Center for a New American Security

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# Blinded: *The Decline of U.S. Earth Monitoring Capabilities and Its Consequences for National Security*

POLICY BRIEF

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Networks of satellites, ground-based sensors and unmanned aerial vehicles – the assets America uses to monitor and understand environmental change and its consequences – are going dark. By 2016, only seven of NASA's current 13 earth monitoring satellites are expected to be operational, leaving a crucial information gap that will hinder national security planning.[1] Meanwhile, efforts to prevent this capability gap have been plagued by budget cuts, launch failures, technical deficiencies, chronic delays and poor interagency coordination. Without the information that these assets provide, core U.S. foreign policy and national security interests will be at risk.

The United States depends on satellite systems for managing the unconventional challenges of the 21st century in ways that are rarely acknowledged. This is particularly true for satellites that monitor climate change and other environmental trends, which, in the words of the Department of Defense's (DOD's) 2010 Quadrennial Defense Review, "will shape the operating environment, roles, and missions" of DOD and "may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world."[2]

Examples abound of how climate change is shaping the strategic environment and of why the U.S. government needs continued access to earth monitoring data:

- The opening of the Arctic is requiring the U.S. Navy and Coast Guard to execute new missions in the High North, including more frequent search and rescue missions.
- The receding Himalayan glaciers and related reduced river flows to South Asia may shape the future relationship between India and Pakistan. Defense planners and diplomats will need to monitor changes in the glaciers that supply rivers in Pakistan in order to determine whether access to water will exacerbate existing military and diplomatic tensions between India and Pakistan – states that have longstanding grievances over how they share water.
- In the South China Sea, changing ocean conditions are altering fish migration, leading neighboring countries to compete over access to billions of dollars in fish resources; this situation could escalate into serious conflict in contested territorial waters.

- DOD and development agencies rely on earth monitoring systems to monitor urbanization, migration patterns and internal population displacement. Several government agencies also rely on earth monitoring capabilities to analyze compliance with deforestation and emissions measures in international climate change treaties, just as the government relies on space-based capabilities to monitor and verify compliance with non-proliferation treaties.

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Responding to environmental and climate change trends requires a steady stream of reliable information from earth monitoring satellites that is quickly becoming unavailable. Ideally, the U.S. government would replace its aging earth monitoring satellites. Yet the current political and fiscal environments constrain available resources, making it less likely that Congress will appropriate funds to wholly replace old systems. Given this reality, U.S. policymakers should use existing systems more efficiently, improve information sharing among interagency partners and leverage international partners' investments in their own systems in order to bolster U.S. climate and environmental data collection capabilities.

## The Capability Gap

Policymakers have known about the challenges stemming from America's declining earth monitoring capabilities for years. In 2005, a report by the National Research Council warned that America's "system of environmental satellites is at risk of collapse."[3] Key U.S. government agencies, including the Office of Science and Technology Policy (OSTP) and the Government Accountability Office (GAO), have recently reiterated those warnings. According to an April 2010 report by the GAO, "gaps in coverage ranging from 1 to 11 years are expected beginning as soon as 2015" and "are expected to affect the continuity of important climate and space weather measurements, such as our understanding of how weather cycles impact global food production."[4] These gaps will include key environmental and climate monitoring functions, from radar altimeters that measure changes in land and ocean surfaces (such as sea level rise and desertification) to aerosol polarimetry sensors that can measure and distinguish between sulfates, organic and black carbon and other atmospheric particles. "Meteorologists, oceanographers, and climatologists reported that these gaps will seriously impact ongoing and planned earth monitoring activities," according to the GAO.[5]

One recent interagency effort to close such gaps has fallen short. The National Polar-orbiting Operational Environmental Satellite System (NPOESS) was designed to translate climate and environmental data (including data from extensive existing databases) into products and analysis for DOD, NASA and the National Oceanic and Atmospheric Administration (NOAA). However, after long delays, cost overruns and inadequate coordination among the partners in the interagency working group, the project was split into two components (as an alternative to being cancelled completely); DOD and the civilian agencies are moving forward separately with their own projects in order to sustain the capabilities that NPOESS was intended to provide.

Despite the program's continuance as two separate projects, however, the replacements for some of its

intended capabilities of interpreting data from earth monitoring systems still lack funding and important technical functions. NASA's NPOESS Preparatory Project (NPP),[6] for example – part of the agency's next generation of weather and climate monitoring systems and the successor to the disbanded NPOESS project – may not be equipped with key instruments that provide sustained earth monitoring and climate data that policymakers can use in their decision-making. Although NASA is on track to launch the NPP in October 2011, a recent report from NASA's Office of the Inspector General found that key instruments aboard the NPP are projected to have a much shorter lifespan than the planned mission.[7] Those instruments include crucial infrared capabilities that will provide data on wildfires, ice cover in the Arctic, ocean temperatures and atmospheric conditions – valuable information that will allow security practitioners and other policymakers to make informed decisions about issues ranging from the Arctic to treaty verification.[8]

In a September 2010 report, OSTP identified several additional capability gaps that many federal officials confirmed could hinder the availability of climate and environmental information and affect key national security and foreign policy interests:

- The health of the Landsat program, which provides information on topics from land use change to urbanization, is a top concern. One of the two remaining Landsat satellites is past its expected lifespan, and the other has declining capabilities. One replacement satellite, the Landsat Data Continuity Mission, has a planned launch date in 2012. The achievement of this mission and its successors is necessary to ensure that one of the most accomplished U.S. satellite programs, spanning nearly four decades, is not lost.[9]
- Space-based monitoring provides critical information on ocean color. According to OSTP, ocean color has "proved to be a key climate variable in quantifying carbon uptake from the atmosphere … in addition to understanding the impacts of global warming on ocean ecological systems."[10] The primary satellite for collecting these data, the Sea-viewing Wide Field-of-view Sensor, is already past its expected lifespan.
- Ocean surface vector winds (OSVWs) "play a key role in regulating the earth's water and energy" and regulate "the interaction between the atmosphere and the ocean, which establishes and maintains both global and regional climates," according to OSTP. Understanding these winds will be critical to forecasting the effects of climate change and improving marine weather prediction, but a key satellite for monitoring them failed in late 2009. The U.S. government has not yet developed a "sustained source for OSVW information."[11]

Recent technical failures have made the challenges stemming from the gaps in U.S. satellite capabilities even more acute. In 2009, NASA's Orbiting Carbon Observatory, a satellite designed to map global carbon dioxide levels, crashed into the Pacific Ocean after a protective shroud failed to separate from the rocket, adding extra weight that prevented the satellite from reaching orbit.[12] In March 2011, a similar failure of a protective nose cone caused NASA's Glory satellite – intended to study the effects of black carbon soot and other atmospheric aerosols – to crash into the Pacific Ocean as well.[13]

## Additional Challenges

Four issues compound the challenges posed by the looming gaps in U.S. satellite capabilities. Budget constraints, ineffective communications, inadequate interpretation of data and over-reliance on the Global Earth Observation System of Systems (GEOSS) program all make it harder to generate and analyze the information on which U.S. national security and foreign policy practitioners increasingly rely.

### BUDGET CONSTRAINTS

Budget constraints are likely to continue to severely limit U.S. investments in new satellites and other capabilities, according to government officials in a range of agencies. Funding may become the critical constraint on future earth monitoring capabilities.

The March 2011 earthquake and tsunami in Japan, for example, highlighted the importance of tsunami early warning capabilities. Yet funding cuts threaten NOAA's Deep-ocean Assessment and Reporting of Tsunamis (DART) program, which proved crucial for leveraging U.S. satellite and ground-based systems to extend evacuation time in Hawaii, including at a range of coastal military bases. The National Weather Service, which runs the DART program, may see cuts of up to 28 percent for fiscal year (FY) 2012.[14] The U.S. Agency for International Development's (USAID) Famine Early Warning System (FEWS) network will likely see its budget reduced in the next several years as well, and according to many USAID officials the agency's climate change work is one of the areas most likely to be cut. NASA's Applied Sciences Program, which disseminates information and other data from NASA satellites, has also contributed to early warning and response to natural disasters. The president's budget request for FY 2012 includes 33.1 million dollars for this program – down from 35.3 million dollars in FY 2010 – and Congress may cut that number even further.[15] These offices and programs are critical to executing the existing satellites' missions.

### COMMUNICATING WITH END USERS

Despite the pressing need to close the gaps in U.S. earth monitoring capabilities, few policymakers have been agitating for investments in these systems. Indeed, many policymakers – the "end users" of environmental and climate data and the very constituents who are in a position to advocate for sustaining this critical capability – do not always understand that the data they receive from their staffs often rely on remote sensing capabilities. Top officials often receive analyses of environmental or climate conditions and of how those conditions affect specific policy questions for which they are responsible (e.g., how decreasing ice cover in the Arctic is affecting Russia's behavior and decision making). Such analyses constitute some of the government's most important work on climate and environmental change, yet they contain little to no information about which satellites and other capabilities produced the underlying data. Even the decision makers who can direct funding toward improving U.S. capabilities or promote new focus areas for international cooperation do not always know how much they rely on these data.

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The same problem exists at the working level. Many federal agencies have teams devoted to tracking specific environmental or climate trends, such as air quality, precipitation, sea level rise and Arctic ice melt. Members of these teams often do not know where their data come from or what additional sources of information could improve their ability to do their jobs. Many people we spoke with in DOD, for example, remain unaware that the U.S. government actively tracks many environmental trends and weather conditions that could affect the department's efforts in places like Afghanistan and the Horn of Africa.

### INADEQUATE DATA INTERPRETATION

The U.S. government, due largely to budget constraints, does not fully analyze the data that it already collects – including several decades' worth of historical remote sensing data and imagery. The U.S. Geological Survey, for example, has extensive digital archives of aerial photographs in storage, but the government has not allocated funds for any agency to make the archives accessible or to use them for policy-relevant analysis. The struggles of the NPOESS program also highlight the difficulty the U.S. government has in interpreting the climate and environmental data it has already paid to collect.

### OVER-RELIANCE ON GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS

Our research suggests that the U.S. government relies heavily on GEOSS – an international program for sharing and analyzing environmental data – to increase international coordination and to access data from other sources. In part, this reliance is due to budget pressures that prevent the U.S. government from investing in new capabilities of its own. Yet over-reliance on GEOSS presents its own challenges: The system lacks key technical mechanisms that would make it user-friendly and interoperable among international partners. Moreover, it does not provide all data necessary to meet U.S. policymakers' unique information needs, including answers to questions specific to U.S. military assets and foreign policy priorities that may not be common among international partners.

Indeed, officials at various agencies fault GEOSS in several respects. Officials with whom we spoke complained that some of the system's programs do not provide data or information beyond what is already publicly available. Others indicated that GEOSS, once fully operational, will cover only about one-third of U.S. climate and environmental data needs – and this assessment likely does not account for emerging concerns about climate change that policymakers at DOD are only beginning to identify, including issues in the Arctic and other regions of the world where U.S. interests are at risk. In addition, given GEOSS's technical nature, one official expressed concern that GEOSS's information would largely be accessible to scientists and highly technical decision-makers, rather than to senior policymakers who would benefit from more actionable information. Even if GEOSS becomes a successful system, the heavy focus on it could distract decision makers from developing a diverse portfolio of tools to meet U.S. needs for environmental and climate change information. Such a portfolio could include data from more productive forms of collaboration, such as the relatively robust international science and technology cooperation between NASA and its foreign counterparts.

All of these issues, and how the U.S. government addresses them, will shape whether or not the United States has the information it needs to understand the security consequences of climate change and to develop effective policy responses. Several agencies have also identified specific, critical gaps in U.S. earth monitoring capabilities that will limit the data and analysis available to them, and thereby limit their ability to do their jobs as effectively. GEOSS may provide a partial solution, but it will not provide all the data that policymakers need to understand and prepare for the effects of environmental and climate change.

## National Security Implications of Gaps in Earth Monitoring

The emerging gaps in U.S. earth monitoring will impede the U.S. government's ability to make efficient and effective decisions to address environmental and climate change. These issues directly affect defense, development and diplomatic issues and policies, not just the scientific community. The examples that

follow illustrate some of the ways in which losing satellite-based earth monitoring capabilities will affect U.S. national security.

**DOD** routinely relies on earth monitoring satellites for up-to-date weather conditions and forecasting. The Air Force, for example, manages the Defense Meteorological Satellite Program (DMSP), which produces specialized weather reports for military operations and monitors drought conditions and other environmental trends. The Special Sensor Microwave/Imager sensors aboard DMSP satellites, for instance, collect data to measure and monitor Arctic ice concentration, which is critical for developing military contingencies and scenarios as sea ice continues to melt and as companies, foreign governments and other actors look to exploit the opening of the High North.[16] Yet with the disbanding of NPOESS – which was intended to fill the capability gap that will occur when the last DMSP satellite is projected to go out of service in 2019 – it is unclear whether DOD will be prepared to meet the capability shortfall on its own. If not, DOD will have to rely on civilian capabilities, such as the NPP being developed by NASA and NOAA. However, as noted above, that system could have a reduced service lifetime and key instrumental deficiencies.[17]

**USAID** relies on remote sensing technologies to efficiently allocate U.S. food assistance and other aid to where it is most needed – which is critically important in the current tight budget environment. Two systems that require major earth monitoring capabilities are particularly important for USAID. Many USAID officials rely on the Regional Monitoring and Visualization System (identified by its Spanish acronym, SERVIR) to collect environmental data for Latin America, and NASA and USAID are using this system as a model for expanding similar data collection in Africa and the Himalayas.[18] Others at USAID rely more heavily on FEWS, which provides information regarding whether water requirements for crops have been met in areas from East Africa to Afghanistan and thus helps policymakers determine whether crops are heading toward normal growth or potential failure. For this water monitoring system, the Water Requirement Satisfaction Index, USAID uses data from a range of U.S. government satellite systems.

Critical gaps in several general categories of data also affect other aspects of USAID's work. The U.S. Agency for International Development does not consistently receive the detailed data it needs to effectively monitor hydrological systems or to measure ice and snow depth, for example. Additionally, it lacks satellite imagery with the resolution necessary to discern what crops are being planted in specific locations, which would inform its agriculture-related programs. USAID officials therefore must overlay general maps of historical planting with water requirements maps to estimate what crops may be failing. In addition to lacking satellite imagery with sufficient resolution, many officials are increasingly concerned that the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard the Aqua satellite will soon cease operations because it is past its normal life expectancy, creating even bigger gaps for USAID. These deficiencies will all influence the ability of officials within USAID to fully understand how environmental conditions and climate change are affecting their missions and to help national security policymakers identify areas of the world that are prone to greater instability.

**The State Department** likewise relies on information generated from earth monitoring systems. Policymakers in the Bureau of Oceans and International Environmental and Scientific Affairs (OES), for example, address environment-focused foreign policy priorities, such as Arctic

issues, climate change, ocean policy and resource scarcity. Information analyzed in OES and other functional bureaus will become increasingly important as policymakers in the State Department's regional bureaus continue to integrate environmental and climate change trends into their decisions. For example, as climate change takes a toll on the world's oceans, OES will need to provide information to officials working in the Bureau of East Asian and Pacific Affairs – where, as mentioned above, changes in ocean conditions are altering fish migration patterns in the South China Sea and exacerbating tensions between regional neighbors.

## Closing the Gap

The U.S. government should take three measures to ensure that it continues to receive reliable climate and environmental data: increasing international cooperation and collaborating on space-based earth monitoring, increasing information sharing and interagency cooperation, and finding budget-conscious ways to shrink the gaps in earth monitoring capabilities.

**Cooperating with key allies and partners will be a vital means of ensuring adequate earth monitoring capabilities in the decades ahead.** The U.S. government has increasingly emphasized the importance of leveraging its partners' space capabilities. The 2010 National Space Strategy, for example, states that "By sharing or exchanging capabilities, data, services, personnel, operations, and technology, we can ensure access to information and services from a more diverse set of systems."[19]

In practice, many agencies still view U.S. participation in the multilateral GEOSS as insufficient. As the U.S. government continues to integrate environmental and climate change issues into key strategic planning documents, policymakers are likely to discover that the United States requires unique information tailored to its specific national security and foreign policy priorities that GEOSS does not provide. Space cooperation on earth monitoring can serve a broader range of U.S. scientific, foreign policy and security interests by being more flexible and more robust.

Thus, the United States must complement GEOSS with other bilateral initiatives to sustain a steady stream of earth monitoring data. Indeed, given likely budget constraints, leveraging the investments of U.S. allies and partners in their own earth monitoring capabilities and sharing that information will give U.S. scientists and policymakers access to the information they need in the short term, while fostering a long-term opportunity for integrating broader science and technology cooperation into international partnerships. India, for example, recently launched three remote sensing satellites to collect information on water, agriculture and climate trends; it plans to launch two more earth monitoring satellites, in 2012 and 2013, to measure carbon emissions and to monitor forest cover.[20] Germany's TerraSAR-X Satellites, designed to provide high-resolution radar imagery that can monitor changes to the earth's surface – for example, changes in land use or land cover – were used after the March 2011 earthquake and tsunami in Japan.

The United States has existing mechanisms to support bilateral cooperation in this area. The Japan-U.S. Science and Technology Cooperation Agreement, for example, already promotes space collaboration between the United States and Japan, including on remote sensing projects.[21] The United States and India have also signed agreements to foster cooperation in space, science, technology and innovation, including "enhancing the understanding of Earth and Ocean dynamics and addressing the challenges of climate change."[22] Diplomats and other foreign policy practitioners need to be aware that these mechanisms exist and that they can be used to expand environmental and climate monitoring. Doing so would be cost-effective and

ensure that the United States has access to the steady stream of data that policymakers need to make informed decisions. Expanding cooperation on environmental and climate monitoring could also foster other opportunities for integrating science and technology cooperation into international partnerships, such as sharing climate and environmental data not derived from satellites and technical knowledge about emerging energy technologies.

**Policymakers must continue to improve information sharing and interagency coordination** so that all agencies can use existing capabilities and promote efficiency. The Obama administration has instructed OSTP, NASA, DOD and other departments to better coordinate interagency earth monitoring efforts, and this coordination appears to have improved in recent years. Yet even though the administration's own policy documents emphasize improving interagency coordination on earth observation, our interviews with officials at a range of agencies provided countless examples of areas where interagency cooperation could further be improved. Additionally, as the State Department implements some of the structural changes envisioned in its 2010 Quadrennial Diplomacy and Development Review, NASA and NOAA should ensure that their international space partnerships are fully coordinated with the appropriate regional and functional State Department bureaus to ensure that they bolster U.S. diplomatic strategies.

Consistent Congressional and executive branch support is also necessary. The MEDEA program, for example, was initiated in 1991 as a civilian-intelligence venture between the CIA and scientists to declassify and allow access to historical satellite images to better inform scientific projections and climate change analysis. However, funding for this program was reduced in subsequent years and was halted altogether during the George W. Bush administration. In 2009, the CIA launched the Center on Climate Change and National Security, reviving the MEDEA program, in part due to renewed interest by the agency and other parts of the U.S. government in studying the national security implications of climate change. Since the center was launched, however, several members of Congress have again threatened to cut funding for this work, charging that assessing climate change is beyond the intelligence agency's purpose.[23] In order to reap the full benefits of past investments, policymakers should ensure that interagency coordination and information sharing are not intermittent, as this program's work has been. Continuous support and interagency cooperation on environmental and climate change data sharing and planning provide obvious opportunities and advantages in addressing the challenges that inevitably will affect the spectrum of U.S. government resources and agencies.

**The U.S. government must find innovative and budget-conscious ways to fill its remaining capability gaps.** This will be extremely difficult given the current fiscal environment and a general mood in Congress to cut work related to environmental and climate change. Furthermore, earth monitoring satellites will be pulled into debates over the future of the U.S. space program. In early 2011, several members of Congress from Florida and Texas – the two homes of manned space operations – recommended reducing NASA's earth sciences budget in exchange for maintaining funding for human space flight.[24] Furthermore, the costs of the 2009 and 2011 launch failures (273 million dollars and 424 million dollars, respectively) may have discredited NASA in the eyes of policymakers who urged federal agencies to be fiscally responsible. Nevertheless, policymakers will need to overcome the tendencies to marginalize and defund whole programs that include partial failures (such as NASA's two recent launch failures) in order to provide the U.S. government with the capabilities it will require in the long term.

Beyond replacing satellites as they reach the end of their lifespans, innovation in space technology may soon allow lower-cost methods of producing policy-relevant information. For example, the failed launch of NASA's Glory satellite in February 2011 included CubeSats – small, standardized satellites designed to carry a small number of specific instruments – designed by students at two U.S. universities for around 100,000 dollars.[25] Advances in satellites that can be tailored to very specific research needs at a relatively low cost highlight that the U.S. government may have more options in the near future for meeting U.S. earth monitoring needs than it does today. Policymakers should look to fund academic research and public-private partnerships tailored to meet national security-related earth monitoring needs.

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As Congress and the executive branch debate these types of solutions, however, policymakers should not dismiss the U.S. government's role. The National Space Policy emphasizes the role of commercial space assets in future U.S. space activities, but the commercial space sector will not necessarily invest in the assets needed to address the national security consequences of climate change. Although the National Space Policy does focus on improving federal earth monitoring capabilities, especially polar-orbiting environmental satellites,[26] commercial assets may not provide the climate and environmental monitoring capabilities that the U.S. government needs. Private sector investments and academic research may also not be tailored to produce policy-relevant information if the U.S. government does not provide the proper guidance and incentives. Congress and the executive branch should prioritize funding for federal assets, including replacing decommissioned satellites, to ensure that the government has the information it needs to address the defense, development and diplomatic effects of global climate change.

## Conclusion

The United States should act now to address the growing decline of its earth monitoring capabilities. With key satellites aging and new systems failing to launch, the nation's technical capacity to plan effectively for global environmental change is waning rapidly. The effects of climate change – from emerging geopolitical tensions in the Arctic to record-breaking natural disasters in Asia – are already affecting military requirements and other security concerns. U.S. policymakers will continue to make daily decisions based on climate change and environmental information. Accurate and accessible information is required to ensure that those decisions are both effective and efficiently made.

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In this three-minute time-exposure made with a fish-eye lens, a Taurus XL rocket carrying NASA's Glory satellite lifts off from Vandenberg Air Force Base, Calif., March 4, 2011. Several minutes into the flight, the rocket carrying the Earth-observation satellite plummeted into the Pacific Ocean.

(The Associated Press/The News-Press/ MIKE ELIASON)