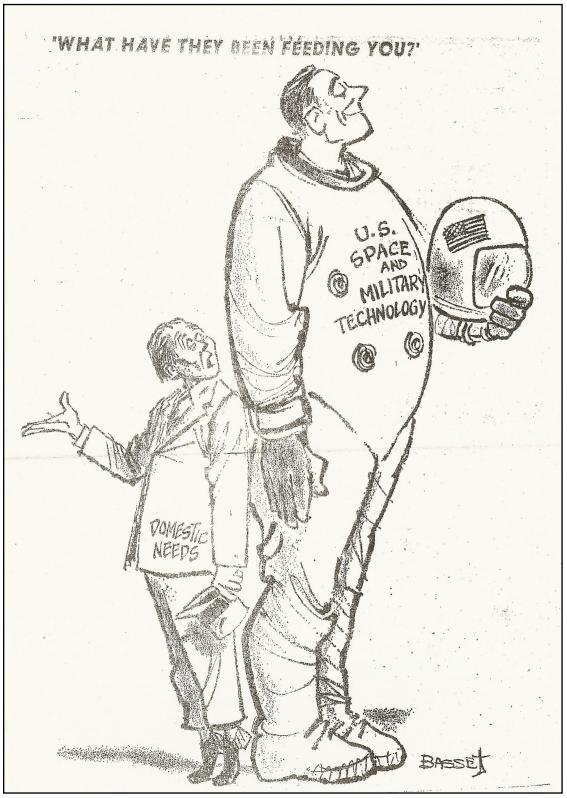
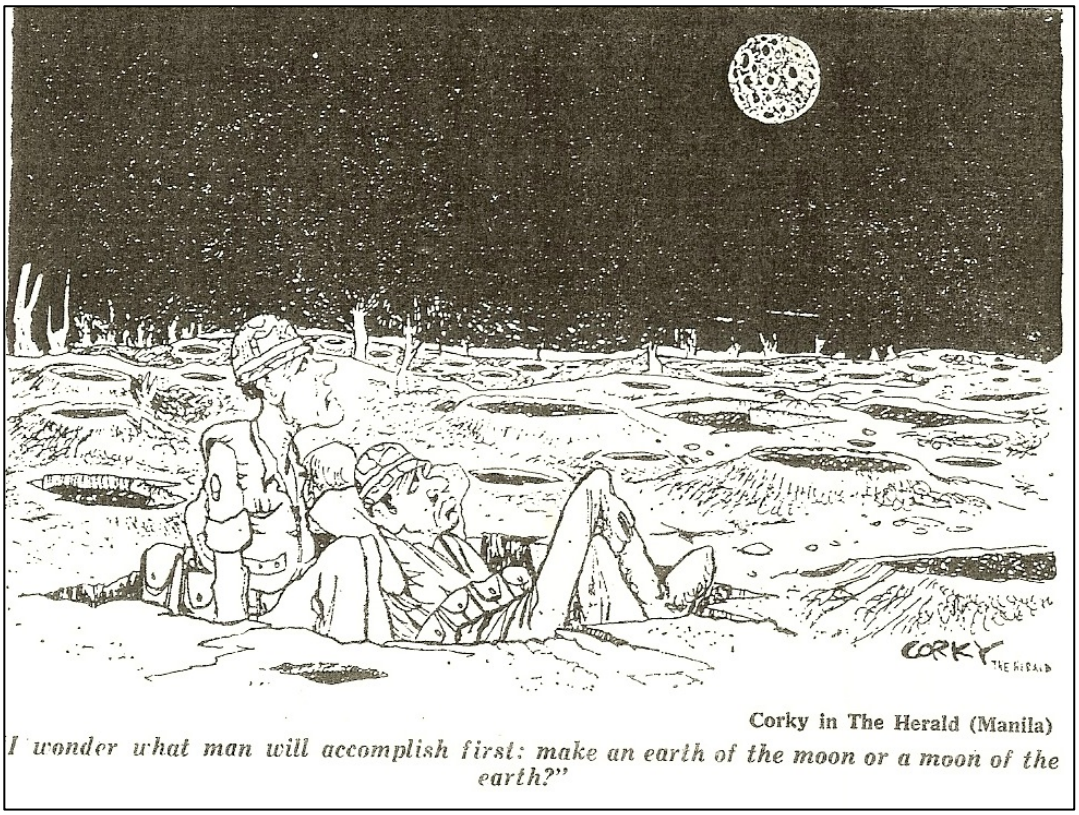


Image 2

Image 3



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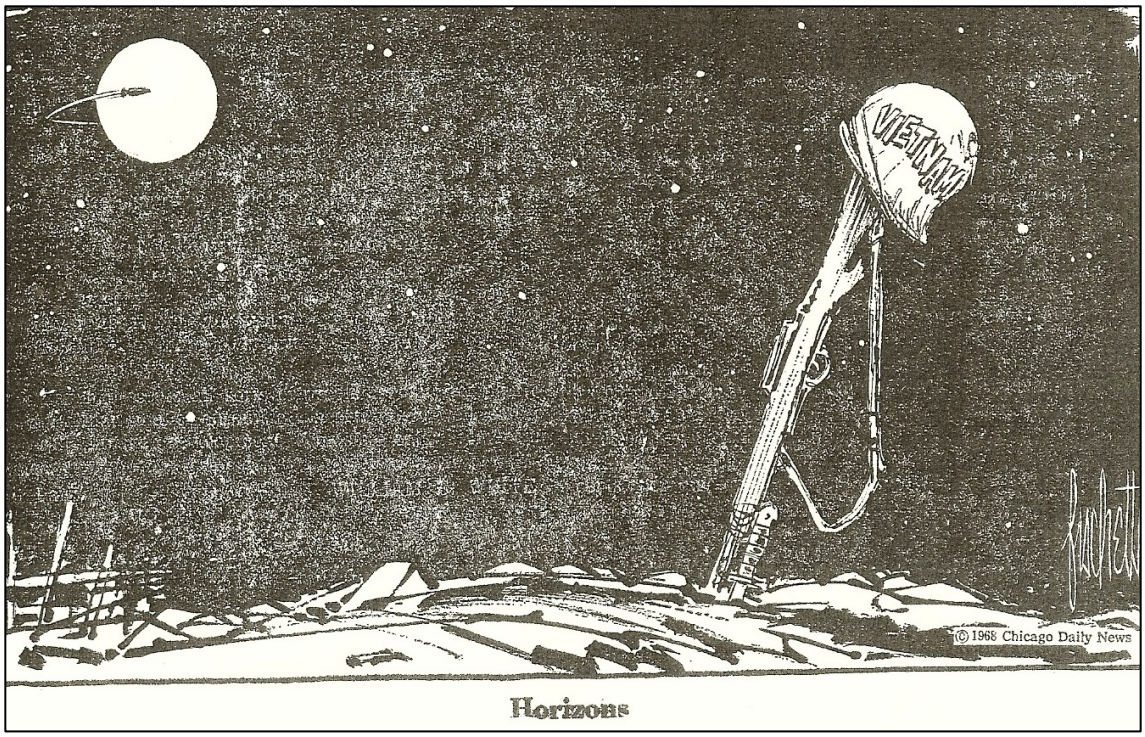

Image 5

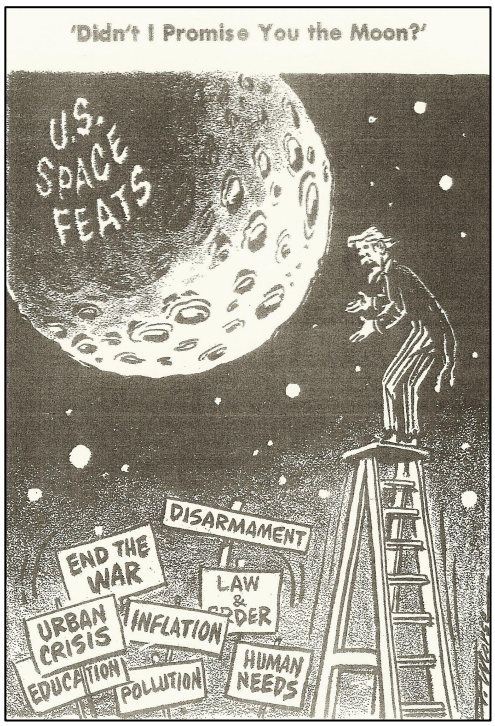

Image 6

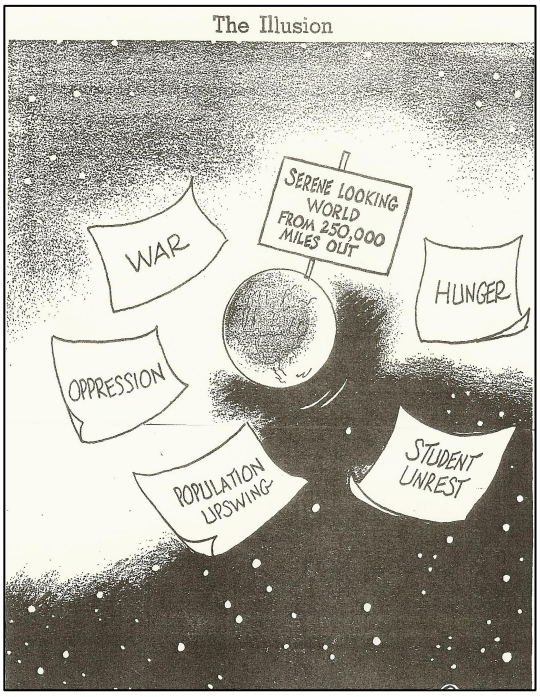

Image 7

[1] Or at least for all Vietnamese who had access to television sets. Vietnamese News Agency, "Cosmonaut Addresses Vietnamese People from Space," (translated into English by the Foreign Broadcast Information Service (FBIS)), July 31, 1980, Folder # 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA HQ, Washington, D.C.

[2] For a discussion of space science and technology being used by the two superpowers to promote national identity see Asif Siddiqi, "Spaceflight in the National Imagination," ins Remembering the Space Age, ed. Steven Dick (Washington, D.C.: NASA Office of External Relations, History Division, 2008): 17-35; and Asif Siddiqi, "Competing Technologies, National(ist) Narratives, and Universal Claims: Toward a Global History of Space Exploration," *Technology and Culture*, 51, no. 2 (April 2010), 427. An insightful example of this sort of space history is Walter McDougall, *The Heavens and the Earth: A Political History of the Space Age* (Baltimore: Johns Hopkins University Press, 1986).

[3] For a good general overview of this relationship see, Carol E. Harrison and Ann Johnson, "Introduction: Science and National Identity," in "National Identity: The Role of Science and Technology," ed., Carol E. Harrison and Ann Johnson, special issue, *Osiris*, 2nd ser., 24, no. 1 (2009): 1-14. Also see the thirteen other essays on this theme in this special issue. This relationship is also discussed by Asif Siddiqi, "Competing Technologies, National(ist) Narratives, and Universal Claims: Toward a Global History of Space Exploration," *Technology and Culture*, 51, no. 2 (April 2010): 427.

[4] For an introduction to the historical literature on the links between science and technology and the Cold War see Mark Solovey, ed. "Science in the Cold War," Special Issue, *Social Studies of Science*, 31, no. 2 (April 2001), especially David Hounshell, "Epilogue: Rethinking the Cold War; Rethinking Science and Technology in the Cold War: Rethinking the Social Study of Science and Technology," *Social Studies of Science*, 31, no. 2 (April 2001): 289-297; and John Cloud and Judith Reppy, eds. "Earth Sciences in the Cold War," Special Issue, *Social Studies of Science*, 33, no. 5 (October 2003).

[5] Vietnamese News Agency, "Cosmonaut Addresses Vietnamese People from Space," (translated into English by FBIS), July 31, 1980, Folder # 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA HQ, Washington, D.C.

[6] Nhan Dan, "We Fly Into Space," Hanoi Domestic Service (translated into English by FBIS), July 23, 1980, Folder # 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA HQ, Washington, D.C.

[7] On this statement by Vietnam's National Scientific Research Center deputy chairman Nguyen Van Hieu see, "Further on Joint Soviet-Vietnamese Spaceflight, First Experiment," Moscow Domestic Service in Russian, July 26, 1980, p. U3, as transcribed by FBIS, Folder #: 014776, Title: "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.

[8] There is a dearth of literature on the environmental history of the Cold War, and even less that examines this relationship between the natural environment and the Cold War across the developing world. For discussions of this historiographical gap, see John R. McNeill and Corinna R. Unger, "Introduction: The Big Picture," in John R. McNeill and Corinna R. Unger, eds., *Environmental Histories of the Cold War* (New York: Cambridge University Press, 2010): 3-4 & 15. In his seminal essay on Cold War historiography, Melvyn Leffler does not once mention the natural environment as a category of analysis. See, Melvyn P. Leffler, "The Cold War: What do 'We Now Know'?," *American Historical Review*, 104, no. 2 (April 1999).

[9] For a discussions of space exploration as conducive to transnational and global history see, Asif Siddiqi, "Competing Technologies, National(ist) Narratives, and Universal Claims: Toward a Global History of Space Exploration,: *Technology and Culture*, 51, no. 2 (April 2010): 425-443.

[10] For a discussion of the legal precedent regarding space as international property see, Hamilton DeSassure, "Remote Sensing by Satellite: What Future for an International Regime?," *American Journal of International Law*, 71, no. 4 (October 1977): 707-724. An organization called the Lunar Embassy has challenged international space law by arguing that while the Outer Space Treaty of 1967 bars nations from appropriating celestial bodies, it does not bar individuals. The Lunar Embassy used this loophole to begin selling plots on the moon for $15.99 per acre.

[11] For further details on this incident see, Steven Hurst, "Vietnamese-Soviet Team Links Up With Space Lab," The Associated Press, July 24, 1980, AM cycle; and Associated Press, "Asian and Russian Board Salyut 6," *New York Times*, July 25, 1980, A13.

[12] For a discussion of Vietnamese communists' use of nature during the First Vietnam War see, David Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta* (Seattle: University of Washington Press, 2010): 133, 144-150, and 204.

[13] Curtis Jordan, "Uncovering Charlie: Spray Destroys Hiding Places of Viet Cong," *Air Force Times* (May 11, 1966): 54. For a similar conclusion by a scientist visiting Vietnam see also, Arthur Westing, "II. Leveling the Jungle," *Environment*, 13, no. 9 (November 1971): 9.

[14] Charles V. Collins, "Herbicide Operations in Southeast Asia, July 1961-June 1967," Department of the Air Force, Headquarters Pacific Air Forces, Directorate, Tactical Evaluation, CHECO Division, 11 October 1967, 16, distributed by National Technical Information Service, U.S. Department of Commerce.

[15] On the history of the tunnels of Ci Chu see, Tom Mangold and John Penycate, *The Tunnels of Cu Chi: A Harrowing Account of America's "Tunnel Rats" in the Underground Battlefields of Vietnam* (New York: Random House, 1985). For a description of the tunnel network by contemporary tourists, see Seth Mydans, "Visit the Vietcong's World: Americans Welcome," *New York Times*, July 7, 1999, A4; Tibor Krausz, "The Cu Chi Tunnels: Vietnam's Deep, Dark Past," *Washington Post*, May 2, 2004, Travel Section, 1; and Rajiv Chandrasekaran, "Vietnam's Tours of Duty: 25 Years

After War's End, Nation Turns Its Battleground Into Business, *Washington Post*, April 9, 2000, Section A, 16.

[16] On nighttime fighting along the Ho Chi Minh Trail see James Gibson, *The Perfect War*, 396; and Terrence Smith, "American Squadron Bombs the Ho Chi Minh Trail Only After Dark," *New York Times*, December 16, 1968, 3. For other newspaper accounts of the widespread use of nighttime darkness by the communist guerillas during the Vietnam War see also, Charles Mohrs, "G.I.'s Contesting Vietcong at Night: Camp in Areas Previously Held by Reds After Dark," *New York Times*, August 2, 1965, 1; Bob Considine, "Reds Own the Country at Night in S. Viet," *Evening News* (Newburgh, NY), August 11, 1967, 3A; and Charles Mohrs, "G.I.'s Fighting in Delta Use Stealth and Surprise," *New York Times*, 22 May 1968, 2.

[17] Horst Faas for the Associated Press, "For Both Americans and Viet Cong Night Alters Face of War," *Eugene Register-Guard*, September 15, 1966, 8A.

[18] Here I am engaging the concept of "legibility" as discussed by James Scott. While Scott does not focus his analysis specifically on natural resource use, local knowledge of nature is central to his concept of "metis," meaning practical knowledge, which he juxtaposes with the "high modernist" practices of more industrialized cultures. On the role of nature in "metis," see James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998), especially chapter 9 "Thin Simplifications and Practical Knowledge: Metis."

[19] Curtis Jordan, "Uncovering Charlie: Spray Destroys Hiding Places of Viet Cong," *Air Force Times* (May 11, 1966); Peter R. Kann, "The Invisible Foe: New Intelligence Push Attempts to Wipe Out Vietcong Underground," *Wall Street Journal*, September 5, 1968, 1; and Associated Press, "U.S. Airborne Device Sniffs For Foe Under Jungle Canopy," *New York Times*, May 28, 1967, 7.

[20] Lt. Col. Stanley D. Fair, "No Place to Hide: How Defoliants Expose the Viet Cong," *Army* (September 1963): 54.

[21] On the Rome Plow's use in Vietnam see, Arthur Westing, "II. Leveling the Jungle," *Environment*, 13, no. 9 (November 1971): 9. On U.S. carpet bombing see, Edward Miguel and Gerard Roland, "The Long Run Impact of Bombing Vietnam," *National Bureau of Economic Research Working Paper No. 11954* (January 2006): 2. For a careful review of the ecological and health impact of bomb craters on Vietnam see, E.W. Pfeiffer, "I. Craters," *Environment*, 13, no. 9 (November 1971): 4. For an extended discussion of the impact of the U.S. military's use of herbicides during the Vietnam War see, G.H. Orians, E.W. Pfeiffer, Clarence Leuba, "Defoliants: Orange, White, and Blue," *Science, New Series*, 165, no. 3892 (August 1, 1969): 442-443; E.W. Pfeiffer, "Defoliation and Bombing Effects in Vietnam," *Biological Conservation*, 2, no. 2 (January 1970): 149-151; G.H. Orians, E.W. Pfeiffer, "Letters: United States Goals in Vietnam," *Science*, 169 (September 11, 1970), 1030; E.W. Pfeiffer, "Final Word on Defoliation Effects," *Science, New Series*, 171, no. 3972 (February 19, 1971): 625-626; Philip M. Boffey, "Herbicides in Vietnam: AAAS Study Finds Widespread Devastation," *Science, New Series*, 171, no. 3966 (January 8, 1971): 43-47; and E.W. Pfeiffer,

"Operation Ranch Hand: the U.S. herbicide program," *Bulletin of the Atomic Scientists*, 38, no. 5 (May 1982): 20-24.

[22] Fair, "No Place to Hide," 54.

[23] Arthur Westing, "II. Leveling the Jungle," *Environment*, 13, no. 9 (November 1971): 9.

[24] For details of this meeting see, Admiral W. Fred Boone, "NASA Office of Defense Affairs: The First Five Years, December 1, 1962, to January 1, 1968," Historical Division, Office of Policy, National Aeronautics and Space Administration, December 1970, 249, NASA Headquarters Historical Reference Collection, Washington, D.C.; and NASA Deputy Administrator Robert C. Seamans, Jr. to Distribution List, memorandum, 31 March 1965, Box: Office of Defense Affairs, Office of D.D. and interagency Affairs, 1958-1990, #18518, Box 1, Folder: "Chron File 1965/1966 Coulter," NASA History Division, Historical Reference Collection, NASA Headquarters Archives, Washington, D.C.

[25] On the creation of "NASA's Limited War Committee" and its work see, Admiral W. Fred Boone, "NASA Office of Defense Affairs: The First Five Years, December 1, 1962, to January 1, 1968," Historical Division, Office of Policy, National Aeronautics and Space Administration, December 1970, 249-251, NASA Headquarters Historical Reference Collection, Washington, D.C.; and Thomas O'Toole, "NASA's Role in War Grows," *Washington Post*, December 4, 1967, A1.

[26] Robert C. Seamans, Jr. to Distribution List, memorandum, 31 March 1965, Box: Office of Defense Affairs, Office of D.D. and interagency Affairs, 1958-1990, #18518, Box 1, Folder: "Chron File 1965/1966 Coulter," NASA History Division, Historical Reference Collection, NASA Headquarters Archives, Washington, D.C., 2.

[27] On the long relationship between NASA and the military see, Peter Hays, *The U.S. Military and Outer Space: Perspectives, Plans and Programs* (New York: Routeledge, 2011).

[28] On NASA's involvement with the CORONA program see, John Cloud, "Imaging the World in a Barrel: CORONA and the Clandestine Convergence of the Earth Sciences," *Social Studies of Science*, 31, no. 2, special issue on "Science in the Cold War" (April 2011): 231-251; Dwayne A. Day, "CORONA: America's First Spy Satellite Program," *Quest: History of Spaceflight Quarterly*, 4, no. 2 (Summer 1995): 4-21; and Dwayne A. Day, "CORONA: America's First Spy Satellite Program, Part II" *Quest: History of Spaceflight Quarterly*, 4, no. 2 (Fall 1995): 28-36.

[29] On the use of NASA's TIROS for military maneuvers see, Henry Hertzfeld and Ray Williamson, "The Social and Economic Impact of Earth Observing Satellites," in *Societal Impact of Spaceflight*, Steven Dick and Roger Launius, eds., (Washington, D.C.: NASA Office of External Relations, History Division, 2007): 238.

[30] *National Aeronautics and Space Act of 1958*, Public Law #85-568, 85th Cong., 2d sess. (January 7, 1958), 1.

[31] Thomas O'Toole, "NASA's Role in War Grows," *Washington Post*, December 4, 1967, A1.

[32] Between 1967 and 1968 Congress cut NASA's budget from 4.966 billion dollars to 4.578 billion dollars, its lowest amount since 1964. When adjusted for inflation according to 2008 dollars, this represents a decrease of 10.5 percent. For historical data on NASA's total budget in both real and inflation-adjusted dollars see, United States President, United States, National Aeronautics and Space Council, *Aeronautics and Space Report of the President: Fiscal Year 2008 Activities* (Washington, D.C.: U.S. Government Printing Office, 2008), "Appendix D-1A: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of real-year dollars)," p. 146, and "Appendix D-1B: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of inflation-adjusted FY 2008 dollars)," p. 147. See also, Thomas O'Toole, "NASA Cut $282 Million More," *Washington Post*, August 19, 1967, A4.

[33] On the inverse federal funding relationship between NASA and the Vietnam War see, J.V. Reistrup, "War Could Cut Space Funds," *Washington Post*, December 4, 1967, A3; and Murray L. Weidenbaum, "Aerospace Technology and the Federal Budget," NASA, August 28-30, 1968, 1 & 6, NASA Technical Report #AIAA Paper 68-915.

[34] On NASA's concern that it's military research for the Vietnam War might damage its relations with foreign countries see, Thomas O'Toole, "NASA Cut $282 Million More," Washington Post, August 19, 1967, A4.

[35] This internal memo is discussed by Fred Boone, "NASA Office of Defense Affairs: The First Five Years, December 1, 1962, to January 1, 1968," Historical Division, Office of Policy, National Aeronautics and Space Administration, December 1970, 249-251, NASA Headquarters Historical Reference Collection, Washington, D.C., 251.

[36] The quote comes from NASA Deputy Administrator Robert C. Seamans, Jr. to Distribution List, memorandum, 31 March 1965, Box: Office of Defense Affairs, Office of D.D. and interagency Affairs, 1958-1990, #18518, Box 1, Folder: "Chron File 1965/1966 Coulter," NASA History Division, Historical Reference Collection, NASA Headquarters Archives, Washington, D.C., 1. On the expanded role of NASA's Limited Warfare Committee see, Boone, "NASA Office of Defense Affairs," 251; and Thomas O'Toole, "NASA's Role in War Grows," *Washington Post*, December 4, 1967, A1.

[37] On the various research proposals undertaken by NASA's Limited Warfare Committee see, "NASA Limited Warfare Projects Supporting DOD," undated, Box 1: Office of Defense Affairs, Office of D.D. and Interagency Affairs, 1958-1990, #18518, Folder: "Chron File, 1965/1966 Coulter," NASA History Division, Historical Reference Collection, NASA HQ Archive, Washington, D.C.; Freitag to Mueller, memorandum, 20 January 1966, Folder: #002276, Title: Teague (1963-67-NASA Oversight Comm.), NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.; and William Schimandle (JPL) to James O. Spriggs, 19 June 1967, Folder: #002175, Title: "SA Chron 1963-70 Spriggs," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[38] "Summary of Suggestions by NASA Headquarters Personnel as to Ideas That May Have Application to the War in Southeast Asia, "December 10, 1965, Folder: #014776

"Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C., 1.

[39] On the development by NASA's Limited Warfare Committee of an ATS satellite "Cloud Camera "to provide meteorological reports of Vietnam to the U.S. Air Force see, James Spriggs, "Log for Week of 28 Nov," Folder: #002175, Title: "SA Chron-1963-70 Spriggs," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.; James Spriggs to William Schimandle, 13 April 1966, Folder: #002175, Title: "SA Chron-1963-70 Spriggs," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.; and especially, Leonard Jaffe (NASA Space Applications Programs Director) to Edgar Cortright (Director of NASA's Langley Research Center), memorandum, 16 May 1966, Folder: #005628, Title: "ATS Documentation," NASA Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[40] For a brief overview of "Project Able," see "Administrator's Back-Up Book, New Item — PROJECT ABLE," FOLDER # 011535, "Project Able/Mirror Illumination," NASA Headquarters, NASA Archives, Washington, D.C.

[41] Mueller was quoted in, Norman Carlisle, "We Can Turn Night Into Day," *The Sun* (Baltimore), December 8, 1968, 381. On Mueller's congressional testimony regarding Project Able see also, Associated Press, "Illuminating Satellite Underway," *Victoria* (Texas) *Advocate*," August 11, 1966, 6A; and "Schjeldahl Joins Project Able," *Space Daily*, 15 August 1966, Folder # 011535, "Project Able/Mirror Illumination," NASA Headquarters, NASA Archives, Washington, D.C. There is a rich literature on the history of illumination and civic control. See especially Chris Otter, The Victorian Eye: A Political History of Light and Vision in Britain, 1800-1910 (Chicago: University of Chicago Press, 2008); and the forum on Otters book in *History and Technology*, 26, no. 2 (June 2010): 147-185.

[42] For a brief chronology of NASA's involvement with Project Able see, "Administrator's Back-Up Book, New Item – Project Able," July 24, 1967, Folder: # 011535, "Project Able/Mirror Illuminator," NASA Headquarters, NASA Archives, Washington, D.C., 2; and "Project Moonlight, Edward Z. Gray to Associate Administrator for Manned Space Flight George Mueller, memorandum, March 18, 1966, Folder: # 011538, "Project Brilliant/Moonlight/Reflector," NASA History Reference Collection, NASA History Divisions, NASA Headquarters, Washington, D.C.

[43] Seismometers were part of the Apollo 11 Early Apollo Surface Experiments Package (EASEP), and on the five subsequent Apollo missions as part of the Apollo Lunar Surface Experiments Package. On the history of EASEP and ALSEP see, Donald A. Beattie, *Taking Science to the Moon: Lunar Experiments and the Apollo Program* (Baltimore: Johns Hopkins University Press, 2001): 132-133, 144-145.

[44] On NASA's work with the Air Force on "seismic detectors," see "Summary of Suggestions by NASA Headquarters Personnel as to Ideas That May Have Application to the War in Southeast Asia," 10 December 1965; Folder #014776 "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C., 2.

[45] On Project Igloo White and the electronic battlefield in Vietnam see, George Weiss, "Battle for Control of Ho Chi Minh Trail," *Armed Forces Journal*, (January 15, 1971): 19-22; Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge: MIT Press, 1996): 3-8 and 142-143; William Rosenau, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War* (San Diego, CA: Rand Corporation, 2001): 11-13; Gibson, *The Perfect War*, 396; and Daniel Uziel, "Igloo White: The Automated Battlefield," *TFOT* (The Future of Things), February 9, 2009, available online at: http://thefutureofthings.com/column/6369/igloo-white-the-automated-battlefield.html.

[46] George Weiss, "Battle for Control of Ho Chi Minh Trail," *Armed Forces Journal*, (January 15, 1971): 19. In a coordinated effort, NASA also worked with the Air Force to develop for dispersal along the Ho Chi Minh Trail piezoelectric crystals, which when crushed emitted an electric charge that could be sensed by nearby radio receiving equipment. For a description of this research involving piezoelectric crystals see, "Summary of Suggestions by NASA Headquarters Personnel as to Ideas That May Have Application to the War in Southeast Asia," 10 December 1965; Folder #014776 "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C., 3.

[47] Kenneth W. Gatland, "Soviet Satellites Eye Viet Military Scene," *Christian Science Monitor*, April 23, 1975, 4.

[48] William Broad, "Soviet Plans Big Satellites to Make Electricity for Cities and Industry," *New York Times*, June 14, 1987, 1. While "Star Electric" was never deployed over Vietnam, when it was unfurled in space in 1993 it cast a 2.5 mile-wide beam of light across Western Europe. On the Soviet's Star Electric project see, Thomas Ginsberg for the Associated Press, "Sky Mirror Could Turn Night into Day," *Washington Times*, February 3, 1993, A1; Associated Press, "Space Mirror Gives Earth a Night Light," *Washington Post*, February 5, 1993; and Warren E. Leary, "Russia's Space Mirror Bends Light of Sun Into the Dark," *New York Times*, February 5, 1993, 6.

[49] On opposition to Project Able from astronomers see, Evert Clark, "Defense Sky Mirror Study Assailed," *New York Times*, December 29, 1966, 10; "Scientists Oppose Orbiting Mirrors," *New York Times*, May 26, 1967, 4; "Reflecting Satellite: NASA Study Causes Concern among Astronomers," *Science*, 155, no. 3760 (January 1967): 305. On the American Astronomical Society's letter-writing campaign opposing Project Able see, American Astronomical Society Secretary G.C. McVittie to NASA Administrator James Webb, September 2, 1966, Folder: #011535, Folder Title: "Project Able/Mirror Illumination," NASA Headquarters, NASA Archives, Washington, D.C.; Arizona Senator Carl Hayden to NASA Administrator James Webb, October 20, 1966, Folder: #011535, Folder Title: "Project Able/Mirror Illumination," NASA Headquarters, NASA Archives, Washington, D.C.; and Richard L. Callaghan to Kentucky Senator John S. Cooper, April 4, 1967, Folder: # 011535, Folder Title: "Project Able/Mirror Illumination," NASA Headquarters, NASA Archives, Washington, D.C..

[50] There is a rich literature that examines the counterculture's opposition to modern technology and science. See especially, Herbert Marcuse, *One Dimensional Man:*

Studies in the Ideology of Advanced Industrial Society (Boston: Beacon Press, 1964); Lewis Mumford, *The Myth of the Machine: The Pentagon of Power* (New York: Harcourt Brace Jovanovich, 1970); Leo Marx, "Reflections on the Neo-Romantic Critique of Science," in Leo Marx, *The Pilot and the Passenger: Essays on Literature, Technology, and Culture in the United States* (New York: Oxford University Press, 1989), 61, 67, & 72; Matt Wisnioski, "Inside 'The System': Engineers, Scientists and the Boundaries of Social Protest in the Long 1960s," *History and Technology*, 19, no. 4 (@003): 313; and John McNeill and Corrina Unger, "Introduction: The Big Picture," in *Environmental Histories of the Cold War*, John McNeill and Corrina Unger, eds., (New York: Cambridge University Press, 2010), 17; and Andrew Kirk, *Counterculture Green:* The Whole Earth Catalogue *and American Environmentalism* (Lawrence: University Press of Kansas, 2007), 18 & 29.

[51] On Stewart Brand and the appropriate technology movement see Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006), and Andy Kirk, *Counterculture Green:* The Whole Earth Catalogue *and American Environmentalism* (Lawrence: University Press of Kansas, 2007), 18 & 29. The argument that an aversion to technology unified the 1960s counterculture originated with Theodore Roszak, *The Making of a Counter Culture: Reflections on the Technocratic Society* (New York: Doubleday, 1969), 8.

[52] On the New Left's critique of the American university as supporting the rise of technocracy during the 1960s see, Leo Marx, "Reflections on the Neo-Romantic Critique of Science," 72.

[53] For the transcription of this speech by Mario Savio on Sprout Hall Steps at Berkeley, December 2, 1964, see http://www.americanrhetoric.com/speeches/mariosaviosproulhallsitin.htm.

[54] There is a rich literature on academia's role in the military-industrial complex. See especially, Stuart Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993); Margaret Pugh O'Mara, *Cities of Knowledge: Cold War Science and the Search for the Next Silicon Valley* (Princeton: Princeton University Press, 1005); and Matt Wisnioski, "Inside 'The System': Engineers, Scientists, and the Boundaries of Social Protest in the Long 1960s," History and Technology, 19, no. 4 (2003).

[55] On the naval recruitment protest at Berkeley see, Associate Press reporter Harold V. Streeter, "Even Peace Can Lead to Controversy in Berkeley," *The Gazette* (Emporia, KS), July 20, 1967, 14; and Roszak, *Making of a Counter Culture*, 30. On the Free Speech Movement at Berkley transforming into the anti-war movement see, Jeremi Suri, *Power and Protest: Global Revolution and the Rise of Détente* (Cambridge: Harvard University Press, 2003, 166-172.

[56] On this outpouring of student activism in opposition to university research for the Vietnam War see, Paul Goodman, "Can Technology Be Humane?," *New York Review of Books*, 13, no. 9 (20 November 1969), 1. On student sit-ins at Princeton see, Matt

Wisnkoski, "Inside 'The System': Engineers, Scientists, and the Boundaries of Social Protest in the Long 1960s," *History and Technology*, 19, no. 4 (2003): 319-320.

[57] "The College Poll: Students Would Cut New Space Program," *San Francisco Examiner*, July 29, 1969, 2.

[58] Don Hesse, "Could I Interest You in Some Earthly Problems?," *St. Louis Globe*, December 28, 1968.

[59] For reference to the militarization of space see the "Deterrence Policy" section of *The Port Huron Statement of the Students for a Democratic Society*, 1962 (no pages numbers given). For SDS attitudes towards Vietnam see the "Colonial Revolution" section of *The Port Huron Statement of the Students for a Democratic Society*, 1962 (no pages numbers given). Years later Tom Hayden stated, "those who were really engaged with the struggle against . . . war, probably had a jaundiced view of [the space race] as a kind of escapism." For Hayden's comment see, James Sterngold, "Bound Once More for the Moon, Without the Stressful 60's Cargo: Mini-Series Casts the Mission as the Defining Spirit of a Decade," *New York Times*, 5 March 1998, E1

[60] "The College Poll: Students Would Cut New Space Program," *San Francisco Examiner*, 29 July 1969, n. pag.

[61] Gene Bassett, "What Have They Been Feeding You," *Washington Daily News*, July 28, 1969.

[62] Thomas O'Toole, "NASA's Role in War Grows," *Washington Post*, December 4, 1967, 1; and "NASA to Study Military Satellites," *Technology Week*, July 25, 1966, 16. For a similar description of NASA technicians working for the Pentagon for the Vietnam War see also, Thorne Dreyer, "Desolation Row: . . . Comments on the News," *The Rag* (Austin, TX), 2, no. 8 (December 11, 1967), n. pag.

[63] "Table B. Federal obligations for research and development, by major agency and performer: fiscal years 1956-1994," in National Science Foundation, *Federal Funds for Research and Development Detailed Historical Tables: Fiscal Years 1956-1994*, NSF 94-331 (Bethesda, MD: Quantum Research Corp., 1994).

[64] Kenneth J. Heineman, *Campus Wars: The Peace Movement at American State Universities in the Vietnam Era*, (New York: NYU Press, 1994), 14.

[65] "The Moon Age, A Special Section: How We Got There, Where We're Going," *Newsweek*, July 7, 1969, 64.

[66] Victor Cohn, "MIT Study Due," *Washington Post*, 31 May 1969, A1.

[67] On student demonstrations at MIT against the university's Instrumentation Laboratory see, Victor Cohn, "MIT Study Due," *Washington Post*, 31 May 1969, A1; Associated Press, "Scientist at MIT Says He Was Fired," *St. Joseph* (MO) *News-Press*, 17 October 1969, 4B; and Crocker Snow Jr., "800 in Antiwar March at MIT," *Boston Globe*, 5 November 1969, 1. On MIT's decision to "divest" itself of the I-Lab see, Robert Reinhold, "Panel Urges Shift in MIT Research," *New York Times*, 3 June 1969, 1; Nobel Wilford, "MIT Weapons Lab Shifts to Urban Problems," *New York Times*, 17 October

1969, 49; and Victor K. McElheny, "Draper Believes MIT Will Keep Moon Work," *Boston Globe*, 18 October 1969, 2.

[68] Joseph Alsop, "New Left's Assault on I-Lab Is Uglier Than Yet Revealed," Washington Post, November 21, 1969, A27. On student activism at MIT against the Draper lab see also, Victor Cohn, "MIT Study Due," *Washington Post*, May 31, 1969, A1; Robert Reinhold, "Panel Urges Shift in M.I.T. Research," *New York Times*, June 3, 1969, 1; and John Noble Wilford, "M.I.T. Weapons Lab Shifts to Urban Problems," *New York Times*, October 17, 1969, 49.

[69] NASA's Cloud Camera was also cancelled because its implementation would interfere with other experiments already scheduled for the space agency's Advanced Technology Satellite. On this scheduling conflict see, Leonard Jaffe (NASA Space Applications Programs Director) to Edgar Cortright (Director of NASA's Langley Research Center), memorandum, 16 May 1966, Folder: #005628, Title: "ATS Documentation," NASA Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[70] NASA Deputy Administrator Robert C. Seamans, Jr. to Heads, Program and Staff Offices and Center Directors, memorandum, 10 November 1969, Folder # 014777: "Vietnam, South," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.

[71] On Senator Proxmire's leak in Congress regarding the "electronic battlefield" see, United Press International, "'Automated Battlefield' Rapped," *News and Courier* (Charleston, SC), July 6, 1970, 10B; and Associated Press, "Goldwater Raps Proxmire Security Leak," *Pittsburgh Press*, July 8, 1970, 11.

[72] Pentagon director of defense John Foster as quoted in Night Editor Larry Lempert, "On Classified Research," The Michigan Daily, March 16, 1971, 4. On student activism at the University of Michigan opposing faculty research on the electronic battlefield see, Sara Fitzgerald, "Faculty to Vote on Classified Research Tomorrow," *Michigan Daily*, March 21, 1971, 1; and Alan Lenhoff, "Research Panel Report," *Michigan Daily*, May 19, 1971, 4. On NASA contracts at the University of Michigan during the 1960s see, Kenneth Heineman, *Campus Wars: The Peace Movement At American State Universities in the Vietnam Era*, (New York: NYU Press, 1994), 13.

[73] United Press International, "Pennsylvania Students Hit Nixon Talk," *Beaver County Times* (Pennsylvania), April 26, 1972, B8.

[74] For details of the Columbia building take-over see, John Darton, "Lab Occupation Ends," *New York Times*, April 29, 1972, 1. On the JASON's involvement in the electronic battlefield see, Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge: MIT Press, 1996):142. On the history of the JASONs see, Ann Finkbeiner, *The JASONS: The Secret History of Science's Postwar Elite*, (New York: Penguin Group, 2006).

[75] Martin Arnold, "Columbia Classes Are Held Under Makeshift Conditions," *New York Times*, April 27, 1972, 45.

[76] On students finding materials linking Columbia to the "war machine" in Vietnam see, Martin Arnold, "Lawsuit is Threatened," New York Times, April 29, 1972, 1; and John Darton, "Lab Occupation Ends," *New York Times*, April 29, 1972, 1.

[77] Associated Press, "Automated Battlefield Object of Anti-War Group Anger," *Morning Record* (Meriden, CT), December 20, 1971, 13.

[78] For photographs of this anti-NASA protest see, National Archives and Records Administration, NAIL NWDNS-428-KN-193335, as reprinted in Mitchell K. Hall, "The Vietnam Era Antiwar Movement," *OAH Magazine of History*, 18, no. 5 (2004), 13.

[79] On American Friends Service Committee's slide show on the electronic battlefield see, "Citizens for Peace to Hear Retired Brigadier General, *Meriden Journal* (CT), July 7, 1972, 17; and Associated Press, "Automated Battlefield Object of Anti-War Group Anger," *Morning Record* (Meriden, CT), 13. On the proposed amendment by members of the American Physical Society see, Associated Press, "Amendment Urged," *New York Times*, April 26, 1972, 11. For a description of the fast by Berrigan and other inmates at the Federal Correctional Institution at Danbury, Connecticut see, Raymond Pontier, "A Fast Continues," *New York Times*, August 30, 1972, 37; and Associated Press, "Berrigan, Six Prisoners Transferred to Danbury," *The Telegraph* (Nashua, NH), September 21, 1971; United Press International, "Philip Berrigan is Returned to Danbury Cell After Fast," *New York Times*, September 20, 1971, 75.

[80] Bruce Shanks, "Space Progress, Peace Progress," *Los Angeles Times*, April 9, 1972, n. pag.; John Fischetti, "Horizons," *Chicago Daily News*, December 26, 1968, n. pag.; Corky (Francisco Flores Trinidad), "I Wonder What Man Will Accomplish First," *Minneapolis Tribune*, May 20, 1969, n. pag.; Taylor Morse, "Didn't I Promise you the Moon?," *Los Angeles Herald-Examiner*, May 20, 1969; and Anonymous, "The Illusion," *New Orleans Times-Picayune*, May 26, 1969.

[81] Jeremy Suri, *Power and Protest: Global Revolution and the Rise of Détente* (Cambridge: Harvard University Press, 2005), 211.

[82] The quote comes from, "Cambodia Protests 'Consideration' of Project Able," Folder # 011535, "Project Able/Mirror Illuminator," NASA Headquarters, NASA Archive, Washington, D.C. On the opposition of the Cambodian government see, G. Ostruoumov, "U.S. Mirror Satellite Research Denounced," *Izvestiya* (Moscow), 11 May 1968, Folder # 011535, "Project Able/Mirror Illuminator," NASA Headquarters, NASA Archive, Washington, D.C.

[83] Jonathan Spivak, "The First Space Handshake," *Wall Street Journal*, July 22, 1975, 16. Even *Aviation Week & Space Technology*, historically a staunch supporter of space exploration, called such experiments "pseudo-scientific. See William H. Gregory, "Special Report: ASTP Mission — Airmanship, Science Highlight Project," *Aviation Week & Space Technology*, July 28, 1975, 16.

[84] On the ASTP mission's 4 million dollar television see, Jonathan Spivak, "The First Space Handshake," *Wall Street Journal*, July 22, 1975, 16.

[85] David Streitfeld quoting San Francisco writer Barry Malzberg in, "Footprints in the Cosmic Dust: Twenty Years Later, Six Voices on the Lost Promise of the Apollo Mission," *Washington Post*, 20 July 1989, D1. For similar comments see also, Frank Joyce, "Moonism," *Fifth Estate Newspaper* (Detroit, MI), 4, no. 6 (July-August, 1969), 5; and Mary Clarke and Varda Ullman, "escalation," *L.A. Wisp* (Women Strike for Peace), (February 1971), 1.

[86] As the *Wall Street Journal* reported, "The earth resources program owes most of its technology to the highly classified military programs." William Burrows, "Sizing Up the Planet: Satellites Will seek to Inventory Resources of Earth from Orbit," *Wall Street Journal*, June 8, 1970, 1. On the evolution of NASA technology from TIROS to ATS to Landsat see, Henry Hertzfeld and Ray Williamson, "The Social and Economic Impact of Earth Observing Satellites," in *Societal Impact of Spaceflight*, Steven Dick and Roger Launius, eds., (Washington, D.C.: NASA Office of External Relations, History Division, 2007): 240-238. Landsat was originally called the Earth Resources Technology Satellite (ERTS).

[87] M. Mitchel Waldrop, "Imaging the Earth (I): The Troubled First Decade of Landsat," *Science*, 215 (March 26, 1982), 1601.

[88] "Ecological Survey's From Space," Office of Technological Utilization, NASA SP-230, 1970, NASA Headquarters Archives, NASA Historical Materials, Folder 5754: Earth Resources Satellite, 1970, Washington, D.C.; NASA, "Improving Our Environment," (Washington, D.C.: U.S. Government Printing Office, 1973); and "Photography From Space to Help Solve Problems on Earth," NASA's Goddard Space Flight Center, circa 1972, NASA Headquarters Archives, NASA Historical Materials, Folder 5745: ERTS Photos and Booklets, Washington, D.C.

[89] United Press International, "NASA Satellite to be Launched: 2d Earth Resources Craft to Relay Environmental Data," *New York Times*, January 15, 1975, 53. See also, "Photography From Space to Help Solve Problems on Earth: NASA Earth Resources Technology Satellite," pamphlet published by NASA's Goddard Space Flight Center, circa 1972, NASA Headquarters Archives, NASA Historical Materials, Folder 5745: ERTS Photos and Booklets, Washington, D.C., 2.

[90] Jeffrey St. John, "Space Effort: No Apologies Necessary," *Los Angeles Times*, April 9, 1972, C3. See also, "Space: Can NASA Keep Its Programs Aloft?," *BusinessWeek*, February 13, 1971, 23.

[91] NASA's budget during these years decreased from 3.9 to 3.2 billion dollars annually. For historical data on NASA's total budget for these years in both real and in 2008 inflation-adjusted dollars see, United States President, United States, National Aeronautics and Space Council, *Aeronautics and Space Report of the President: Fiscal Year 2008 Activities* (Washington, D.C.: U.S. Government Printing Office, 2008), "Appendix D-1A: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of real-year dollars)," p. 146, and "Appendix D-1B: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of inflation-adjusted FY 2008 dollars)," p. 147.

[92] George Low Papers #27, 18 July 1970, "Fiscal Year 1972 Budget and Programmatic Discussions," 12-14, Box 70, Low, Rensselaer Polytech Institute.

[93] On the economic benefits to American farmers of NASA's LACIE program see, Henry Hertzfeld and Ray Williamson, "The Social and Economic Impact of Earth Observing Satellites," in *Societal Impact of Spaceflight*, Steven Dick and Roger Launius, eds., (Washington, D.C.: NASA Office of External Relations, History Division, 2007): 240-241 and 262. In the late 1970s the LACIE program was also used to forecast Soviet wheat supplies in an effort to avoid fluctuations in the international wheat market. On LACIE see also, "Landsat-2 Data Aid Research Management," *Bioscience*, 25, no. 4 (April 1975), 280. On the economic benefits for the United States of other satellite earth observations see, "Aerospace Research Profits Earth," *Roundup* (Newspaper of the Johnson Space Center), February 18, 1972, 2.

[94] Between 1975 and 1980 Congress increased NASA's total budget from 3.22 to 5.24 billion dollars. When adjusted for inflation according to 2008 dollars, this represents an increase of 10 percent. For historical data on NASA's total budget in both real and inflation-adjusted dollars see, United States President, United States, National Aeronautics and Space Council, *Aeronautics and Space Report of the President: Fiscal Year 2008 Activities* (Washington, D.C.: U.S. Government Printing Office, 2008), "Appendix D-1A: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of real-year dollars)," p. 146, and "Appendix D-1B: Space Activities of the U.S. Government, Historical Table of Budget Authority (in millions of inflation-adjusted FY 2008 dollars)," p. 147.

[95] "Text of Address by President Nixon to General Assembly of the United Nations," *New York Times*, September 19, 1969, 16.

[96] "NASA Position Paper on the Remote Sensing of Planetary Surfaces (Earth, Moon, Mars, Venus, etc) From Orbital and Fly-By Spacecraft," paper attached to memorandum by NASA Advanced Missions Program Chief Peter Badgley, October 8, 1965, Box #: 075-14, Series: Apollo, Johnson Space Center History Collection, University of Houston at Clear Lake, Houston, Texas.

[97] For an example of this concern see, Edward Keating, "Hard Times: World Spy," *Ramparts*, 9, no. 8 (March 1971): n. pag.

[98] The proposal, which ultimately stalled in the UN's Scientific and Technical Sub-Committee, was actually stricter than a similar United Nations proposal put forth by France and the Soviet Union the year before. On both these proposals to the United Nations see, Hamilton DeSassure, "Remote Sensing by Satellite: What Future for an International Regime?," *American journal of International Law*, 71, no. 4 (October 1977), 714 & 720. On Landsat possibly being used by developed countries to exploit natural resources in developing countries see also, Hanessian, "International Aspects of Earth Resources Survey Satellite Programs," 548.

[99] "ERTS-EREP Proposal Review," memorandum by Verl Wilmarth to TA/Director of Science and Applications, July 7, 1971, Record Number: 14994, Location: Box 529, Johnson Space Center Archives, University of Houston at Clear Lake, Houston, Texas.

[100] On the lack of trained photointerpreters in the developing world see, John Hanessian, "International Aspects of Earth Resources Survey Satellite Programs," *Journal of the British Interplanetary Society*, 23 (Spring 1970), 545. For additional concerns within NASA regarding a lack of skilled scientists in developing countries to take advantage of space technology see, "Practical Applications of Space Systems" (NASA-CR-145434), National Academy of Sciences, Washington, D.C., 1975.

[101] For examples of these press releases by NASA see, "Earth Resources Experiments RFP," Press Release No: 70-117, July 14, 1970, Folder 5754: Earth Resources Satellite, 1970, NASA Headquarters Archive, NASA Historical Materials, Washington, D.C.; and "Skylab Experimenters Sought," Press Release No: 71-5, January 19, 1971, Record Number: 142778, Location: Box 502, Johnson Space Center Archives, University of Houston at Clear Lake, Houston, Texas.

[102] In 1971 the United Nations created a Space Applications Program specifically to promote the use of earth observing remote sensing data throughout the developing world. On the efforts of these international organizations to promote earth observing technology in developing countries see, V. Klemas and D.J. Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," Center for Remote Sensing, University of Delaware, report prepared for the School of Engineering and Applied Science, George Washington University, Washington, D.C., and the Division of International Programs, National Science Foundation, Washington, D.C., March 31, 1977, 31-48.

[103] On NASA's Landsat conference at the University of Michigan see, "Earth Resources Survey Workshop," NASA Press Release No: 70-215, December 23, 1970, NASA Headquarters Archive, NASA Historical Materials, Folder 5754: Earth Resources Satellite, 1970, Washington, D.C.. On the Johnson Space Center Conference see, "All You Wanted to Know About Earth Resources," *Roundup* (newspaper of the Johnson Space Center), 14, no. 12 (June 6, 1975), 1. Lady Bird Johnson had NASA Administrator Thomas Paine give a similar lecture on remote sensing of earth resources at a cocktail party she threw for a group of foreign correspondents covering one of the early Apollo launches. On this cocktail party lecture see, Oral Interview of Dr. Thomas O. Paine by T. Harri Baker (Tape 2), Folder 4185: Paine Interviews Conducted by Baker, Lodsdon, Cohen, and Burke, NASA Historical Materials, NASA Headquarters Archives, Washington, D.C.

[104] For a description of Landsat conferences in Africa in Ghana and Mali see, "Landsat May Help Bridge Technological Gap," *Roundup* (official publication of NASA's Johnson Space Center in Houston), 23 May 1975, 2; and "W. Africans Confer on Uses of Remote Sensing Data," *Roundup*, 6 June 1975, 2. On Landsat data being used in response to the Sahel drought see, "Aid to W. Africa Aim of US Profs.," *Chicago Defender*, September 8, 1973, 25.

[105] On similar Landsat conferences in the Philippines see, "Earth Resources Team Visits to the Philippines," Record Number: 210333, Report Number: SRE, Date: September 21, 1971, Location/Box: 546, Johnson Space Center History Collection, University of Houston at Clear Lake. On efforts to promote Landsat across Latin America see, "Inter

American Geodetic Survey Proposal for Multi-National ERTS (Earth Resources Technology Satellite) Cartographic Experiments," Record Number: 213145, Report Number: IAGS-EROS, Date: April 7, 1972, Location/Box: 563, Johnson Space Center History Collection, University of Houston at Clear Lake.

[106] On the expansion of NASA's international fellowship program to include study at U> universities on Landsat see, John Hanessian Jr. and John Logsdon, "Earth Resources Technology Satellite: Securing International Participation," *Astronautics & Aeronautics* (August, 1970), 60.

[107] On NASA's training of Brazilian and Mexican scientists and engineers at the Johnson Space Center, see John Hanessian Jr. and John Logsdon, "Earth Resources Technology Satellite: Securing International Participation," *Astronautics & Aeronautics* (August, 1970), 59; and John Hanessian, Jr., "International Aspects of Earth Resources Survey Satellite Programs," *Journal of the British Interplanetary Society*, 23 (Spring 1970), 546. In this particular case, the actual data was obtained from aircraft circling above those countries.

[108] On NASA encouraging developing countries to build their own receiving stations see Henry Hertzfeld and Ray Williamson, "The Social and Economic Impact of Earth Observing Satellites," in *Societal Impact of Spaceflight*, Steven Dick and Roger Launius, eds., (Washington, D.C.: NASA Office of External Relations, History Division, 2007), 239. On developing nations building Landsat receiving stations see, Klemas and Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," 42. On Zaire's Landsat receiving station in particular see, "Landsat May Help Bridge Technological Gap," *Roundup* (Newspaper of the Johnson Space Center), May 23, 1975, 2.

[109] For a detailed description of Landsat data use in South America, especially in Brazil, see, Allen Hammond, "Remote Sensing (I): Landsat Takes Hold in South America," *Science*, 196, no. 4289 (April 29, 1977), 511-512.

[110] On NASA's Landsat program across the Sahel region of Africa, the Sudan's Kordofan Province, and Botswana's Okavango Delta region see, Klemas and Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," 7, 33 & 41. On Landsat data being used for range management in Kenya see, "LANDSAT May Help Bridge Technological Gap," *Roundup* (Newspaper of the Johnson Space Center), May 23, 1975, 2. For a list of African countries undertaking experiments with Landsat data see, Klemas and Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," 47.

[111] On material on NASA's use of Landsat in cooperation with the World Bank in Asia see, Klemas and Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," 35-36.

[112] On this extensive use of Landsat data by 50 countries worldwide see, Klemas and Leu, "Applicability of Spacecraft Remote Sensing to the Management of Food Resources in Developing Countries," 41.

[113] NASA's Goddard Space Flight Center in Greenbelt, Maryland oversaw this Landsat project, which was a cooperative effort with the Mekong Committee, an international planning organization sponsored by the United Nation's Economic and Social Commission for Asia and the Pacific. Mekong Committee, *1966-1992 Mekong Committee Annual Report,* Bangkok, Thailand, as quoted in Jeffrey W. Jacobs, "Mekong Committee History and Lessons for River Basin Development," *The Geographical Journal*, 161, no. 2, July 1995, 142. Jacobs essay provides an insightful history of the Mekong Committee. For the early history of the Committee see also, W.R. Derrick Sewell, "The Mekong Scheme: Guideline for a Solution to Strife in Southeast Asia," *Asian Survey*, 8, no. 6 (June 1968): 448-455.

[114] Mekong Committee Secretariat Willem J. van Liere, "Applications of Multispectral Photography to Water Resources Development Planning in the Lower Mekong Basin (Khmer Republic, Laos, Thailand and Viet-Nam," March 9, 1073, NASA Technical Report Document ID: 19730008739, Accession ID: 73N17466, Report Number: E73-10257; PAPER-W3, NASA Headquarters, Washington, D.C., 76.

[115] On diplomatic difficulties between China and the Soviet Union during this period see, Lorenz Luthi, *The Sino-Soviet Split: Cold War in the Communist World* (Princeton: Princeton University Press, 2008); and Jian Chen, *Mao's China and the Cold War* (Chapel Hill: University of North Carolina Press, 2000).

[116] On the Intercosmos Council pace program see, "Socialist Countries Cooperation in Space," *TASS* (Moscow), 16 September 1977, Folder: 001693, Title: "Petrov, Boris N. (USSR Academician – Bio), NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[117] B. Petrov, chairman of the Intercosmos Council, "New Stage of Cooperation," *Pravda* (Moscow), 5 March 1978, translated from Russian by FBIS, Folder: 001693, Title: "Petrov, Boris, N (USSR Academician-Bio), NASA Archives, NASA Headquarters, Washington, D.C., 1. For additional material on the central role played by the Salyut space station in the efforts of the Intercosmos Council see, Boris Petrov, "Orbital Stations: A Soviet Scientist Reviews the Scientific and Economic Benefits," Spaceflight (August 1973): 288-290; and Boris Petrov, "The USSR and International Cooperation in Space Research," *Moscow News*, no. 15 (1162), (April 21-28, 1973): 3 & 14.

[118] The "Western specialist" is quoted in Marc Rosenwasser, "Soviet Space Program for Foreigners Reaps Public Relations Benefit," *Association Press*, September 22, 1980 (AM cycle).

[119] On the Soyuz 37 mission being used to promote the benefits of Soviet-style communism see, "Vietnamese Cable to Soviet Leaders," Moscow Domestic Service in Russian, August 1, 1980, translated from Russian by FBIS, Folder #: 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.; and "Remarks by Giap/Source of Inspiration," *Pravda* (Moscow), August 6, 1980, 4, translated from Russian by FBIS, Folder #: 014776, Title: "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.

[120] On the Laotian government's praise for the Soyuz 37 mission see, "Leaders Congratulate SRV Counterparts on Space Shot," Vientiane KPL in English, July 26, 1980, as transcribed by FBIS, Folder #: 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C. On similar praise from Sri Lanka see, "Sri Lanka CP Leader Congratulates Le Duan on Space Flight," Hanoi VNA (Vietnamese News Agency) in English, July 31, 1980, as transcribed by FBIS, Folder #: 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C. For information on the Cuban reception see, "USSR-SRV Space Flight, Cooperation Lauded, Havana, Phnom Phen Meetings," Hanoi VNA (Vietnam News Agency) in English, August 9, 1980, as transcribed by FBIS, Folder #: 014776, Title: "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.

[121] James P. Sterba, "Hanoi Touts Its Astronaut as a Benefit of Moscow Ties," *New York Time*s, August 2, 1980, 3. For additional examples of western concern regarding the impact of the Soyuz 37 across the developing world see, Anthony Austin, "Vietnam-Soviet Space Team Down; Political Impact Is Called Extensive," *New York Times*, August 1, 1980, Section B, Page 4, who reported that the mission was "important mainly for its psychological effect, particularly in Asia and other third-world countries," and was "bound to have an impact on people's minds throughout Asia."

[122] On Intercosmos Council Chairman Boris Petrov's discussion of the MKF-6 multizone camera for assessing natural resources back on earth see, Boris Petrov, "New Stage of Cooperation," *Pravda* (Moscow), 5 March 1978, translated from Russian by FBIS, Folder: 001693, Title: "Petrov, Boris, N (USSR Academician-Bio), NASA Archives, NASA Headquarters, Washington, D.C. The Soviets also mounted a KT-140 high-resolution topographical camera system on the Salyut space station. On this topographical camera see, "Cosmonauts Land After 140-Day Flight, *Aviation Week & Space Technology*, November 6, 1978, 21.

[123] On Soyuz 37-Salyut 6 experiments regarding Vietnamese natural resources see, "Further on Joint Soviet-Vietnamese Spaceflight, First Experiment," Moscow Domestic Service in Russian, July 26, 1980, p. U3, as translated by FBIS, Folder #: 014776, Title: "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.; and Neville Kidger, "Salyut 6 Mission Report – Part 6," *Spaceflight*, 23, no. 3, March 1981, 75. On the mission's experiments forecasting typhoons and hurricanes see, "Academician on Soyuz-37 Program," Moscow Domestic Service in Russian, July 25, 1980, as transcribed by FBIS, Folder #: 001693, Title: "Petrov, Boris N (USSR Academician-Bio)," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C. And regarding the mission's hydrological studies of the Mekong and Red River basins see, "Further Details of Soyuz-37 Mission," Telegraph Agency of the Soviet Union in English and Vietnamese News Agency in English, as reported by the BBC Summary of World Broadcasts, August 6, 1980, Section: Part 1-The USSR; D. Space Research; SU/6490/D/1.

[124] On this statement by Vietnam's National Scientific Research Center deputy chairman Nguyen Van Hieu see, "Co-operation in Cosmic Studies with USSR and GDR," Hanoi in

English, as reported by the BBC Summary of World Broadcasts, August 6, 1980, Section: Part 3 The Far East, Weekly Economic Report; B, Broadcasting, Telecommunications, Space, Vietnam, FE/W1096/B/2.

[125] On the mapping of natural resources in Cuba during the Intercosmos Council's Soyuz-38 mission see, United Press International, "Cuban Cosmonaut and His Soviet Comrade Return to Earth," September 26, 1980. For similar mapping of Mongolia during Soyuz 39 see, Associate Press, "Soviet Spacemen Return to Earth," *Tri City Herald* (Pasco, Richland and Kennewick, Washington), March 27, 1981, 4. And for the mapping of Afghanistan's natural resources during the Soyuz TM-6 mission see, Esther B. Fein, "Soviets Send Doctor to Space Station," *New York Times*, August 30, 1988, C10.

[126] "Further on Joint Soviet-Vietnamese Spaceflight," TASS (Moscow) in English, July 26, 1980, as transcribed by FBIS, Folder #: 014776, Title: "Vietnam," NASA History Reference Collection, NASA History Division, NASA Headquarters, Washington, D.C.

[127] Neville Kidger, "Salyut 6 Mission Report – Part 6," *Spaceflight*, 23, no. 3, (March 1981): 75.

[128] "Brezhnev-Le Duan Congratulations," *Pravda* (Moscow) in Russian, July 26, 1980, as translated by FBIS, Folder #: 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[129] David K. Willis, "Soviets Bid for Third-World Prestige with Viet Cosmonaut," *Christian Science Monitor*, July 15, 1980, 3. For additional examples of the Soviet's use of the 1980 summer Olympics to promote the Soyuz-37 mission and its scientific findings see, Associate Press, "Soviet Puts Spacecraft Aloft with 2 Aboard; One is a Vietnamese," *New York Times*, July 24, 1980, Section A, p. 20; and "Brezhnev-Le Duan Congratulations," *Pravda* (Moscow) in Russian, July 26, 1980, as translated by FBIS, Folder #: 002345, Title: "Tuan, Pham (Lt. Col.) Soyuz 37 North Vietnamese," NASA History Archives, NASA History Division, NASA Headquarters, Washington, D.C.

[130] James P. Sterba, "Hanoi Touts Its Astronaut as a Benefit of Moscow Ties," New York Times, August 2, 1980, 3.

[131] On Pham Tuan returning home with photographs of Vietnam from space, undertaking a national tour of the country, and planting trees as "keepsakes" see, "Hero Pham Tuan Talks About Historic Flight - Part IV: Seven Days in Space and a Lifelong Brotherhood," *People's Army Newspaper Online*, May 8, 2008, http://www.qdnd.vn/qdndsite/en-us/75/72/184/164/207/61322/Default.aspx.

[132] On the porous boundaries between science and technology on the one hand and politics on the other, especially during the Cold War, see Mark Solovey, ed. "Science in the Cold War," Special Issue, *Social Studies of Science*, 31, no. 2 (April 2001), especially the introduction by Mark Sloveny, "Science and the State during the Cold War: Blurred Boundaries and a Contested Legacy." For other examples see, Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanfor*d (New York: Columbia University Press, 1993); Rebecca Lowen, *Creating the Cold War University: The Transformation of Stanford* (Berkeley: University of California

Press, 1997); Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical Sciences*, 18, Part 1 (1987), 149-229; and Langdon Winner, "Do Artifacts Have Politics," *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: University of Chicago Press, 1986): 19-39.

[133] For a similar discussion of local indigenous people using Landsat data for their own purposes see, Karen Litfin, "The Gendered Eye in the Sky: A Feminist Perspective on Earth Observation Satellites," *Frontiers: A Journal of Women Studies* (Fall 1997); 41.

[134] On NASA and the U.S. government retaining ultimate control over Landsat experiments see, Hanessian, "International Aspects of Earth Resources Survey Satellite Programs," 552. In reviewing Landsat proposals from developing countries NASA administrators were able list an experiment as "N," meaning "Negotiation Required." Doing so gave NASA more control over the experiment being proposed. For an example of this process see "Additional EREP Investigations," memorandum by NASA Associate Administrator for Applications Charles Mathews to Manned Spacecraft Center (Johnson Space Flight Center) Director Chris Kraft, April 21, 1972, Record Number: 146924, Location: Box 535, Johnson Space Center Archives, University of Houston at Clear Lake, Houston, Texas.

[135] Hanessian, "International Aspects of Earth Resources Survey Satellite Programs," 555.

[136] My thinking here has been influenced by John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (Cambridge, MA: MIT Press, 2006, especially its introduction. For examples of the rich literature on co-production within science studies see, Shelia Jasanoff, *States of Knowledge: The Co-Production of Science and the Social Order* (London: Routledge, 2004). The idea of co-production obviously builds on notions of hegemony, particularly that developed by Antonio Gramsci, as well as on the idea of "consensual hegemony" as put forth by Charles Maier in "The Politics of Productivity: Foundations of American International Economic Policy After World War II," in Charles Maier, *In Search of Stability: Explorations in Historical Political Economy* (Cambridge: Cambridge University Press, 1987). For an example of a similar scientific relationship during the colonial era see, Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600-1860* (New York: Cambridge University Press, 1996).

[137] NASA's involvement on the SDI program included research and development for the Clementine Mission, a joint project between the Strategic Defense Initiative Organization and NASA. On this partnership see, http://www.nasa.gov/mission_pages/LCROSS/searchforwater/clementine.html

[138] On Mission to Planet Earth see, Erin Hatch, "RS20673: NASA's Earth Science Enterprise," Congressional Research Service Report for Congress, September 14, 2000; William K. Stevens, "NASA Plans a 'Mission to Planet Earth,'" *New York Times*, July 25, 1989, C1.