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OCEAN SCIENCE AND TECHNOLOGY: WHERE WE ARE AND WHAT IS NEEDED

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Introduction

In recent years, we have seen dramatic changes in the world's political landscape and the emergence of a truly global economy. The world is no longer driven by the interactions between two military superpowers; it is now driven by the global economic and environmental concerns in addition to traditional defense issues. The world's population is expected to grow until well into the 21st century, straining the environment and natural resources in many regions of the world and contributing to the displacement of many of the world's peoples. At the same time, a greater degree of free trade—both of capital goods and information—will create unprecedented opportunities for people around the world.

With the globalization of the world's economy, the comparative well-being of countries is likely to change. There are currently just three or four regions of the world that enjoy a large gross domestic product (GDP). In the year 2050 and beyond, we are likely to see a leveling out of the GDP around the world, with economic differences among countries becoming less stark. We often think of development as including traditional infrastructure such as bridges and highways, but it will increasingly include a country's scientific and technological capabilities—from forecasting natural hazards to research and development.

As we experience these changes in the world's political and economic landscape, we also see continuing public demands for a clean environment. We want to be assured that we will have clean air and water, as well as the use of natural resources (e.g., fisheries, forests, agricultural lands, minerals, and fuels), both now and in the future. We have found that economic prosperity and environmental protection can go hand-in-hand, but not without concerted and continuing effort by the United States and our partners around the world.

There are many important lessons to be learned from our use of the oceans. In the past fifty years or so we have invested millions of U.S. dollars in ocean science and technology and we have learned a lot about ocean processes. We have developed a broad array of technological tools to help us uncover the mysteries of the oceans including satellite-based remote sensing systems; ship-based scientific instruments; extensive arrays of ocean buoys; and numerical models that predict the tides, currents, surface temperatures, and interactions among the atmosphere and ocean. We are rapidly harvesting the ocean's resources, such as fish, minerals, and gravel. We have learned that the world's oceans present many opportunities as well as many unanswered questions. In my view, we are likely to demonstrate much broader use of ocean resources in the 21st century. The Pacific Ocean will be particularly important since it is so large and its resources are so great.

In the United States, many of the ocean-related activities fall under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA). NOAA was created in 1970 in response to the need for better coordination of oceanic and atmospheric programs. It is responsible for a wide range of activities—including weather and climate prediction, sustainable fisheries management, coastal zone management, restoring endangered marine species, and nautical mapping and charting. NOAA's responsibilities include both research and operations, and partnerships with the international community are essential in achieving our mission.

This article will focus on three issues of particular importance to NOAA: fisheries, marine technology, and weather and climate forecasting.

Fisheries

The total global marine fishery catch has leveled off in recent years. For much of this century, we were able to increase fishery yields by increasing fishing efforts, by using new technologies, and/or by fishing for different species. But now we have reached the limit of the world's fisheries resources, and we must find ways to restore and increase the world's supply of fish. In developing countries, with continuing human population growth, the demand for fish and fish products is growing, and the limits of the world's fisheries will be most evident. Aquaculture and new technologies offer some hope for increasing yields, but they will not be sufficient to address the global fisheries crisis. We must also continue to conduct research on ocean processes and ecosystem interactions and to develop improved national and international fishery management approaches.

There are several cooperative marine fisheries programs that involve both the United States and Korea. One of these programs is the Yellow Sea Large Marine Ecosystem Project which is funded by Korea's Ministry of Science and Technology and the World Bank. Project scientists are monitoring and studying pollution and the status of fish species in the Yellow Sea.

Another U.S.-Korea cooperative research project is focusing on an area in the central Bering Sea known as the "Doughnut hole." This are is not part of any country's 200-mile exclusive economic zone, nor is it subject to management by any single country. It serves as an important habitat for pollock, which has become a valuable resource with many different markets. U.S.-Korea joint research in this region should improve our understanding of both pollock and the Bering Sea ecosystem.

Both the United States and Korea participated in the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks in August 1995. International coordination is essential to managing these high seas stocks and to reaching agreement on catch quotas and enforcement. The Conference resulted in the consensus adoption of the U.N. Fish Stocks Agreement, which will provide a framework for improved conservation and management of these stocks and reduce the likelihood of fisheries disputes among states. I am pleased that the U.S. Congress has ratified the agreement.

The United States has also been involved in the North Pacific Anadromous Fish Commission. Anadromous fish spawn in fresh water, but live much of their lives in the ocean; salmon is perhaps the best known example. We hope that Korea will join us in participating in this Commission.

Marine Technology

Ocean-going ships transport approximately 98 percent of the goods imported into the United States, and it is essential that these vessels have access to accurate nautical charts and information on currents, tides, and water levels.

The nature of nautical charting has changed dramatically over the years with advances in technology. NOAA is now using new technology to convert hard-copy nautical charts to digital form, so that the charts can be stored and revised more easily and made available to users electronically. We are working with the International Maritime Organization to develop international standards for these electronic charts.

We are also using advanced technologies to improve our surveying, hydrographic, and positioning capabilities. These new technologies include sonar- and laser-based instruments, new devices for gathering and reporting water level and wind measurements, and the Global Positioning System (GPS). GPS is based on a system of 24 satellites and can provide very accurate positioning information. The United States recently announced that within a few years, GPS capabilities that are currently available only to the national security community will be made available to the non-defense community and the private sector.

The culmination of this data collection for marine navigation is the Physical Oceanographic Real-Time System (PORTS). Through PORTS, we are providing real-time information on currents, waves, and tides to ships as they come into and leave harbors. This physical oceanographic data can improve the efficiency of the marine transportation industry; the more accurate the information on water depths at specific times, the more oil or other cargo a vessel can transport per trip. PORTS is now operating in several places in the United States, and we have been talking to other countries about the possibility of transferring the technology abroad. We know that if we can provide real-time digitized information, we can eliminate about a third of tanker accidents.

Weather and Climate Forecasting

As world populations continue to grow and as more people move to coastal regions, their vulnerability to floods, hurricanes, typhoons, and tsunamis will increase. In areas with intense coastal development, a single severe natural hazard can destroy billions of dollars worth of infrastructure and capital, in addition to causing injuries and the possible loss of life for thousands of people.

A recent study on natural hazards conducted by the Federal Emergency Management Agency (FEMA) showed that for 80 to 90 percent of the weather-related natural disasters, the most severe impacts are due to high winds (e.g., tornadoes, hurricanes, windstorms). We have succeeded in reducing the loss of life due to hazardous weather events through improved forecasts and warnings, but property losses continue to grow. In 1995, U.S. insurance companies covered billions of dollars in insured property losses. The value of insured coastal property from Maine to Florida and around to Texas is approximately $1.6 trillion—about the size of the entire U.S. Federal budget for one year. Although it is unlikely that a single storm would damage the entire eastern seaboard, it could have huge impacts on insurance company reserves. Many insurance companies have become concerned about the future viability of the insurance industry if the United States continues to sustain increasing losses. In fact, the insurance industry has become an important advocate for NOAA's efforts to improve weather and climate prediction and forecasting capabilities.

Within the U.S. Department of Commerce—NOAA's parent agency—the National Institute of Standards and Technology (NIST) also plays an important role in reducing our vulnerability to natural disasters by developing building codes and standards that are suitable for regions that sustain high winds. NIST has found that the communities that have adopted the recommended building standards have generally improved their chances of surviving big wind events.

I am pleased with the collaborative efforts between NOAA's Forecast Systems Laboratory and the Korean Meteorological Administration to improve our technical forecasting capabilities. This work has been successful to date, but we have far to go. During one monsoon event in 1995, Korea experienced severe floods, while the United States experienced both droughts and floods. It would have been useful if we could have predicted this event and the associated weather patterns weeks or months in advance.

One of the great successes of global change research over the past ten years has been our success in understanding the El Niño phenomenon and related seasonal-to-interannual climate changes. The ocean-atmosphere observation system in the tropical Pacific has been a key to providing the information we needed to understand El Niño, and Korea has contributed valuable ship-time and moorings for this system. These observations and climate forecasts have been useful in guiding public decision-making.

The benefits of improved seasonal-to-interannual forecasts to the agricultural sector alone can be immense. South America and Africa are utilizing climate forecasts to decide what crops to plant and when. In fact, the climate forecasting system has worked so well that we must take special precautions to ensure that commodities market traders do not gain access to experimental forecasts before other users.

The United States and Korea (specifically, the Korean Meteorological Research Institute and the University of Seoul) have been working with other international partners to establish an international climate research institute. This institute will facilitate the international collection and exchange of observational data, the development of improved forecasting capabilities, and the application of climate information to address societal needs.

We look forward to continued Korean participation in the various international fora that are developing global observing systems, such as the Global Ocean Observing System, the Global Climate Observing System, and the Global Terrestrial Observing System.

Budget Constraints and a New Framework for Cooperation

NOAA and its sister agencies abroad will face many opportunities and challenges in the years ahead—from sustainable fisheries management, to developing improved marine technologies, to improving weather and climate forecasts. Continued progress will require funding, and I expect that the international community will strongly support Korea's plans to double its investment in research and development (R&D). Japan also plans to double its investment in science and technology, and China is trying to do similar things.

In the United States, the current focus is on balancing the Federal budget, and we face real difficulties in increasing our own investment in R&D. It is easy to understand why it will be difficult to obtain greater funding for R&D when one considers the components of the U.S. Federal budget. In 1980, 47 percent of the U.S. Federal budget was spent on entitlement programs (e.g., Medicare, Medicaid, and Social Security). Nearly 8 percent was used to pay the interest on the national debt, and 23 percent was used to fund defense programs. Only 22 percent was available for domestic discretionary programs, including R&D. In 1997, the total budget is larger than it was in 1980, but entitlement programs consume almost 55 percent of the total and the net interest on the national debt has increased to over 14 percent. Defense spending has decreased to about 17 percent, and the percentage available for domestic discretionary programs has decreased to about 14 percent. In the coming years, the interest on the national debt and funding for defense programs are likely to remain about the same. But spending on entitlement programs will increase as the U.S. population grows and as more people enter retirement. Within the context of a balanced budget, increased entitlement spending will mean that less money will be available for discretionary programs. NOAA and other U.S. Federal science agencies must face the reality of level or declining budgets.

Given these budgetary constraints, it is clear that if we want to ensure continued scientific and technological progress, we must strengthen the partnerships among U.S. Federal agencies and between Federal agencies and the outside community, both in the United States and abroad. We are making real progress in some areas. For example, NOAA and the Department of Defense have agreed to merge their separate civilian and military weather satellite programs into a single program. This will reduce the out-year costs of developing and operating two separate systems. We have also established a new interagency effort to examine observation and prediction capabilities, the potential implementation of national and global observing systems, and the socio-economic impacts of environmental change.

International cooperation is a key to success—not just for fisheries management and weather and climate prediction—but for many areas of science and technology. The international Ocean Drilling Program (ODP) is a good example of how international cooperation makes it possible to conduct research that otherwise would not be possible. Through ODP, 19 countries are contributing to the operation of a large ocean research vessel to conduct ocean drilling, collect samples of the ocean bottom, and take a variety of scientific measurements. ODP's success is based on international cooperation, and no one country could conduct a program of this magnitude on its own.

There are many opportunities for scientific cooperation as we look into the 21st century, and that is particularly true when we consider the Pacific basin. The United States and Korea can work together in a number of exciting areas, and I look forward to our continuing partnership in the years to come.