

ENVIRONMENT

Over the past two decades, the scientific community has been successful in achieving worldwide recognition of the consequences of both naturally occurring and human-induced changes to the Earth's ecological balance. Global environmental change was one of the key political issues of the 1989 Paris Economic Summit of industrialized nations, and the U.S. Global Change Research Program (USGCRP) was established as a Presidential Initiative in the FY 1990 budget to help develop sound national and international policies germane to this area. Within the next century, Earth faces the prospect of accelerated climate warming and rising sea levels, ozone reduction, continued ocean and groundwater contamination, acid rain, deforestation and desertification, as well as reduced biodiversity. The atmospheric and oceanic processes that govern many of these changes are not well understood and are poorly measured. The Paris Summit devoted more than one-third of its final communiqué to environmental issues, and urged "all countries to combine their efforts in order to improve observation and monitoring on a global scale."¹

Although the responsibility to protect and preserve the environment is "a challenge that until recently may have been of little or no concern to the military," the dramatic changes that have occurred in the world's political climate over the past few years have led to substantial alterations in military missions and shifts in funding that make it "essential that every effort be made to build platforms and systems that meet regulations by design." In these "fiscally austere times, we cannot afford to devote a heavy portion of our budget to cleaning up after the fact or paying hefty fines."²

Nevertheless, the reductions-in-force and base closings that have accompanied these political changes have led to the recognition of potentially enormous environmental liabilities for the military. Every state in the Union now has strict environmental laws that are becoming more stringent. The operational profiles of Navy ships are already constrained in some domestic and international waters because they lack appropriate shipboard waste management systems. The discharge of all solid wastes from surface ships must be eliminated in certain special areas by the year 2000. The Air Force and Army face similar environmental liabilities that require the characterization and remediation of substantial areas contaminated by fuels, munitions, solvents, and various other toxic substances.

Environmental leadership will require a balance among understanding diverse and complex ecosystems, the new military missions, and the technologies needed to diagnose and preserve both. The Johns Hopkins University Applied Physics Laboratory's (APL's) systems approach to significant operational problems, its long

relationship with the Navy and familiarity with naval systems, and the environmental engineering expertise both at APL and on The Johns Hopkins University Homewood Campus provide this breadth. The Environment Thrust Area has been established within APL's Independent Research and Development (IR&D) Program to perform the additional research and development necessary to establish APL as a solid contributor in the preservation of environmental quality and our military and industrial effectiveness. This program also seeks to initiate pilot projects capable of attracting new sponsors. Particular emphasis will be placed on projects that address the near-term needs of multiple sponsors (e.g., Army, Air Force, and EPA; NOAA and the Navy; NASA and the Navy), leverage existing APL strengths, and foster increased involvement with other divisions of the University.

To address these issues and to support the Laboratory's evolving environmental business plan, the tasks supported by this thrust area will be organized into the three theme-oriented projects described in the following paragraphs.

Techniques for Minimizing the Pollution from Warships. An environmentally sound ship that could operate worldwide without causing significant adverse environmental impacts must sufficiently treat or destroy all waste streams onboard such that processed waste could be discharged or released without harm to the environment. Alternatively, it could be returned to shore for recycling or disposal. To achieve this overall goal in the twenty-first century, the Navy must continue to identify and address the wastes generated as well as the hazardous materials used and discharged from ships. Eliminating the use of environmentally harmful chemicals, such as ozone-depleting substances and toxic antifoulant hull coatings, may be the best approach for complying with some regulations. However, reducing the amount of wastes generated onboard may be the preferred approach in other cases (for example, reducing the amount of plastics or unnecessary packaging taken onboard). Similarly, reducing the volume of liquid wastes generated may simplify onboard treatment of liquid waste streams.

Unfortunately, waste treatment technologies and equipment that work effectively on shore often do not work on warships because of space and weight limitations, and harsh, rolling environments. Any equipment or system installed on Navy ships must perform its intended function effectively, and must also meet strict requirements for reliability, maintainability, and shock and vibration tolerance. As a consequence of these special requirements, "off-the-shelf" commercial waste management equipment is generally not suitable. This project seeks to identify the tools for conducting systems-level assessments of the best overall strategy for jointly achieving ship compliance and mission effectiveness; develop

sensors for waste-stream characterization; and determine the fate and effects of any chemicals that are discharged.

The Characterization, Localization, and Remediation of Buried and Submerged Wastes. Military bases contain large tracts of land where operations over the past decades may have resulted in the continued presence of unexploded ordnance, buried munitions and chemical drums, or contaminated soil and groundwater. In the latter case, contaminated subsurface plumes may be leaching into nearby rivers or estuaries. However, the task of locating and remediating these sites is labor-intensive, often requiring the drilling of numerous sampling wells and the removal of contaminated soil. Techniques are needed for rapidly surveying large areas for the presence of these wastes, and for noninvasively localizing them in three dimensions to focus the subsequent and costly remediation efforts. This will probably require the cooperative use of several types of sensors and subsequent fusion of the data processed by each type of device. This project seeks to develop these characterization systems.

Environmental Remote Sensing in Support of Mission to Planet Earth. The USGCRP was conceived and developed to address significant uncertainties concerning the natural and human-induced changes now occurring in the Earth's life-sustaining environmental envelope. It is being implemented through a priority-driven scientific research agenda that is designed to provide a comprehensive "Earth-system science" approach to addressing the problems of both global- and regional-scale changes in the Earth's environment.

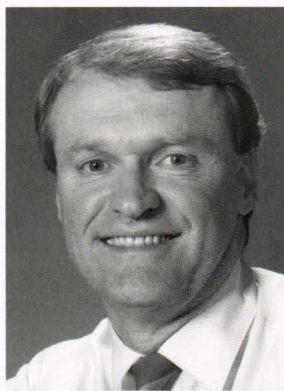
The Mission to Planet Earth is a NASA-initiated program that supports the USGCRP by integrating both space- and ground-based measurement systems, and a data and information system, to monitor long-term changes in the environment. It fosters interagency and international participation to provide the scientific basis for understanding global change. Mission to Planet Earth includes three new program elements: the multisensor Earth Observing System (EOS); the single-sensor Earth Probes; and the Geostationary Platforms. Although the EOS sensors and participants have been determined, and

the Geostationary Platforms program element has not been fully defined, the Earth Probes program element offers an attractive opportunity to apply APL's expertise in environmental characterization, and in satellite and space-sensor development. This project seeks to develop new remote sensing techniques that improve our ability to sense environmental changes (particularly of the oceans). As such, it complements the existing Mission to Planet Earth project in the Space Department's IR&D program that is focused on miniaturization of existing sensors.

REFERENCES

- ¹*Final Communiqué*, Paris Economic Summit of the Industrialized Nations (Jul 1989).
- ²Owens, W. A., "Joint Littoral Warfare: Our Future," *Johns Hopkins APL Tech. Dig.* **14**(2), 90 (1993).

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