A CONCEPT OF OPERATIONS | 2002

REMOTE SENSING

NOAA Coastal Services Center

FROM THE DIRECTOR

Dear Employees of the NOAA Coastal Services Center:

Recent technological advances are improving the relevancy of remote sensing for coastal resource managers. It is only a matter of time before this technology becomes a more commonly used tool when addressing coastal issues.

This document, a concept of operations, relays the philosophy behind the NOAA Coastal Service Center's remote sensing efforts. This philosophy was developed over time through contact with the nation's coastal managers, and with help from a blue ribbon panel convened to determine the appropriate role the Center should play in this growing field. This document is a companion piece to the Center's strategic plan, as the contents are used to direct the Center's remote sensing program.

The ultimate goal of the remote sensing program is to further the Center's mission, which is to become the most useful federal organization possible by linking the nation's coastal resource managers with the people, information, and technology they need to protect coastal resources.

In the field of remote sensing, the Center accomplishes this goal by buying down the cost, in terms of time and money, of getting the relevant applications of this technology into the hands of coastal managers. This is being accomplished as the Center's coastal remote sensing program bridges the lingering gaps between coastal resource managers, data providers, and researchers.

I look forward to working with you to achieve this goal.

Sincerely,

Margaret A. Davidson

TABLE OF CONTENTS

INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center (Center) helps support the management of a valuable geographic region—the coastal zone. This relatively fragile area is host to an increasing resident and tourist population, a large and stable contributor to the nation's economy, a unique supplier of outdoor recreation opportunities, and home to many irreplaceable natural assets. As the demands on the coastal zone increase, so do the challenges before the nation's coastal resource managers. Geospatial technology, such as geographic information systems (GIS), is playing an increasingly vital role in the coastal management process.

Remote sensing is another geospatial tool that holds tremendous promise for coastal resource managers. Technological advances and a new and growing understanding of the benefits of this powerful tool and data source are causing coastal managers to look to remote sensing for help in ways that would not have been possible in the past. This document, Remote Sensing at the NOAA Coastal Services Center: A Concept of Operations, describes the Center's philosophy and action plan for addressing the remote sensing needs of the nation's coastal resource managers.

This concept of operations seeks to accomplish three objectives:

- Provide a solid conceptual framework for the Center's remote sensing efforts;
- Document and align remote sensing activities with the Center's strategic plan;
- Document the Center's commitment to addressing emerging remote sensing opportunities for the Center's customers.

The primary audience for the concept of operations includes the following:

- Center employees;
- The Center's primary customers (the nation's coastal resource managers) and partners;
- Private sector data and service providers.

This document is written in accordance with the Center's overall strategic plan. It is a "living document" that will be modified and strengthened as the Center and its external audiences alter their course to meet the demands and opportunities before them. The primary Center program entrusted with carrying out this concept of operations is the Center's Coastal Remote Sensing (CRS) program.

SUMMARY CONCEPT AND DEFINITIONS

The Concept

The NOAA Coastal Services Center's Coastal Remote Sensing (CRS) program is a service-oriented enterprise driven by the needs of its customers—primarily state, local, and federal entities involved with managing coastal resources. CRS serves this community through a portfolio of projects that produce, support, and transfer remote sensing-based data products, technology tools, and applications to coastal managers. CRS assumes a "service" role toward its customers, or one that enables others to effectively carry out their missions. This enabling role helps the Center achieve its strategic goals, as well as those of the nation's coastal resource management community. Ultimately, CRS' success is defined by the success of its customers.

CRS assesses, tests, and validates remotely sensed data for its customers and for more general national use. CRS supports the coastal aspects of the National Spatial Data Infrastructure (NSDI) by contributing to remote sensing data product validation, protocols, metadata, and standards. The data acquired through the Center's private-sector outsourcing will serve its customers and help populate the coastal NSDI.

CRS develops two types of management applications: issue or thematic-based and software-based decision support tools. Applications and data products include research and development, testing, and delivery mechanisms tailored to meet the needs of the Center's customers. Training seminars and technical support complement CRS applications and products, which help increase the use of remote sensing-based solutions by the nation's coastal resource management community.

In order to provide continuing value to its customers and partners, CRS updates and maintains its distinctive competencies in geospatial data and technologies, applied knowledge of coastal processes, and remote sensing-based applications development. To maintain its competencies, CRS sponsors or conducts applied research that is customer centered and problem defined. CRS conducts structured assessments of the status of remote sensing technologies and relevant coastal knowledge. CRS also encourages and supports both professional and technical interaction and educational opportunities for the continuing professional development of its staff.

The foundation of CRS is its people. To provide lasting benefits to its customers, CRS' people bridge, integrate, and simplify the often-separated domains of science, technology, and management. CRS then finds the best ways to deliver ongoing results.

Working Terms and Definitions

A well-defined and consistently used vocabulary of concepts and terms is necessary for a coherent and consistent CRS effort within the Center, and also to provide the basis to communicate effectively with CRS customers and partners. All too often, key concepts and terms used within an organization lack definition. This section was positioned early in the document, rather than as an appendix, to better emphasize the need for this common vocabulary.

Applications—this term is used in at least two distinct but related ways with respect to remote sensing at the Center. Thematic or issue-based applications refer to those areas of applied remote sensing that focus on coastal issues (e.g., smart growth), coastal features (e.g., land cover, topography, etc.), or specific coastal phenomena (e.g., harmful algal blooms). "Software applications" is a term taken from computer science, which means the process of creating or adapting software tools for the specified needs of end users.

Applications Development—at the Center, the definition of this term includes both the identification and validation of specific uses of a technology, such as remote sensing, as well as the necessary tools (e.g., software) for applying the technology to coastal issues. Applications development is broadly defined here, as opposed to many software development organizations where the term frequently only equates to the development of software programs.

Applied—means put to practical use. Through close coordination with Center customers and other Center groups, CRS determines "practical use." The discipline of maintaining focus on practical use characterizes most Center functions and guides all CRS activities.

Applied Research—is investigation conducted to achieve a practical purpose and is the type of research supported at the Center. The National Science Foundation defines applied research as "research aimed at gaining the knowledge or understanding necessary to meet a specific, recognized need." Research that is supported by CRS must have a defined, specific constituency and a well-defined problem before it is undertaken. Applied research is contrasted with "basic" or theoretical research, which is aimed at illuminating or discovering fundamental principles or advancing knowledge without reference to specific applications. CRS periodically assesses the status of, but does not necessarily invest in, advancing the frontiers of scientific coastal knowledge.

Applied Technology—CRS conducts "applied" technology development—meaning putting available remote sensing and related technologies to practical use. Applied technology and innovation, which CRS undertakes, should be contrasted with technology development that seeks to create new technologies or to push the state of the technical arts. CRS tracks and assesses remote sensing-based technology developments at the Departments of Defense and Energy, NASA, and academia, for example, but does not undertake technology development itself.

Assessments—are structured and systematic evaluations of the state of remote sensing technology and the states of knowledge and understanding of relevant coastal phenomena. When these are combined with a grasp of customer problems and capabilities, CRS is able to offer a scarce resource to its customers—in the form of skilled advisors, developers, and innovators in applied remote sensing.

C-CAP—Coastal Change Analysis Program (C-CAP) refers to (1) a national effort by CRS to produce and distribute regional land cover and change data in the coastal zone, and (2) the digital

land cover (and "change analysis") data products that are developed according to the standards and specifications of the National Oceanic and Atmospheric Administration (NOAA). For more details, see Appendix 3.

Constituents—are the intended beneficiaries of CRS investments, products, processes and services. The primary constituents of CRS are state, local, and federal coastal resource managers. Terms such as "client," "customer," and "stakeholder" often are used interchangeably with the term constituents. This can sometimes lead to confusion, for there are few if any true customer transactions managed by CRS wherein a product, process, or service is provided in exchange for payment. There also are stakeholders (i.e., groups that have a stake in CRS) that are primarily congressional, NOAA, and CRS constituents, but the term "stakeholder" is better applied to private-sector corporate relationships among managers, owners, shareholders, and suppliers. Nonetheless, at the Center, the term "customer" often is used interchangeably with the term "constituent."

Data Products—"data" are considered the basic elements of information (e.g., level 1 or "unprocessed" image data). Remote sensing data products in CRS are defined as the elements of information processed and organized in ways that support reasoning and analysis, that in turn help to support customer decision making. The program's data products generally are geospatial (or "geo-referenced") in nature and have been verified, characterized, and validated. Whenever possible, CRS data products meet defined national standards. Note: the phrase "data development" is regularly used at the Center to mean the process of transforming raw, or unprocessed, data into a more usable, value-added form of data, such as the process of creating land cover "data" from raw satellite imagery. This is noted here because the term "development" has different connotations in different professional circles (see "development" below).

Decision Support—most CRS and Center outputs are designed to support management decisions and take several forms, including data products, technology demonstrations, and software application tools and CD-ROMs. Decision support should be understood broadly to include any routine, reliable way to support customer decision processes. More formally, decision-support tools can be defined as any computer-based, interactive system intended to help managers retrieve, summarize, and analyze decision-relevant data.

Development—(as in Research & Development) is the systematic use of knowledge or understanding in the production of useful materials, devices, systems, or methods, including prototypes and processes. CRS developments often are combined with demonstrations to test results in operational settings with customers and potential operational suppliers.

Geospatial Technologies—"geospatial" means earth-located. Geospatial technologies include any technology and associated methods that are used to acquire, process, analyze, use, or display geospatial data and data products.

National Spatial Data Infrastructure (NSDI)—is defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and nonprofit sectors, and the academic community. NSDI is envisioned as a way of enhancing the accessibility, communication, and use of geospatial data to support a wide variety of decisions. The basic goals of the NSDI are to reduce redundancy and costs in geospatial data creation and

maintenance, improve access to geospatial data, and improve the accuracy of geospatial data used by the broader community.

Outsource—means to contract outside the organization for an item, in contrast to producing it internally. "Outsource" has a particular meaning in CRS, namely the specification, negotiation of terms and conditions, quality assurance, and release of data products produced by the private sector for use by CRS customers, the NSDI, and the general public. Transitioning certain mature CRS products or processes to another entity for routine delivery to customers also falls under the broader definition of this term. An example may be transitioning or transferring the services associated with archiving and delivering very large amounts of LIDAR data (i.e., the Center's LIDAR Data And Retrieval Tool—LDART) to another, more suitable organization.

Partnership—is defined as a documented relationship with one or more collaborators and/or customers that employs a mutual agreement and specific commitments for action among these participants toward a defined purpose.

Project—is the basic unit of budgeted work within the program, which range in type from highly structured data product activities with an established heritage (e.g., land cover analysis) to thematic applications such as harmful algal bloom forecasting.

Protocol—a formal method or widely accepted customary procedure that if followed yields consistent, reliable, and measurable results.

Remote Sensing—is in the name of the program and thus is defined to reflect the roles and competencies of CRS. A generic definition is drawn from engineering and image analysis practice where remote sensing is "the acquisition and analysis of data about objects from sensing equipment from stations or platforms physically remote from such objects." CRS primarily employs data and information derived from remote sensing of the Earth (including both land and water bodies) from all types of platforms with the aim of enabling improved coastal decision support. The distinctive remote sensing competencies of CRS include the analysis and technical translation of customer requirements, assessments and integration of the state of remote sensing practice, thematic coastal applications development, and software applications to achieve reliability, utility, and simplicity.

Standards—are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions to ensure that materials, products, processes, or services are fit for their intended purposes.

Validation—in the general sense, involves laboratory or field methods and procedures to check remotely sensed data and products for conformance with specifications or performance standards. Applications validation specifically refers to the laboratory and/or field evaluation to determine if a remote sensing method meets the requirements of a specific application.

Verification—is the act of measuring the results of an operation to determine whether it has been completed as designed (as in the send-receive verification of telecommunications). Verification also refers to the process of proving quantitatively that a system's outputs meet its formal requirements. Sensor verification entails calibration, transformation, and other measurement disciplines.

STRATEGIC GUIDANCE

The Vision: A Fully Enabled Coastal Community

A fully enabled coastal resource management community is national in scope, yet has the tools and information needed to resolve coastal issues at the local level. From a remote sensing perspective, an enabled community is able to accurately characterize, measure, understand, monitor, visualize, and manage coastal resources and the man-made environment. By doing so, the nation's coastal management issues will be addressed.

The coastal management community includes customers from the natural resource management and environmental communities, elected officials, nonprofit organizations, and relevant sectors of private industry (insurance underwriters, real estate developers, etc.). The coastal remote sensing program helps this community gain access to and gain the ability and confidence to employ remote sensing-based knowledge, information, and technology. Consistent with the Center's strategic plan, coastal remote sensing efforts will help advance smart growth principles, which include the protection of a community's economic, historical, and natural resources.

As the coastal remote sensing program helps its customers move toward an enabled coastal management community, it is helpful to refer to a progression of support capabilities that roughly represent the past state of remote sensing applications, current conditions, and the visionary use of remote sensing in the future.

Remote sensing yesterday—a basic remote sensing characteristic is the ability to capture what has happened. This includes the ability to inventory, characterize, visualize, and measure the extent, nature, and uses of coastal resources. Typical outputs of retrospective remote sensing applications include the creation of annual or biennial data products (digital), reports, or archives on such things as water resources, coastal wetlands, and recreational uses. Historical databases of coastal resources and their uses provide meaningful information that can be used to create baselines against which change may be researched, described, or computed.

Inventories were a major application of remote sensing early on and remain an important contribution of the technologies. Inventories were based in part on what remote sensing technically "could do." However, it sometimes was sold as a solution to resource management and operations. The disappointing realities of what remote sensing-based technologies actually delivered, together with their costs and complexity, disappointed many customers and may have set back the acceptance of remote sensing. Acceptance of the value of remote sensing baselines today, for example in disaster preparedness, has come a long way toward reinstating remote sensing as an important part of decision-support systems.

Remote sensing today—the ability to capture what is happening is a common component in some aspects of remote sensing today. Remote sensing is used to monitor, characterize, measure, and respond to recent or current conditions and events. This aspect focuses on the timeliness of remote sensing-based acquisition and delivery and on the speed of transformation from "raw" image to decision-support information. In many instances the utility of current information is dependent on the availability of inventories and baselines for determining changes or trends.

Considerable attention has been given over the past decade to overcoming the limitations of satellite-based observations for current management purposes. This in turn focuses attention on integrating multi-platform and multi-source inputs into decision support. Significant progress was

made during the 1990s in the speed and relative ease of transforming and linking remote sensing sources to other sources of management information. An example would be disaster readiness applications.

As delivery and processing hurdles are reduced, customers exhibit greater interest in higher resolution baselines and the delivery of current products. Much of this progress from data to decision support is associated with progress in GIS and software applications. CRS has contributed to this trend by training the community; connecting customers with service providers that can effectively produce timely, accurate data and information in a repeatable, standard way; and helping to find funding mechanisms to support customer adoption of remote sensing-based applications.

Remote sensing tomorrow—the use of remote sensing will eventually help give coastal resource managers the ability to determine why events or impacts are happening, and the ability to associate, correlate, or measure cause and effect among activities, resources, and outcomes. This is a demanding area of synthesis where scientific/engineering knowledge, remote sensing-based technology, and applications intersect. It is an area where enabling practitioners, such as those at CRS, are asked to balance the needs of their customers (where a step toward better correlation is a breakthrough) with the ideal world of scientific proof. This is an area that benefits from the results of previous efforts, and may benefit from carefully crafted CRS-sponsored applied research. Contributing to causal understanding and measuring correlations appears to be a step where scientific and technical partnerships are especially suited to the CRS concept of operations.

The foreseeable future—the ability to predict or forecast with reliability what will happen given a reasonable understanding of what has happened, what is happening, and why something is happening, is a real possibility. Improving the capability of projecting or forecasting outcomes is a long-term goal for CRS and the community it serves. Customers will welcome any sound improvement in this area. This is the domain of modeling, estimation, and continuing research and development.

CRS customers have made significant but not uniform or nationwide progress in this arena. Much CRS effort is directed, as it should be, toward refining and expanding data products (e.g., coastal NSDI) and applications that support nationwide understanding of the past and present and detect the changes that may constitute trends. These core functions of CRS must be accompanied by significant capacity building among its customers if the effort is to be sustainable and successful.

At the same time, the Center strategy sets an enterprise course toward the integration of coastal factors and issues (i.e., causes and effects) that, for example, are necessary to promote “smart” coastal growth. The Center strategic plan also makes helping coastal managers cope with natural and human-induced hazards a primary priority. Both of these Center strategies imply that CRS must contribute to pushing the applied state of the practice toward improved cause-effect understanding and predictive approaches and tools.

CRS should carefully identify opportunities to advance the state of customer decision support. This concept implies that CRS must set aside resources to expand its relationships and potential partnerships with knowledge providers in applied research, with emerging technologists (public and private), and with decision-support innovators (e.g., hazard modelers). Expanded relationships among these interests are needed to move toward a fully enabled coastal community.

Challenges

As a customer-driven enterprise, all CRS activities must trace back to customer needs and priorities. Therefore, it is fitting for this section to begin with some of the generic challenges that stand between remote sensing-based capabilities and a coastal community fully enabled with the technology.

Awareness—Center conferences and surveys reveal that many coastal practitioners and, proportionately, many more policy makers remain unaware of contemporary remote sensing capabilities. CRS experience shows that remote sensing technologies themselves evoke little interest in customers unless they are intertwined with relevant coastal knowledge, practice, and priorities. Effective communication of germane remote sensing capabilities (both public and private sector), demonstrated relevance to important coastal resources and issues, and information about affordability are major aspects of remote sensing that must be addressed.

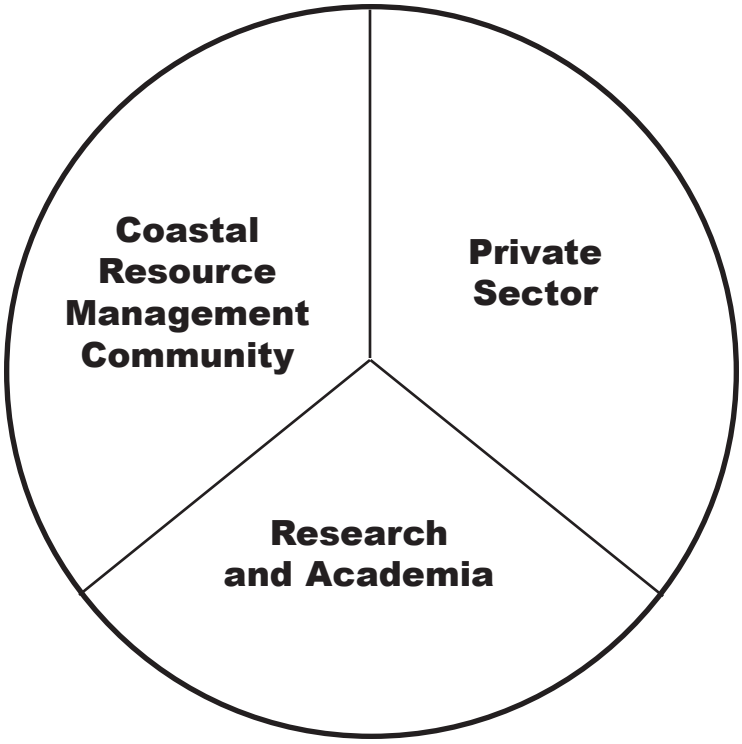
Understanding—remote sensing has its roots in "high technology," particularly national security, a use that constrained the development of practical user requirements and responses for the coastal management community. This genesis also resulted in many years of restrictions on satellite observations, resulting in slow evolution of high-resolution civil systems. For the coastal resource management community, remote sensing continues to be a relatively new data resource. There is frequently little time or budget available to commit to this technology. An opportunity presents itself in supporting the needs of this community by developing understanding through effectively and objectively straddling the scientific and technical realms, the public and private sectors, and the coastal community. Private sector firms can also benefit from CRS information and training activities and should be included in plans to further "community" understanding.

Reliability and simplicity—remote sensing products and services still lag behind standard mapping and engineering in regard to supply reliability, product standards, and use in decision-support systems. In the past, false expectations of what remote sensing could and could not provide, in addition to the timeliness (or "currentness") of products, may have contributed to a lack of confidence or perception of unreliability. As a result, remote sensing products and processes generally are not incorporated into routine operational decision making (weather reporting and forecasting being a major exception). The reliability of remote sensing supply is in flux, but signs show that reliable supplies of higher resolution data products will increase. Regardless of recent gains, insufficient reliability, simplicity, and standards remain major hurdles to widespread operational adoption of remote sensing capabilities.

Affordability, costs, and benefits—affordability of remote sensing data products and applications continues to be a major hurdle. The potential of competitive pricing to reduce costs has yet to be realized. The imbalance between potential remote sensing uses and customer remote sensing budgets is likely to remain significant until more and better efforts are mounted to demonstrate and measure remote sensing benefits versus costs. This is an area of underinvestment that shows a need for innovation on the part of applications development programs.

Implementing the Vision

It is only through partnerships between the end users, data providers in the public and private sectors, and the research community that the previously noted challenges can be addressed. CRS is working to become the linchpin in this effort. In this role, the CRS challenge is to relate, leverage, and channel the research, technology, and information capabilities of agencies and other organizations to enable the coastal community. Operating in this capacity is challenging because CRS must understand each community, the driving forces behind them, and the changes that are constantly occurring in each community. The key ways by which such energies and interests can be engaged is through partnerships (both internal and external to the Center) that truly share accomplishments, as well as risks—and "give" results to users.



EXTERNAL PARTNERSHIPS

CRS' external partners can be categorized generally into three separate communities. It is important to note that these communities don't necessarily operate mutually exclusively from one another, but for the purposes of this concept of operations, they will be described separately.

Coastal Resource Management Community—the End-Users

The end-user community consists of those individuals and agencies that are given the authority to decide how natural resources are managed and maintained within the coastal zone. This community uses remote sensing to support the day-to-day decisions that impact the natural environment and quality of life along the coast. They have a need to implement methods that work—methods that have been tried and tested. They have limited resources for research and development, and usually have limited time. They strive to make effective decisions in a timely fashion that maintain a well-managed coastal zone.

Private Sector—the Providers

The private sector consists of companies and corporations that provide products and services. They develop (supply) and market operational technologies, research capabilities, and technology innovation to various market sectors. They look for new markets to exploit products and services, and strive to reduce cost, increase efficiency, and maintain quality.

Research and Academic Community—the Discoverers

The research and academic community largely consists of academic institutions (i.e., universities, colleges, etc.), portions of federal agencies (i.e., NASA, NOAA, U.S. Geological Survey, Environmental Protection Agency, etc.), and nongovernmental organizations (NGOs). This community explores data, technologies, and applications. They indirectly support natural resource decision making through basic and applied research, but may not be aware of coastal management needs. They

strive to understand or discover physical, chemical, and technological processes and how they relate to each other.

INTERNAL PARTNERSHIPS

The Center's strategic plan (2001) provides the essential framework for the CRS concept of operations. The Center's mission is "to support the environmental, social, and economic well being of the coast by linking people, information, and technology." A CRS or remote sensing strategy does not appear in the strategic plan. The important message CRS draws from this is that remote sensing in and of itself is not a strategy; the CRS strategy is serving the Center's mission through remote sensing-based services.

The Center's driving concept of "linking people, information, and technology" can be thought of in the CRS context as "linking coastal resource managers and partners to relevant remote sensing tools, data, and information."

A good conceptual fit exists between the Center mission and the CRS program. CRS provides the following specific contributions to the Center mission:

- Data products, including validation and demonstration
- Applications development and demonstration
- Support services and training
- Applied research and technology

Comparison of a few specific examples of the Center's operating principles and themes with CRS' four major areas of Center contribution reveals the following complementary relationships:

• CRS data products, especially those that move from development to validation and demonstration to the coastal NSDI, provide "common linkages" among the social, economic, and environmental issues in the nation's coastal region.

• Many CRS applications are "local in approach, but national in scope" because the spatial ranges and coverage of remote sensing technology lend themselves to common methods and digital products that support diverse local and regional applications and, at the same time, are amenable to nationwide adoption.

• CRS support services and training provide states and localities the know-how and skills to realize the benefits of remote sensing products and applications—CRS designs its advisory and training delivery to these practical needs.

• CRS applied research and technology allow it to provide objective and competent advisory services to its Center colleagues and to its customers. As issues such as homeland security, climate change, and ocean observations emerge to policy and practical importance, CRS' applied research and technology expertise will increase in importance, too.

The matrix on the next page links and compares the 2001 CRS project portfolio and the five strategic themes of the Center. CRS projects are assigned either a primary (P) or secondary (S) link to the Center's strategic themes. In the case of CRS projects currently being defined, an asterisk is assigned noting a provisional theme linkage. As a further aid to understanding this matrix of relationships, a brief description of the Center themes is outlined on next page.

	I. Smart Coastal Growth	II. Habitat	III. Hazards	IV. Coastal NSDI	V. Organization and Culture
Benthic Mapping		P		S	
Estuarine Habitat	*S	P			
Harmful Algal Bloom Forecasting		S	P		
Impervious Surfaces	P	*S			
Land Cover Analysis		S		P	
Outsourcing				P	*S
Remote Sensing Applications				P	
Remote Sensing Outreach / Training				P	*S
Topographic Change Mapping			S	P	
Visualizing Coastal Growth	P				

Strategic Theme I:
Smart Coastal Growth
Smart coastal growth focuses Center results on supporting an informed balance among coastal environmental, social, economic, and quality of life issues.

Strategic Theme II: Habitat
The habitat theme involves information and tools to characterize the coastal environments wherein plants, animals, and other organisms live.

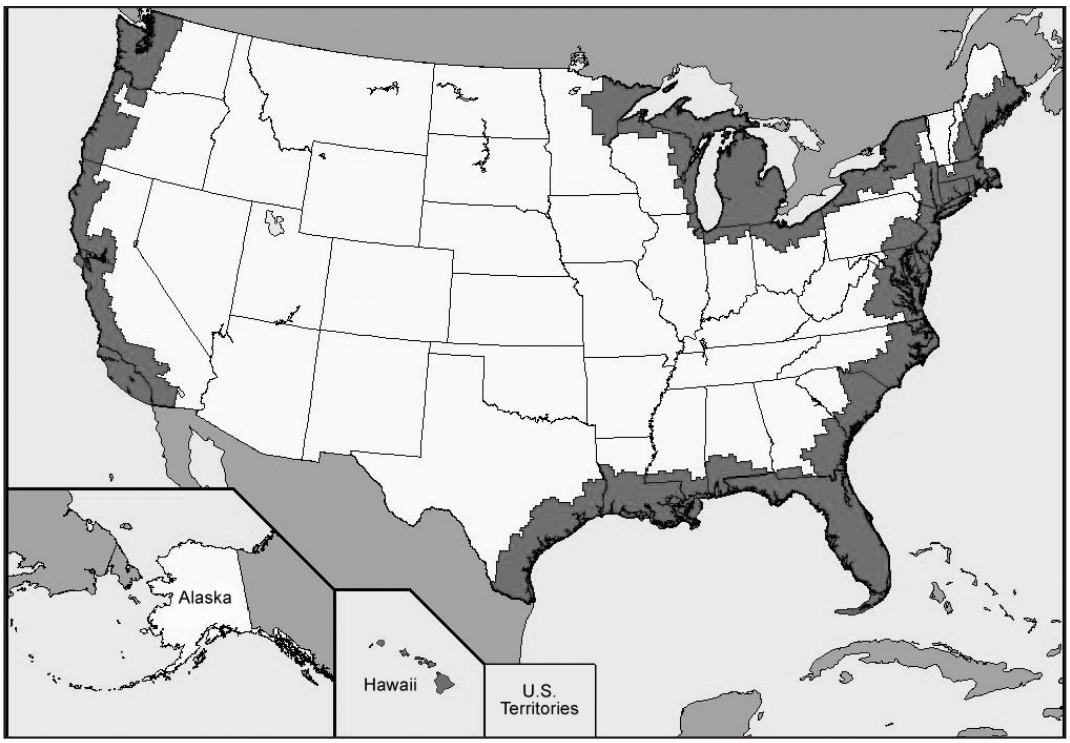
Strategic Theme III: Hazards
The hazards theme seeks to reduce the adverse impacts of natural and man-made hazards that threaten the health of coastal ecosystems and safety of communities.

Strategic Theme IV: Coastal NSDI
The coastal NSDI theme supports the development and implementation of the NSDI for coastal and marine management, including especially national framework data/products.

Strategic Theme V:
Organization and Culture
The organization and culture theme is inwardly focused on Center capabilities to serve the changing needs and priorities of its customers and thus to advance coastal resource management nationwide, at the same time that it provides an innovative, challenging, and rewarding work environment for CRS people and partners.

OPERATIONS GUIDANCE

Our Constituency



United States Coastal Regions

This section of the concept of operations moves from "concept" to "operations" and from Center-level matters to program-level matters. The section shifts attention from the more abstract to the particular and from what CRS is about to how it is expected to operate. The following section seeks to clarify, communicate, and guide the more day-to-day life of the program and its employees.

The primary customers from which requirements have been drawn and results should be focused include state and local governments, federal counterparts, and nongovernmental organizations (NGOs) within the coastal zone of the United States and its territories. Typical examples of this constituency include the following:

- Coastal management programs
- Coastal natural resource agencies
- Regulatory agencies
- Protected area programs
- Emergency management agencies
- Sea Grant and related coastal extension services

Although the geographic extent of where the Center works will remain flexible, it is important to outline the criteria used to define the boundaries of Center efforts. The inland extent is primarily based on three components: (1) the coastal zone as defined by the Coastal Zone Management Act, as amended; (2) the estuarine drainage areas as defined by NOAA (and based on watersheds defined by the U.S. Geological Survey—USGS); and (3) the inland boundaries of the coastal counties. The diagram on this page illustrates the synthesis of these three components. The seaward extent of interest generally is defined by the 3-mile jurisdictional boundaries, although some Center and CRS projects have extended into the nation's maritime exclusive economic zone (EEZ). The CRS geographic extent of interest and its constituency mirrors the Center's.

The People of the Coastal Remote Sensing Program

By design, CRS employees embody a diverse set of technical skills and educational backgrounds, including computer science, ecology, environmental studies, geography, GIS, marine biology, meteorology, oceanography, policy, remote sensing, resource management, and more. In addition to technical proficiency, the employees must be well versed in the needs of the coastal management community, for these two banks of knowledge are equally valued in this customer service organization. This blend of diverse backgrounds, all focused on customer needs and on the coastal applications of remote sensing, provides a unique opportunity for effectively implementing the vision of an enabled coastal community.

One of the primary roles of the coastal remote sensing program is that of an interpreter. Many in the coastal management community do not have the expertise or the time to understand the underlying details associated with remote sensing. Filling in this gap is one of the most important roles of CRS. The staff must not only be technically proficient, but also must be able to transfer this knowledge to the coastal management community. Remote sensing employees must help coastal managers find effective uses of remote sensing data, and work to ensure that the data and information are in a form that is readily accessible and useable for this community. Another part of the mission is the relationship between the remote sensing program, the private sector, and academia. Employees work with this community to help them design and deliver the products coastal managers need.

Roles and Expectations

WORKING WITHIN THE CENTER
One of the reoccurring themes at the Center is the importance of partnerships, both externally and internally. Very rarely is an issue resolved because of one organization or one discipline. Most issues are too complex for that. The Center values the team approach, and the coastal remote sensing program is a team member for many Center projects where the lead is outside of the remote sensing program and vice versa.

Some of the basic components of Center teamwork include

- having an understanding of the Center strategy—know what the rest of the Center does
- performing all work according to the Center's goals and objectives, as outlined in the Center's strategic plan
- organizing and planning projects by interacting closely with other members of the Center, including sharing of information on the broad base of customer requirements
- seeking to integrate CRS with other Center projects and provide proactive assistance
- conducting business primarily through teamwork, using collaborative approaches—this means that the members of a project team develop and accomplish project goals and objectives together. Achieving the goals and objectives of a particular project will be the responsibility of the team.
- communicating and sharing ideas within the program and throughout the Center
- embracing change and the need to adapt work. Adapting to change is one of the few things that will remain a constant.

As the Center leaders in remote sensing technology and remote sensing-based applications, CRS employees

- act as proactive, in-house remote sensing resources and advisors to Center projects by offering assistance as a regular part of doing business
- provide expertise within the larger NOAA community on coastal resource applications, both thematic and software
- keep abreast of customer needs and opportunities to work with them
- keep abreast of commercial technology and opportunities through the use of focus groups and other means that explore technical and market needs
- help bridge the gap between terrestrial and oceanographic remote sensing (and their communities) by identifying the synergies and challenges of both disciplines
- embrace emerging technologies and applications and transfer to others those results that have achieved operational readiness
- participate in multiagency initiatives to increase the effective use of resources and to help shape these initiatives to serve Center customers. Examples of such initiatives are the National Spatial Data Infrastructure (NSDI), the USGS National Map, the Multi-Resolution Land Characteristics

consortium (MRLC), the National Digital Elevation Program (NDEP), the Gulf of Mexico Program's Harmful Algal Blooms Observing System (HABSOS), the Joint Agency Commercial Imagery Evaluation (JACIE) team, and NASA's Program Planning and Assessment activity.

PROMOTING THE CUSTOMER FOCUS

CRS employees are customer centered, focused on results, and committed to partnerships. A key criterion of employee and program success is the usefulness and adoption of results by customers. Program leadership will increase its reliance on customer evaluations and eliciting of customer requirements in program planning and metrics. End-user relevance is the litmus test for all program efforts.

The ability to anticipate and accept change is an important part of a customer-focused organization. As CRS defines, develops, and delivers high-quality data products, applications, and services in this environment, the definition of project transition or completion points becomes more and more important. For example, the Center is committed to producing a national coastal land cover/change baseline in the next three years. Completing this nationwide baseline without delay, while simultaneously developing specific applications of these data products, is a program and Center commitment. While this effort is under way, CRS employees must be prepared to respond to changing customer demands, changes in government satellite policy, the potential for private-sector partnerships, the coastal NSDI, and potential technical challenges.

An important but often overlooked role of CRS on behalf of its customers is its ability to separate the remote sensing "chaff" from the "wheat." CRS must objectively and skillfully discern what is technically relevant and useful for the coastal management community, from what may simply be interesting, unusual, or "glitzy." This objective technical advisory role entails the ability to provide Internet-distributed or direct consultation support to customers and to help connect customers with private-sector data, tools, and services. This is accomplished as CRS employees

- work with customers to identify, validate, document, trace, and manage the process of changing requirements
- seek solutions to customer issues and problems through a thorough understanding of what others are doing and through partnerships and linkages
- provide technical remote sensing expertise to the customers and to the Center
- provide technical assistance tailored to specific needs, both internally and externally (e.g., recent efforts to help the National Estuarine Research Reserves develop a nationwide plan for habitat mapping)

Another vital role and significant challenge for CRS is making remote sensing more easily understandable to the user community. As enablers or facilitators, CRS contributes to the "link" articulated for the Center in the organization's mission statement, "linking people, information, and technology." From the CRS program perspective, linkage is achieved when the employees

- understand the CRS constituency (their needs and requirements, their setting, their level of skill, limitations, and so on)
- enable the coastal resource management community to effectively use remote sensing data, information, and technology, through

demonstrations, partnerships, and capacity building

• provide tailored technology training to customers (integrated with other Center program training areas such as GIS, metadata, etc.)

• develop applications and demonstrate the uses of remote sensing, taking user needs directly into account

• develop software application tools to better exploit data and information for coastal applications

• provide a "reality check" on the potentials and limitations of remote sensing and of the relationships of remote sensing to other enabling technologies

One of CRS' greatest contributions to the coastal resource management community is providing access to spatial data derived from remote sensing technology. CRS will continue to meet this need by ensuring that these data products are easily accessible and understandable. As data providers, the remote sensing team must

• understand the ways in which customers currently use and interpret spatial data

• understand the strengths and limitations of selected current products, processes, and service offerings of government and the remote sensing industry

• pursue the best value for the government by outsourcing defined coastal data products to private industry

• develop strong working relationships with citizens and industry, including market development ideas that inform industry of coastal management needs and help link industry to the coastal community

PROVIDING TECHNOLOGY ASSESSMENT AND VALIDATION

An important role of CRS is to be alert and knowledgeable concerning emerging technologies and to understand these technologies as they unfold. Close attention must be paid to technologies that have reasonable promise of being adopted by the customers. As providers of technology assessments and validation, it is expected that CRS employees engage in assessments of customer-relevant remote sensing technologies, to include

detailed assessments of the promising applications of coastal data, rather than in-depth studies of specific sensors airborne and satellite sensors, especially for their potential to be used in operational "mapping" applications rigorous evaluation of performance characteristics, but this should be pursued in partnership with organizations better suited to analyze these aspects experimental sensors, only for the purposes of gaining awareness. Little time will be spent assessing those sensors that have a known life expectancy and are planned for experimental purposes only. Priorities will be based on direct application to coastal management and on the feasibility of getting these sensors' data and derived products into the hands of the coastal community.

APPLIED RESEARCH

Primarily through partnerships, CRS will conduct limited applied research to determine which technologies have direct application to coastal management. CRS' role will be primarily supportive rather than a lead role. Participation in

partnerships similar to the Joint Agency Commercial Imagery Evaluation (JACIE) team will be pursued. Specific to applied research (which goes hand in hand with assessment and validation), CRS will

• develop understanding of the state of knowledge in areas of high priority customer interest; this understanding will be derived from both disciplinary expertise and by participating in or conducting relevant science assessments.

• Formulate and carry out, or contract with experts to conduct, tightly focused research, the results of which will make a positive practical difference to customers

• Identify specific customer advocacy prior to embarking on an applied research project, for example, a coastal resource management organization with an identified issue and a reasonable likelihood of adopting the results or outcomes of such applied research

WORKING WITH THE PRIVATE SECTOR

CRS works with the private sector to obtain data products and services for customers. The role of CRS in outsourcing is to define, acquire, and demonstrate the technical and performance characteristics of these data products (e.g., land cover, digital elevation models). CRS specifications are used as a basis to outsource data production through competitive solicitation of service and product providers. CRS then provides contractual, technical, and quality assurance oversight for the outsourced production on behalf of the coastal management community. The resulting data are then ultimately incorporated into the NSDI by working closely with the coastal community to access and effectively use these data products for decision support.

Consistent with Center guidance to continue beneficial private-sector partnerships, new CRS roles will continue to be explored and developed. As partners with private industry, CRS will follow these guidelines.

Develop positive and mutually beneficial relationships with private-sector suppliers and users:

- Invite dialogue on issues and interests
- Clarify interests and issues
- Identify and clarify Center needs and expectations
- Respond quickly and consistently to inquiries
- Create an environment of trust

Develop understanding of private-sector interests and practices:

- Understand key products, processes, and services
- Understand federal policies (e.g., licensing and contracting)
- Conduct product and service validations (e.g., the work of the Joint Agency Commercial Imagery Evaluation (JACIE) team) when appropriate

Develop constructive working relationships:

- Share customer needs, requirements, and standards
- Increase efforts to inform and educate private firms about program and Center plans and results
- Identify and communicate inherently governmental functions

- Identify likely transfers of government data products, processes, and services
- Develop an outsourcing policy and guide

The Center also contributes to public-private partnerships by employing on-site contractors who share the Center's vision, mission, and goals. The role of the private sector at the Center is to support project activities as full members of the team. Through a very explicit process, the on-site contractor team develops project implementation plans (PIPs) based on the documented needs and objectives of NOAA. As projects are carried out by the contractor team, these plans are used by NOAA and the contractor throughout the fiscal year to track progress and deliverables. These technical contributions of the private sector are paramount to the success of the Center, and this positive relationship helps demonstrate how effective government-private partnerships can work. More than half of the CRS program consists of on-site contractor employees.

CRS Project Selection and Life Cycle

The concept of a "balanced portfolio" of projects reflects CRS' response to the Center's broadly charted mission. Some CRS projects focus directly on needs identified by state and local customers; some projects help other NOAA offices serve the coastal management community; and some projects explore emerging issues and technologies expected to become important over the long term. As CRS matures, this balance of projects will adjust to stay in alignment with the Center's strategic theme areas.

The process of determining which projects to pursue within CRS employs the concept of integrated approaches to project planning and execution. Strong intra-Center coordination must take place early in the process. To create balance, consideration must be given to a number of factors:

- Customer goals and needs
- Center goals and objectives
- Strengths and limitations of the Center and its employees
- The balance between mature projects and developmental projects

During project planning, important questions must also be considered, such as the following:

- What is the status of work in this region—are there other similar efforts being conducted?
- Have interested and qualified people been consulted and coordinated with here at the Center?
- Does relevant expertise exist within NOAA or elsewhere?
- Will the results of this project be affordable?
- Who are the potential partners in this project?

The Center's management information system (MIS), the on-site contractor's project implementation plans (PIPs), and the Center's annual operating plan are the mechanisms that track timelines and define specific goals, objectives, and outcomes. It is expected that these tools will continue to be used to articulate detailed aspects and expected results of the project, but also to logically constrain the project to deliberate and timely schedules. Delivering on commitments in a timely manner is a fundamental aspect of the Center.

Since CRS is committed to timely delivery of products and services, there will be times when even the best conceived projects fail to produce results—for a variety of reasons. In these cases, terminating a project and documenting the reasons for its conclusion are truly in the program's highest interest. There will be no penalties associated with projects that are terminated for cause; in fact, there will be positive acknowledgements of management performance, and documented feedback and learning that will reduce the risk for future endeavors.

An important part of project delivery includes the implementation plan, for it is in the Center and its customers' best interest for the product to receive as much customer exposure as possible. Proper conclusion to a project, though, is as important as its initiation. Finalizing and wrapping up projects must involve documented metrics and "lessons learned." The reactions of partners and customers must be captured as part of this documentation. The elements of finishing also include product evaluations, packaging, metadata, partner meetings, and plans to sustain the results. Frequently, the final ten percent of a project is given little to no attention, but within the Center's philosophy is considered a critical part of the CRS "deliverable." It is expected that with every project these completion elements be considered, planned for, and executed.

The Future

This section outlines three primary initiatives to be developed and implemented in the fiscal year (FY) 2002-2004 time frame.

1. The first initiative is to systematically identify and document the emerging remote sensing needs/ requirements, technologies, and priorities that will best serve CRS customers. This initiative will involve an assessment of the Center's 2002 Coastal Resource Management Customer Survey and closer alignment of the FY 2003 CRS program and projects to the Center's strategic theme areas, in particular habitat, smart coastal growth, hazards, and ocean observations. It will involve conducting formal assessments of emerging remote sensing-based technologies and selected areas of applications development. It will involve further clarification of options to strengthen CRS relationships with the private sector for future project implementation. The preliminary results of this process will be presented and discussed at GeoTools 2003.

2. The second initiative is to develop a plan and process for the effective distribution of mature CRS products, processes, and services to sustaining providers, such as other NOAA offices and federal, state, or local agencies. Candidates for such transition include long-range trend analyses associated with Coastal Change Analysis Program (C-CAP) land cover data sets, the LDART topographic LIDAR database function, and certain aspects of the harmful algal bloom forecasting (HABF) function. Transition of the responsibility for the product or process is a fundamental "enabling" concept. However, CRS, as experts with these functions, must continue to work (or stay at "the table") with these organizations as they transition to "maintainers" of such functions.

3. The third initiative is to improve the understanding and measurement of the values and benefits of remote sensing-based applications in general, and CRS results specifically. CRS will also seek to improve its project performance metrics and its means of eliciting customer feedback on CRS outputs. These evaluation challenges require CRS to link effectively to outside sources that specialize in outcome measurement, including benefit/cost analysis of applied remote sensing. In particular, the private sector may provide unique contributions to this task. These investigations will push CRS to adopt new concepts of operation, relationships, and partnerships.

Appendix 1

PRODUCTS AND SERVICES

Recent examples of remote sensing-based products developed by the Center and its partners

Spatial Data Products
- Coastal land cover / change
- Coastal topography
- Benthic habitat / cover

Demonstration CD-ROM Products
- Using Remote Sensing to Address Coastal Management Issue—The Maine Project
- Submerged Aquatic Vegetation—Data Development and Applied Uses
- South Carolina's Coast—A Remote Sensing Perspective
- Topographic LIDAR: An Emerging Beach Management Tool—The Northwest Project
- Topographic LIDAR: Exploring the Cape Hatteras National Seashore

Methods and Protocols
- NOAA's Coastal Change Analysis Program, Guidance for Regional Implementation
- Benthic Habitat Mapping, An Aerial Photographic Approach

Decision Support Tools
- C-CAP Data Handler—for assessing coastal land cover changes (ArcView extension)
- C-CAP Legend Handler—for viewing coastal land cover changes (ArcView extension)
- Chart Viewer—for viewing digital NOAA nautical charts (ArcGIS extension)
- Dune Hazard Assessment Tool (DHAT)—for assessing the hazard potential of beach property (ArcView extension)
- HAB Bulletin System—for tracking the extent and direction of harmful algal blooms
- Impervious Surface Analysis Tool (ISAT)—for estimating percent-impervious cover
- LIDAR Data Handler—for assessing coastal beach topography changes (ArcView extension)

Outreach
- Technical remote sensing support and guidance to all Center customers
- Web-based tools and information on remote sensing
  - Internet map accessibility to spatial data
  - Demonstration of coastal land cover changes
  - Frequently asked questions (FAQs)
  - Appropriate uses of remote sensing
- One-pagers on coastal applications of remote sensing
- Image maps and posters
  - The Main Hawaiian Islands—A View from Space
  - A Satellite View of Hurricanes

Training Seminars and Courses
- Introduction to Remote Sensing (2 hour seminar)
- Remote Sensing for Geospatial Analysts (2 day course)
- Supplemental training modules to standard 3-Day ArcView course
  - Coastwatch training module
  - LIDAR training module
  - C-CAP training module

Applied Research
Examples of current applied research projects
- Forecasting of harmful algal bloom events
- Determining impervious surfaces from C-CAP land cover data
- Evaluation of airborne sensors for use in estuarine water quality measurements
- Evaluation of airborne multispectral cameras (digital) for use in terrestrial and benthic mapping applications (e.g., mapping land cover, oyster reefs, submerged aquatic vegetation)

Appendix 2

1999 CUSTOMER SURVEY

Sample results

The Center's triennial Coastal Resource Management Customer Survey serves as a mechanism for determining whether the Center's products and services are meeting the needs of the Center's constituency. Examples of the 1999 survey results are provided here to help illustrate information that CRS uses to plan projects that meet the needs of the coastal resource management community. This survey had a 70% response rate (270 surveys were distributed). For more information on the Center's triennial survey, see www.csc.noaa.gov/survey/.

1. Special purpose software used by survey respondents' office

GIS	= 91%
Database management systems	= 65%
Remote Sensing*	= 42%
Visualization	= 36%
Environmental process modeling	= 33%
Computer-aided design	= 26%
Decision support / decision analysis	= 10%

**19 % of respondents use ERDAS IMAGINE, 10 % use ESRI's Image Analysis for remote sensing purposes.*

2. Level of expertise in GIS in the coastal community

None	= 14%
Beginning	= 42%
Intermediate	= 44%
Advanced	= 33%

3. Level of expertise in remote sensing in the coastal community

None	= 47%
Beginning	= 24%
Intermediate	= 22%
Advanced	= 9%

4. Nearly 40% of the offices surveyed have one to two staff trained in remote sensing software use. Nearly 30% of the respondents have staff members who regularly use remote sensing software.

5. Current number of staff members (respondents) with formal remote sensing training

0	= 47%
1-2	= 34%
3-5	= 12%
6-10	= 0
Over 10	= 1

6. Number of staff who use remote sensing regularly

0	= 59%
1-2	= 27%
2-5	= 9%
6-10	= 1%
Over 10	= 0%

7. External sources of GIS / remote sensing expertise

No access	= 13%
State remote sensing / GIS coord. council	= 9%
Partnership with other agency	= 18%
Academic institutions	= 22%
Private sector	= 9%
Non-government	= 3%

8. Top coastal application priorities

Habitat mapping	= 48%
Habitat status and health	= 39%
Watershed management planning	= 38%
Protected area management	= 37%
Habitat restoration	= 30%
Protected or endangered species	= 29%
Surface waters	= 26%
Fish and shellfish stocks	= 26%
Land use or changes in land use	= 25%
Coastal erosion or accretion	= 23%

9. Top coastal data layer priorities (data sets considered very useful)

High resolution aerial photography	= 61%
Nearshore bathymetry (0–3 miles)	= 59%
Fish distributions	= 57%
Estuarine and bay bathymetry	= 56%
Wetland function	= 56%
Coastal land cover change maps	= 54%
Shoreline erosion or accretion rates	= 53%
Habitat suitability indices	= 53%
Coastal topography	= 52%
Shoreline	= 51%
Shellfish bed distribution maps	= 50%

Appendix 3

NOAA COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)

The NOAA Coastal Change Analysis Program (C-CAP) evolved over the last 15 years and most recently operated as an independent program of the Center. In 2000, the C-CAP function was merged with the other remote sensing activities at the Center. This merger created a stronger, more comprehensive remote sensing program that is better suited for addressing both the land and water aspects of the coast.

C-CAP now refers to both a national effort to develop and distribute regional land cover and "change" data in the coastal zone, and to the digital data products that are developed according to the specific standards and methods developed by the National Oceanic and Atmospheric Administration (NOAA). As part of the NOAA Coastal Services Center's Coastal Remote Sensing (CRS) program, C-CAP products have been produced for most of the east coast, Hawaii, and portions of the west coast and Alaska. The majority of these data products illustrate land cover for one date, a 5-year retrospective land cover product, and a product that illustrates the changes between the two dates. In fiscal year 2001, baseline land cover (circa 2000) data products were produced for the main eight islands of Hawaii, and a contract has been awarded for the production of land cover and "change" data products for the Great Lakes region. Contracting for the production of C-CAP data products in other regions of the country is on schedule for fiscal year 2002.

The basic vision for the C-CAP land cover "product-line" is to complete the national baseline as soon as possible through contracts with the private sector. These contracts will include land cover for the most current date available, a 5-year retrospective land cover product, and a product that illustrates the changes between the two dates. During the production of this national baseline, CRS will emphasize the applications of these products to coastal management issues. In tandem, documented methodologies/ procedures will be made available to anyone interested in adding additional land cover dates. This will then provide a means for others to track regional trends over time. It is also envisioned that methodologies for introducing more detailed (higher spatial resolution) land cover, for those coastal areas that are changing rapidly, will be developed.

Benthic mapping, originally envisioned as part of the C-CAP function, will be pursued separately and according to new standards. The original vision of linking changes in land cover to the changes occurring in the estuarine aquatic environment, to better observe causal relationships, remains an interest to the program, and perhaps presents itself as a partnership opportunity.

Appendix 4

ACRONYMS

C-CAP	Coastal Change Analysis Program (NOAA)
CRS	Coastal Remote Sensing (Center program)
DHAT	Dune Hazard Assessment Tool
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
FGDC	Federal Geographic Data Committee
GIS	geographic information system
GPS	Global Positioning System
HAB	harmful algal bloom
HABSOS	Harmful Algal Blooms Observing System
JACIE	Joint Agency Commercial Imagery Evaluation team (NASA, USGS, NIMA)
LCA	Land Cover Analysis (CRS project)
LDART	LIDAR Data Retrieval Tool
LIDAR	Light Detection and Ranging
MRLC	Multi-Resolution Land Characteristics consortium
NASA	National Aeronautics and Space Administration
NDEP	National Digital Elevation Program
NIMA	National Imagery and Mapping Agency
NOAA	National Oceanic and Atmospheric Administration
NSDI	National Spatial Data Infrastructure
PIP	project implementation plan
PP&A	Program Planning and Assessment (NASA)
SAV	Submerged Aquatic Vegetation
USGS	United States Geological Survey

Appendix 5

SOURCES AND REFERENCES

- *Dictionary of Science and Technology*
- National Academy for Public Administration
- National Institute for Science and Technology
- Office of Management and Budget U.S. Geological Survey

Christensen, Claude J., Information Sciences Program Manager, Department of the Interior, "A Recommended Framework for Defining and Implementing a Decision Support System," November 21, 1997.

D.J. Power, "Decision Support Systems Glossary," <*http://dssresources.com*>, 1999.

Executive Office of the President, Office of Management and Budget, "Revised OMB Circular A-16: Coordination of Geographic Information and Related Spatial Data Activities," (Draft), June 20, 2001.

Independent Commission on the National Imagery and Mapping Agency, *The Information Edge: Imagery Intelligence and Geospatial Information in an Evolving National Security Environment*, Final Report, December 2000.

National Academy of Science, Space Studies Board, Committee on Space Applications and Commercialization, "Remote Sensing Data: The Changing Environment for Earth Science Research: Workshop," March 27-28, 2001.

National Aeronautics and Space Administration, *Earth Science Enterprise: Research Strategy*, December 2000.

National Aeronautics and Space Administration, *Earth Science Enterprise: Technology Strategy*, June 1999.

National Aeronautics and Space Administration, Applications Program, Stennis Lead Center for Applications (together with NIMA and USGS), "High Spatial Resolution Commercial Imagery Workshop," Greenbelt Marriott Hotel, March 19-21, 2001.

National Council for Science and the Environment, "First National Conference on Science, Policy and the Environment," December 2000.

National Research Council, Committee to Assess the Portfolio of the Division of Science Resources Studies of NSF, *Measuring the Science and Engineering Enterprise: Priorities for the Division of Science Resources Studies*, 2000.

National Research Council, Committee on Global Change Research, *Science of Regional and Global Change: Putting Knowledge to Work*, 2001.

National Science Board, "Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation," 2000.

National Science Foundation, National Science Board, *Science and Engineering Indicators*—1998, 1999.

NOAA Coastal Change Analysis Program Effectiveness Review—Summary Report, June 27, 2000.

NOAA Coastal Services Center, *NOAA Coastal Change Analysis Program—Guidance for Regional Implementation*, NOAA Technical Report NMFS 123, U.S. Dept. of Commerce, 1995 <*www.csc.noaa.gov/crs/lca/protocol.html*>.

NOAA Coastal Services Center, *1999 Coastal Resource Management Customer Survey* <*www.csc.noaa.gov/survey/*>.

NOAA Coastal Services Center, *Strategic Plan 2001 – 2006* <*www.csc.noaa.gov/strategic_plan.pdf*>.

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

2234 South Hobson Avenue
Charleston, South Carolina 29405
(843) 740-1200
www.csc.noaa.gov