P1.19 **NOAA's National Climatic Data Center Role in Climate Services: Climate Information for Decision-Making**

Adam Smith, Eileen Shea, Neal Lott, and Wayne Faas
NOAA's National Climatic Data Center, Asheville, North Carolina

ABSTRACT

NOAA's National Climatic Data Center (NCDC) is developing a series of workshops and collaborations with industry, academic, and government groups to strengthen the communication of climate data needs and enhance the usability of climate data products in decision-making. Over the last two years NCDC has participated in several industry-focused conferences, the first being the NOAA Data Users Workshop (November 2007), which sought to identify the data and information needs of the energy, insurance, and transportation sectors, in the context of a changing climate. This meeting and others have explored how emerging information needs might guide future products and services. In addition, NCDC has collaborated with industry, academic, and government groups to enhance the usability of existing climate products through an expansion of web services, Geographic Information Services (GIS), and portal technologies.

1. WHY CLIMATE SERVICES?

Coping with climate variability and change presents a substantial challenge in government policy and business decision-making. Consequently, the demand for climate information has increased over the past decade and continues to grow. This demand is also fueled by increased data availability and the need to support decision-making throughout the global economy. To meet this challenge the Federal government can take a proactive role in understanding the emerging data and information needs facing a variety of data users and decision-makers.

During the 20th century, private industry and regulatory bodies made decisions for future investments (*i.e.*, airports, seaports, power plants) under the assumption of a stationary climate (*i.e.,* that past climate is a good measurement of future climate). In the 21st century this business approach is no longer tenable as a large body of scientific evidence (*i.e.,* Intergovernmental Panel on Climate Change, Climate Change Science Program, academic research) shows that climate conditions are exhibiting non-stationary characteristics (*e.g.,* increased extreme rainfall events, increased temperature extremes, drought and wildfire). As this evidence becomes more established, decision-makers are showing a more active interest in understanding what climate information products are currently available and how to integrate this information into their decision-making processes.

For example, capital intensive industries such as energy and transportation are more frequently seeking information regarding how climate trends may impact engineering design standards, regulatory requirements, and day-to-day business operations. Expansion or alteration of long-term infrastructure is a major undertaking that can require vast resources, complex logistics, and many years to accomplish. More acutely, the decision-making needs of energy providers are being strained as the traditional 30-year normal climate data are becoming less useful in a future exhibiting non-stationary climate. As a result, there is concern that the climate change data products being presented by NOAA are difficult to interpret in the context of these planning needs (*e.g.,* how will these temperature projections affect infrastructure), and often are not presented at a scale in which meaningful decisions can be made.

As the world's largest active archive of weather and climate data, NOAA's National Climatic Data Center (NCDC) is on the frontline in meeting the increasing demand for climate information. NCDC acts as the nation's "Scorekeeper" regarding the trends and anomalies of weather and climate, in addition to developing national and global datasets. These datasets and other derived products are widely used to understand the risks of climate variability and weather extremes. Federal resource managers, state, local and tribal governments, as well as private industry leaders recognize that a changing climate complicates their ability to plan for tomorrow. Consequently, these organizations can seek to work together for improved data access and capacity for decision-making.

2. NCDC CONTRIBUTIONS

In this respect, NCDC is seeking to better understand and respond to the information needs of industry sectors, which are more frequently considering how climate variability may impact near-term decision-making and long-term planning. Over the last two years NCDC has participated in a number of industry-related workshops including:

- NOAA Data Users workshop (November, 2007)
- The Reinsurance Association of America: Catastrophe Modeling Annual Conference (February, 2008)
- Association of State Dam Safety Officials (ASDSO) meeting (May, 2008)
- Climate Information for Managing Risks: Partnerships and Solutions for Agriculture and Natural Resources (June, 2008)
- Climate, Weather and Tourism in North Carolina (November, 2008)
- Climate Change and the Plant Sector: A Growing Interest (November, 2008)

As an example, the NOAA Data Users workshop (November, 2007) was held to identify the requirements of the national energy, insurance, and transportation sectors, with respect to data and information needs in a changing

climate. This workshop convened large and small group sessions to explore the following overarching goals:

- To identify and explore the challenges and opportunities that changing climate conditions present for businesses and state and local governments in energy, transportation and insurance;
- Better understand the current state of scientific understanding of climate change;
- Determine the energy, insurance, and transportation sectors' emerging data and information needs to better respond to a changing climate versus a stationary climate;
- Explore NOAA's capabilities to meet those requirements and develop strategies to leverage and enhance those capabilities for the energy, insurance, and transportation sectors.

A common sentiment from industry representatives was that NOAA and its many partners play a central role as "trusted information broker" in responding to the increasing demands for climate data. However, there was also the acknowledgment that industry does not know what scientific information it needs for future decision-making, and inversely, NOAA often does not know what information it needs to provide. As a result, there is a need for sustained dialogue between the public-private sector to improve the development and dissemination of climate information. This feedback underscores industry's growing need to evaluate the potential impacts of climate change and explore appropriate response options (*i.e.,* adaption and/or mitigation).

In responding to recommendations from the workshop, NCDC is exploring the possibility to coordinate a meeting for climate modelers (global climate models (GCM) and downscale models) and insurance catastrophe (CAT) risk modelers. This meeting would explore the mutual modeling challenges faced by both communities even though risk evaluation is approximately 1-10 years for CAT modelers but is 25-100 years for GCM. Another recommendation from the November workshop is to examine sub-sector transportation issues (*e.g.,* rail, air, ship, road, pipeline) to identify the specific climate change information needs of each. This same approach could also be recognized for sub-sector energy issues.

Branching out from the November 2007 workshop, NCDC participated in the "Climate Change and the Plant Sector: A Growing Interest" workshop to identify the climate change issues facing plant-related businesses such as landscape architects, golf course architects, and nurseries. This workshop focused on the following questions:

- How much does this sector know about climate change (*i.e.,* maturity level of the science)?
- What information is needed in the near-term (1-3 years)?
- What information is needed in the long-term (3 years and beyond)?
- How are decisions made for operations and planning, both short and long term?
- What are the current sources of climate change information?

Answering these questions provides first steps in building a critical information bridge between the science community and the numerous business sector leaders and public interests that rely on the health and well being of plants. The workshop also establishes greater awareness within the plant community of resources available for adaptation strategies at varying scales (*i.e.,* local, regional, national, and global).

NCDC expects to continue this dialogue with key sectors and decision-making communities. For example, NCDC is hosting a climate information needs listening session as part of the Coastal Zone 2009 meeting in Boston. In addition, NCDC staff will be expanding their participation in a variety of sectoral association meetings to enhance our understanding of sectoral climate risks and their information needs to support decision-making.

3. SPECIFIC CONTRIBUTIONS

The following section highlights several ongoing collaborations with industry, academic, and government groups, which strengthen the communication of climate data needs and enhance the usability of climate products for a variety data user needs.

Collaboration with Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI, http://www.cuahsi.org/)

With support from the National Science Foundation, CUAHSI has developed a Hydrologic Information System (HIS) for the discovery and delivery of water-related data from a variety of government agencies, as well as the publication and archiving of the data from the academic research community. The CUAHSI HIS project has been operational since April 2004, led by academic hydrologists collaborating with the San Diego Supercomputer Center as a technology partner.

Since NCDC is a major provider of NOAA water-related data, the success of HIS depended upon cooperation and collaboration between NCDC and CUAHSI. The basis for this collaboration is the common interest of both NCDC and CUAHSI to make hydrologic data and products readily available. The U.S. Geological Survey (USGS) National Water Information System (NWIS) is also a partner in this effort. As a result of this partnership, "WaterOneFlow" Web Services are now operational and allow users to query data from multiple systems for their area of interest (Fig. 1). For example, users can request streamflow data from USGS and rainfall data from NCDC via a single Web Service-enabled interface. This also serves as a prototype for future expansion of these types of services.

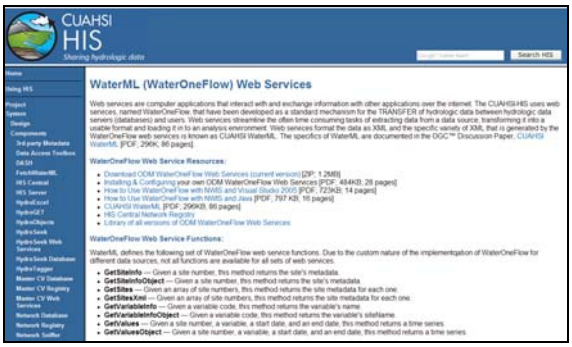

Fig. 1. Hydrologic Information System (HIS) WaterOneFlow interface

Geographic Information Services (GIS, http://gis.ncdc.noaa.gov)

NOAA also has a number of collaborative efforts ongoing in the GIS arena. NCDC has been working closely with NOAA's National Ocean Service Coastal Services Center (CSC) in Charleston, SC in various activities, such as the ESRI Geoportal Toolkit (http://www.esri.com/library/fliers/pdfs/gis-portal-toolkit.pdf). Other collaborations include NCDC with the National Weather Service's Climate Prediction Center (CPC) and with USGS.

A key goal in developing and deploying GIS technology is to provide users with simple map-based access to climate services (Fig. 2). Users who are presented with data discovery options which flow into detailed product selection maps can search using standard tools or gazetteer (geographical dictionary search) functions. Each tabbed selection offers steps to help users progress through the system. A series of additional base map layers and data types provide companion information.

In addition to providing dynamic maps to access data, Web Map Services (WMS) provide maps or images and Web Feature Services (WFS) provide spatial features. These services may be used from Open Geospatial Consortium (OGC)-compliant applications to directly access data and metadata. Keyhole Markup Language (KMZ) files used directly within 3D GIS viewers (*e.g.*, ArcExplorer, Google Earth) are also available for a number of datasets and products. Datasets and products are recorded in Federal Geographic Data Committee (FGDC)-compliant metadata which are harvested into catalog portals such as Geospatial One-Stop (http://gos2.geodata.gov/wps/portal/gos) and the Global Change Master Directory (http://gcmd.nasa.gov/).

Value-added layers and data types are also included which visually provide, for example: agricultural regions, coastal hazards, population density, global ecoregions and wetlands, state and regional climate divisions, National Transportation Atlas data, topography data, and visual imagery (*e.g.*, aerial photos). "Gazetteers" provide advanced search functions which allow users to rapidly isolate stations or areas of interest, such as by location name, zip code, river name, country, etc.

Fig. 2. NCDC GIS data discovery and mapping Portal

NOAA Economics Website (http://www.economics.noaa.gov/)

In response to the growing importance of socio-economic research with respect to industry decision-making using environmental information, NCDC has led the development of a NOAA-wide Economics website with its NOAA partners (Fig. 3). This Web Site presents a centralized source of information pertaining to the economic value and real-world application of NOAA's data products in decision-making, as well as the economic costs of extreme events on the environment and society. The information provided in this Web Site is synthesized from a vast array of contemporary scientific literature and is presented in *four Themes* (*i.e.*, Climate, Ecosystems, Weather & Water, and Commerce & Transportation). Each theme is then subdivided into *three Categories* (Data Users, Extreme Events, and Observing Systems). Within these Categories there are *numerous Topics* in relation to NOAA - each with *five summary Sections* (Topic Overview, Economic Benefits, Economic Costs, Data Applications, Data & Products).

Fundamentally, the Web Site is intended for a general audience and provides a clear, accurate, citable, but not overly academic explanation of NOAA's value to society. Common users of this Web Site include the general public, Media, educators, Congressional staffers and NOAA personnel. Peer-reviewed research that is primarily quantitative and other related content (see bulleted list below) may be submitted for possible inclusion on the site: (www.economics.noaa.gov/?file=submit).

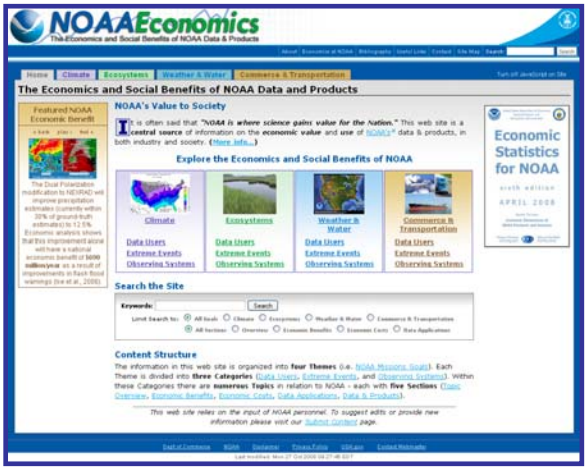

Fig. 3. The entry page of the NOAA Economics web site provides access to economic data and analyses across many subject areas for a variety of audiences.

Specifically, the NOAA Economics website incorporates:

- *208* topic overview narratives providing societal and economic perspectives on the value of NOAA data and products (*i.e.*, for business, consumer, policy decision-making, etc.)
- *172* sources of peer-reviewed literature; 77% of this literature is hyper-linked to the source.
- *119* summaries on the economic benefits of / cost mitigation by NOAA data and products.
- *185* summaries regarding the economic costs / impacts of environmental extreme events.
- *720* data user-stories (*i.e.*, real-world accounts on the use of NOAA products in decision-making).
- *Hundreds* of external hyperlinks to NOAA datasets/products and internal hyperlinks interconnecting many NOAA program missions and responsibilities.

4. CONCLUSION

This article is intended to be the first in a series of BAMS articles on the advancement of climate service engagements and partnerships with industry leaders and decision-makers. NCDC industry sector teams have been established to support focused dialogue with industry on potential data product improvements and the development of new data sources, as necessary for decision-making in a changing climate. We also recognize that the development of new climate products is, in some cases, a role for the private sector.

In summary, NCDC and other partners in NOAA are striving to develop a series of initiatives with their partners to meet the rising demand for climate data and products, which support decision-making in a number of nationally significant industry sectors. Government and industry leaders recognize the value in planning for future climate change through an enhanced climate services partnership between the public and private sectors. This partnership will assist in bridging the gap between the nation's scientific and technical expertise and the climate mitigation and adaptation decision-making interests that many industries may face in the future.