



A POLICY FORUM: IMPROVING RESPONSES TO CLIMATE PREDICTIONS



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Panel 3

Policy Issues In Managing Climate Variability At Relevant Levels

POSITION PAPERS

Policy Issues of Relevance in Managing Responses to Climate Variability

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Introduction

The beauty of Montana's famous Big Sky Country landscapes reflect its climate variability. Visitors are often surprised to see the open valley floors beneath the lower timberline. Not far above, the forests again give way to the harsh, but beautiful alpine elevations. Climate in any season or year, is in large, a factor of elevation and topography. Climate variability adds yet another dimension to the picture.

Although Montanans love to play in the alpine zones, they live, for the most part, on the valley floors. With high climate variability the rule east of the Continental Divide, Montana west of the Divide, benefits from the temperate influences of the Pacific Ocean. Issues driven by climate here include the anadromous fisheries, endangered species, hydropower generation and recreation.

It is in the eastern two-thirds where a majority of the cattle are raised and grain is grown. Many argue that the finest trout fishing lies on the east side in the blue ribbon tributaries in the headwaters of the Missouri and Yellowstone rivers. An old map that I recovered from the archives where I work is titled, "Montana – Water Rich, Water Poor. Climate variability drives the bounty of the land and the people. The following areas of concern are affected by policy-making and occur in the context of climate variability.

Continued support for real-time data collection

The availability and improvement of real-time monitoring of water supply conditions has contributed greatly to the ability of the forecasting and planning community to develop and implement timely responses to address precipitation shortfalls due to climate variability. However, real-time monitoring networks are at risk due to budgetary constraints. The case needs to be made to policy-makers that investment in monitoring capabilities contributes to proactive drought mitigation strategies that help users of the data mitigate economic losses. Coupling long-lead outlooks with real-time data creates a powerful planning tool combination for western states.

Ranchers and farmers prefer to have decision-making support in advance of drought to applying for disaster assistance to compensate for loss during and following the drought. Many of the over 50 active watershed planning groups in Montana depend upon products offered by the Natural Resources Conservation Service for streamflow forecasting and the U.S. Geological Survey for real-time streamflow data. The Bureau of Reclamation also provides water storage data for use

by natural resource, hydropower, and fishery managers. Support to maintain and improve these networks is key to effective planning.

Assistance programs must address multiple-year drought cycles

Disaster assistance programs play an important role in sustaining established family farming and ranching operations in Montana and elsewhere in the Great Plains. For example, the Conservation Reserve Program (CRP) provides a readily available source of forage for local ranchers during periods of drought that allows them to retain, rather than liquidate breed stock that has taken generations to develop.

In 2002 alone, 550,000 acres of CRP land was hayed, and 370,000 acres grazed by livestock producers, in spite of the fact that 150,000 head were liquidated between 2001 and 2002, due to drought. According to the FSA, in 2001, ECP was opened early enough to provide timely mitigation to stock production loss, and was approved for 44 of 56 Montana counties. This assistance is critical to the survival of family-owned operations during extended cycles of drought.

During protracted periods of drought, loss of surface water supplies is followed by the loss of groundwater supplies. The Emergency Conservation Program (ECP) provides cost-sharing for water well development for livestock. Many Montana ranchers used ECP in 2000 and 2001. In 2001 alone, ECP was approved for \$10M and \$5.89M had been distributed by September, mostly for stock water wells, including \$.5M in October alone.

If these programs are accessible in a timely manner, a producer can access local grazing or develop a supply of water that will provide yields through the duration of a cycle of drought. However, if nationwide criteria based upon monthly percentage of average precipitation received over a selected period of consecutive months, access to the ECP may come too late, if at all, to allow retention of the breeding stock of a herd.

The drought advisory committee was told in March by the Farm Service Agency that the Drought Monitor would be used to determine county eligibility for disaster assistance. While the committee welcomes the change to a multi-agency drought assessment tool from the percentage of average monthly precipitation format, it is concerned that the change could present new problems.

Since the Drought Monitor incorporates a qualitative element among its components, the committee has expressed concern that interpretations by a variety of individuals may create some inconsistencies. With desperately needed disaster assistance hanging in the balance, the Monitor is now much more than an advisory composite index. During recovery from prolonged drought, improving conditions may ameliorate the meteorological drought, while leaving the agricultural or hydrological drought behind.

Drought-proofing - Support for long-term solutions

A number of assistance programs seem to be structured with an underlying presumption that drought is an annual phenomenon and that those impacted by drought will have a fresh start the following spring. The applicant to disaster assistance may be burdened with the challenge of meeting program criteria that do not account for the continued presence of drought. The U.S. Bureau of Reclamation administers the Reclamation States Drought Relief Assistance Act of 1991, which was designed to promote activities that mitigate impacts of drought. Part of the Act provides assistance for planning and another part, funds for temporary construction projects designed to address drought.

Concerned that successful applicants would have an infrastructure windfall providing years of benefits, lawmakers provided only one primary exception to the limitation that the construction be temporary. Water wells may be drilled or existing wells deepened by Reclamation for communities without a firm supply of potable water due to the effects of drought. About ten Montana small towns have been able to benefit greatly by the program's exception to the construction rule for water wells.

But many worthwhile projects cannot be funded since projects that could provide tangible benefits are almost invariably excluded by the rules. Projects that support instream flows for Montana fisheries, including threatened species such as fluvial arctic grayling, as well as wild trout, could be funded and built to provide lasting benefits to this growing multi-million dollar industry.

If policy-makers can restructure the program using a cost-share approach, projects with lasting benefits can help people and communities endure prolonged droughts as well as future droughts. Drought programs have to move toward drought proofing just as flood project planning has evolved to support flood proofing, to avoid costly damage rather than funding the rebuilding after the disaster, as in the past.

Recovery from prolonged cycles of drought

New research indicates that there is a trend for precipitation events to be greater in intensity and shorter in duration. This trend may have implications for the actual rate of recovery as a region begins its recovery from consecutive years of severe drought, as well as cycles of mild drought that result in cumulative shortfalls of drought. While a meteorological drought cycle may see both short-and long-term recoveries from a series of intense storms in summer months, an agricultural or hydrological drought often will lag behind its counterparts for a variety of reasons.

If assessment tools, such as the Drought Monitor, characterize the degree of recovery as significant, using precipitation received as a surrogate for actual soil moisture, those adversely affected by drought may be left behind with respect to eligibility for assistance. The committee

has been told that the soil moisture tool uses a single soil type as a constant in its assessment of moisture conditions. Such presumptions have great implications for areas recovering from consecutive years of drought.

Improving the Policy/Decision-making Framework

Improved communication and coordination between the states and federal government

National Drought Policy Act of 1998 created the National Drought Policy Commission, which was charged by Congress to develop recommendations for improving the ways the nation prepares for drought. Goals included in the recommendations of the Commission were improving the coordination among the numerous federal drought-related programs and better integrating the non-federal initiatives with the existing federal programs. The Commission's policy statement included three policy principles:

- 1) *Favor preparedness over insurance, insurance over relief, and incentives over regulation;*
- 2) *Set research priorities based on the potential of the research results to reduce drought impacts; and*
- 3) *Coordinate the delivery of federal services through cooperation and collaboration with non-federal entities.*

Montana's Congressional delegation has recently been joined, in both the U.S. House and Senate, by many Congressmen and women to pass a National Drought Preparedness bill. Such a measure would bring the recommendations of the National Drought Policy Commission to fruition. The role of the federal government should be in providing incentives and support to states, enabling them to address the problems presented by climate variability using their own approach with constituents. With the proliferation of watershed groups, great strides have been made in preventing the dewatering of Montana's fabled rivers. Funding assistance has great potential with these grass roots groups with proven records of success.

The federal government can play a meaningful and supportive role by seeing that the successes realized by some states, using currently available and new forecasting tools, is shared with other states learning to mitigate effects of variability. The Montana Drought Advisory Committee relies heavily upon the climate products currently offered by the federal government. The media is always present at its meetings for the Weather Service's leadoff report of climatological outlooks.

With the advent and acceptance of the Internet, end users and resource managers are watching forecasts closely. The drought committee's state and federal reservoir managers, water supply forecasters, wildfire suppression resource managers, wildlife and fishery managers, and water quality experts carefully consider climate forecast products. Quantifying

the success of individuals using forecasts in decision-making is difficult, but we know that mitigation is occurring at the ranch, farm, and business levels.

The state drought advisory committee welcomes the April 8, 2003 announcement by Secretary of Agriculture Veneman that a drought coordinating council was formed to, “monitor ongoing drought conditions and the impact of agriculture producers. The council will coordinate the full array of resources to assist affected producers and communities.” This is consistent with the above stated policy statement of the National Drought Policy Commission.

One benefit of prolonged drought is that the learning curve steepens with new experience and resourceful and creative solutions to address the challenge of climate variability. With the prospect of more refined climate forecasting ahead, Montana welcomes the continued support it receives from NOAA and will learn to rely more upon the long-lead outlooks for what they are: the best guess, given the best technology available, from the people who provide the best climate science available. We try to reach out proactively to our constituents with our information, at the risk of being wrong. And that is a reasonable risk to take.

Climate Forecasts and Water Resources Management Policies

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Introduction

All water resources agencies must deal with climate variability. One of their primary missions is to manage hydrologic extremes: reducing damages during floods and providing water supply during droughts. For example, reservoirs are designed to reduce the variability of water supply by storing water during periods of high flows and releasing water during low flows.

Responses to climate variability depend on the time scale of the response. On a time scale of years to decades, water managers can design projects to help manage hydrologic variability. A structural project such as a levee or reservoir may have a project life of 50 years or more. The design criteria for projects vary, but they generally are based on the range of flows in the historical record and assume climate stationarity. On the shortest time scale, an imminent flood requires an emergency response within hours or days. This paper will deal with responses on the time scale of climate forecasts with lead times of one month to several months. I will discuss two missions of the Corps of Engineers that can use climate forecasts: emergency flood management and management of multipurpose reservoirs. *The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983) is the governing document for the Corps of Engineers for planning water resources projects and states what the objectives should be for water management agencies.

The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (WRC, 1983).

The Principles and Guidelines list four accounts that water managers must balance: national economic development, environmental quality, regional economic development, and other social effects. Although the broad outline of water resources management is to contribute to economic development and maintain the environment, management policies must balance multiple objectives and competing interests.

Climate Forecasts in Emergency Management

The Corps of Engineers has authority to provide emergency response and disaster assistance. When floods are imminent, the Corps of Engineers provides assistance to communities for flood fighting. In most cases, warning of an impending flood on a major river has a lead-time of less than one week. However, the Corps of Engineers Advance Measures program was designed when there is a warning of a potential flood several weeks or longer in advance. It was designed for spring snow melt floods when an unusually large snow pack occurs. It has also been applied along the Great Lakes when lake levels reach record high levels and recently for a climate forecast.

The Advance Measures program is intended to protect urban areas from loss of life or significant damages "due to an imminent threat of unusual flooding" prior to flooding or flood fighting activities.

The Advance Measures Program requires several criteria that must be met for assistance (USACE, 2001, ER 500-1-1). First, the “imminent threat of unusual flooding” is based on either National Weather Service forecasts or Corps determination of unusual flooding due to adverse conditions. Both “imminent threat” and “unusual flooding” are recognized to be subjective terms. An imminent threat has “a high probability of occurrence” and includes consideration of the likely timing of the threat, its likelihood in a particular geographic location, and the likelihood of catastrophic consequences. Another consideration is that the threat occurs “inside the normal Corps decision and execution cycle for small project construction.” An “unusual flood” has the “potential ability to approach an area’s flood of record, a catastrophic level of flooding, or a greater than 50-year level of flooding.” Another requirement is for the project to have a favorable benefit-to-cost ratio (greater than 1:1). The calculation of expected benefits requires an estimate of the probability of flood damages.

A report by Wernstedt and Hersh (2002) of Resources for the Future (RFF) criticized the eligibility criteria of the Advance Measures program by saying that “these criteria set an almost impossibly high threshold for any jurisdiction seeking federal funding for flood mitigation criteria.” They recommended that the Corps design programs to use ENSO forecasts that recognize both their strengths and limitations.

These programs would make greater use of ENSO forecasts to identify basins and sub-basins where the ENSO signal in the past has been associated with a higher incidence of peak flows and flooding. Funding could be provided to local jurisdictions for mitigation activities before a flood fight became necessary.

Despite the strict criteria for Advance Measures projects, the Corps of Engineers and local communities funded two advance measures projects in the Pacific Northwest. There was an unusually strong La Niña during the winter of 1998-1999. A continuation of the La Niña was forecast for the winter of 1999-2000. One of the projects was located in Tillamook County on the northwestern coast of Oregon. Tillamook County was prone to frequent flooding. During the first La Niña winter of 1998-99, four flood events occurred. The Corps of Engineers and the local community initiated an advance measures project during the autumn of 1999. As required by the Advance Measures program, a benefit cost analysis was conducted. The benefits of the project were estimated to be a fraction of the 1998-1999 damages. The benefit-cost ratio was found to be greater than one and the project was built. Floods did occur in the winter of 1999-2000. A flood occurred on Thanksgiving Day and a second flood occurred on December 16, 1999. The Corps of Engineers estimated damages of \$2.6 million were prevented in the two floods, justifying the cost of several hundred thousand dollars (USACE, IWR, 2000).

It is true that the criteria for the Advance Measures program are somewhat problematic for its use with climate forecasts. Calculation of expected benefits is difficult, since flooding probabilities for La Niña conditions are highly uncertain. An implicit assumption behind the calculation method used at Tillamook was that the flood in 1999-2000 would be at least as large as the floods that occurred in the 1998-1999 season. The assumption seems reasonable given the outlook for wetter climate conditions and that floods in 1998-1999 were not particularly extreme. It is also questionable whether the floods in the winter of 1999-2000 can be considered “imminent” or “unusual,” but these terms are recognized to be subjective. The use of the Advance Measures program in the Pacific Northwest was helped by the La Niña conditions persisting into the second winter. In the first winter, emergency managers were not as concerned about potential flood risk.

The fact that the Corps funded the Advance Measures projects belies the criticism that the threshold for funding was impossibly high. There are reasons to have strict criteria before Advance Measures funds

are spent. Lax advance measures criteria potentially permit the construction of unnecessary structural flood control projects that bypass thorough benefit-cost analysis and environmental review. In the past, the Advance Measures criteria have generally been interpreted too loosely. The Advance Measures program should not be used in place of a long-range plan for flood mitigation. The program must support the water resources management goals of providing positive economic benefits while preserving environmental quality.

Climate Forecasts in Reservoir Management

Another potential application of seasonal climate forecasts is the management of reservoirs. Reservoirs are often managed for multiple uses. Flood control was one of the original goals for building many Corps storage reservoirs. Reservoirs are major producers of hydropower. Reservoir releases often support river navigation. Reservoirs are a source for municipal water supplies and in the West of water for irrigation. The protection of fish migration patterns and wildlife habitat has become important goals since the Endangered Species Act was enacted. Rivers and lakes are used for recreation by thousands of visitors each year. Reservoirs are also operated to ensure high water quality and to preserve significant cultural resources.

The various objectives imply conflicting demands for reservoir storage and the timing of fill and releases throughout the year. To support flood control, reservoir levels are often lowered before the season of peak flooding (usually during spring snowmelt runoff). Hydropower demand occurs throughout the year but peak demand can occur in the winter heating system or summer cooling season. Endangered species often prefer naturalized flows, which mean large runoffs during the flood season. The demand for irrigation water occurs during the growing season of late spring and summer. Reservoir operating plans must accommodate these sometimes-conflicting uses.

Reservoir management is therefore governed by a complex set of laws, institutions, and regulations. There are multiple pressures influencing decisions, such as environmental requirements and water rights. International treaties, laws, and other agreements regulate the use of water and make changes to operating procedures difficult. Changes in operational plans require a long, complex study. Public approval is needed to implement changes, and many interest groups distrust changes. Interest groups support different competing uses for water. Changes in operational plans may result in some interests being winners while others are losers. Use of forecasts in reservoir operations must be evaluated in this context.

The Corps of Engineers has guidelines on the use of long-range predictions of streamflow in water management (USACE, 1987, EM 1110-2-3600). The manual does not distinguish between long-range climate and weather forecasts and considers long-range forecasts are “not of sufficient accuracy for application to real-time project regulation.”

Long-range (monthly, seasonal, or annual) weather forecasts are considered to be experimental. Their accuracy, when compared to the use of statistically derived climatological averages, does not warrant their application to management of water control systems. (USACE, 1987).

The guidelines do allow for two situations where hydrologic factors can lead to reliable long-range forecasts of streamflow: groundwater conditions for estimating low flow and snow pack accumulation for forecasting spring runoff volume.

Forecasts of spring runoff are generally limited to rivers dominated by snowmelt, predominately in the mountainous West, and to the season of snowmelt, spring or early summer. Knowledge of the snow

water equivalent of the snow pack can provide lead times of four to six months of expected runoff volumes. Forecasts of spring runoff volume provide a potential model by which water managers can incorporate other forecasts of runoff with long lead-times in operations. The forecasts provide a measure of runoff volume, but they do not predict the timing of runoff. Spring runoff outlooks are probabilistic, since the forecast values are presented as probabilities of exceedance, rather than as a single best estimate. The forecasts are also uncertain, especially in the forecasts made in mid-winter with lead-times of several months. Snowmelt forecasts can also include climate information if it improves the water supply outlooks in the early winter (USACE, 1998). The information is generally included by using a variable such as the Southern Oscillation Index (SOI) in a multiple linear regression. The example of spring runoff volume forecasts is used to show that the Corps already deals with probabilistic, uncertain forecasts with lead-times of several months, but water managers distrust climate forecasts in particular.

Conclusion

Asking, “How can the policy/decision-making framework be improved?” implies there is something wrong with present policy. However, the use of climate forecasts is not an objective in water resources management, nor should it be. It is not up to water management agencies to change policies to increase the use of climate forecasts. It is up to the forecasters to produce a product that water managers can use in the context of current water management institutions. Current policies are appropriate to utilize climate predictions in some instances, but the benefits of using the forecasts must be demonstrated!

As noted earlier, the process of introducing changes in operational procedures is complex. Retrospective analyses of operational procedures using climate forecasts are necessary before changes in operating procedures can be implemented. The analyses must demonstrate the benefits of forecasts, their reliability, and how their use impacts various operating objectives and interest groups.

A recommended policy improvement is for the Corps of Engineers and other water management agencies to conduct their own evaluation of climate forecasts. Evaluation can be part of an ongoing study to revise project-operating rules or as a collaborative research project with NOAA or another institution. Participation would allow the Corps to objectively assess and verify climate forecasts and give feedback to forecasters on what water managers need. However, water management agencies have limited funds and personnel for evaluation of climate forecasts and their application. The skepticism of Corps managers to climate forecasts limits the expenditures the Corps is willing to spend to evaluate their use in operations. Furthermore, forecasting agencies do not routinely provide hindcasts to user agencies to conduct these analyses. The lack of hindcasts is another impediment to the evaluation of the usefulness and skill of forecasts for water management operations.

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Improving Responses To Climate Predictions

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Introduction

Throughout this summary and in my presentation, I will be providing a perspective derived largely from recent work in the Asia-Pacific region. This includes: work in climate variability and change in American Flag and U.S.-Affiliated Pacific Islands; climate, oceans and environmental work in Pacific Islands (North and South Pacific); and work on climate and extreme events in both the Pacific and Southeast Asia. In the case of Pacific experiences, I'll draw heavily on experiences from the Pacific ENSO Applications Center (PEAC) that has been developing and issuing ENSO-based climate forecasts and supporting their applications in American Flag and U.S.-Affiliated Pacific Islands since 1994. PEAC began as a research pilot project funded by the NOAA Office of Global Programs and is now in the process of transition to operational status as part of the programs of the National Weather Service Pacific Region. I will also draw heavily from the findings and recommendations developed as part of the Pacific Islands regional assessment of the consequences of climate variability and change completed in the fall of 2001.

In the case of Southeast Asia, my perspective is drawn largely from work being done in the context of the Extreme Climate Events (ECE) project managed by the Asian Disaster Preparedness Center (ADPC) and funded by NOAA's Office of Global Programs, USAID's Office of Foreign Disaster Assistance and the UN Bureau of Crisis Prevention and Recovery. Many of the issues and suggestions I'll be discussing emerged during a Symposium on Climate and Extreme Events in Asia-Pacific: Enhancing Resilience and Improving Decision-Making that was held in mid-March as part of the 20th Pacific Science Congress in Bangkok, Thailand¹. The Symposium gave us an opportunity to share insights from ENSO-based climate forecasting and applications experiences in both S.E. Asia and Pacific Islands and to develop guidelines for future efforts to more effectively mainstream the use of climate information to support decision-making.

Question (1): What are the key policy issues in managing responses to climate variability?

I'd like to start by revising this first question slightly to "What are the policy opportunities for enhancing resilience and capitalizing on opportunities in the face of climate variability?" I offer this revision to help us focus our discussion on pro-active, anticipatory policy responses and consider how forecasts of climate variability can (and already do) contribute to decision-making that protects lives and property, supports economic development, manages resources and enhances quality of life. In many ways, the simplest part of responding to **this** question involves an exploration of policy opportunities in climate-sensitive sectors. In this context, my own experience would reinforce the idea that there are realizable opportunities in a number of key climate-sensitive policy arenas:

¹ The Symposium final report is currently in preparation so findings should be treated as draft; presentations and background material on the Symposium can be found at (<http://www2.EastWestCenter.org/climate/extreme>)

- Providing access to freshwater resources;
- Promoting economic development in key, climate-sensitive sectors (Asia-Pacific examples include agriculture, fisheries, tourism, forestry as high priorities); this includes both public and private sector opportunities;
- Ensuring public safety and protecting critical infrastructure, with a particular emphasis in the Asia-Pacific region on managing responses to extreme events such as droughts, floods, tropical cyclones and high surf/wave conditions;
- Supporting energy production and managing energy resources;
- Protecting public health;
- Managing terrestrial and aquatic resources and protecting critical ecosystems.

This list is, of course, incomplete and within each item is a rich tapestry of opportunities. Identifying these generic opportunities, however, is only the beginning of our shared journey. As experience in natural hazards, climate adaptation and resource management communities suggests, place and context matter by defining the specific strengths, weaknesses, opportunities and constraints facing those interested in establishing an effective climate science-policy partnership and I will come back to this in a few moments.

For a number of reasons, I think that the concept of “climate risk management” offers us an exciting opportunity to demonstrate the real and potential value of more effectively mainstreaming considerations of climate variability into practical decision-making. During the past few years, national governments, humanitarian relief agencies, development agencies and the climate change scientific community have begun to explore “*climate risk management*” as a conceptual framework for more effectively integrating considerations of climate variability and change in disaster management and development planning (UNDP, 2002). In this context, “climate risk management” refers to a more effective integration of climate adaptation with comprehensive emergency management programs. The concept of climate risk management continues to take shape with UNDP Bureau of Crisis Prevention and Recovery, the International Federation of Red Cross and Red Crescent Societies, the International Strategy for Disaster Reduction (ISDR), disaster management agencies and humanitarian relief organizations actively leading those discussions. I strongly encourage us to embrace this emerging concept both for the near-term benefits it can provide to society and for the lessons we can learn about the integration of climate forecast information in policy formulation.

As a participant in the Pacific Assessment noted, extreme events can provide a galvanizing focus for both the scientific and the public policy communities (Shea, 2001). Sarewitz and Pielke, Jr. (2001) note, for example, that understanding the process of preparing for, anticipating and responding to extreme events can also provide valuable insights into the decision-making context for the development and use of climate information.

As discussed during the March 2003 Symposium on Climate and Extreme Events in Asia-Pacific, an effective program of climate risk management would address the integrated climate-society system with a focus on building resilience. In this context, then, understanding and addressing the societal (economic, legal, political and institutional) aspects of vulnerability² is just as important as understanding and anticipating (forecasting) the physical conditions that are often used to characterize

² For these purposes, vulnerability is defined as an integrated measure representing sensitivity, exposure and adaptive capacity or “resilience” and incorporates considerations of social, economic and environmental (in this case, climate) factors.

a region's sensitivity and exposure to climate risks. My own experience suggests that each of the sector-based projects with which I am familiar has an underlying focus on managing climate-related risks. Over the past decade, we have seen the emergence of targeted climate risk partnerships in some geographic areas and for some sectors. As Mickey Glantz noted last month in Bangkok, we have an opportunity (and I might suggest an obligation) to evaluate these individual experiences and look for shared lessons that can be applied to designing future climate prediction-policy enterprises.

In addition to climate risk management, I'd like to mention a couple of other policy trends that provide opportunities for establishing more effective climate prediction-policy partnerships. National governments, regional organizations and international scientific, development and donor agencies are increasingly recognizing the importance of enhancing resilience to climate-related extreme events as an integral component of sustainable development planning. Other climate-related discussions also reinforce this move toward effective *integration of climate considerations in economic development and community planning in the medium and long-term*. The United Nations Development Programme (UNDP), the Organization for Economic Cooperation in Development (OECD), the International Union for the Conservation of Nature (IUCN), the World Bank, the Asian and Inter-American Development Banks and other partners have begun a dialogue on how to *integrate adaptation to climate variability and change into poverty reduction programs*. Early discussions of planning for the IPCC Fourth Assessment Report suggest increasing attention to regional consequences with the effects of extreme events highlighted as a particularly important focus. One common element of all of these discussions is a recognition that adaptation to natural climate variability not only promises to reduce vulnerability in the near-term but also provide insights and experience that will prove valuable in enhancing resilience to long-term climate change as well.

As we identify and pursue these policy opportunities, I think it might be useful to recall Sarewitz et al's (2000) description of a climate "prediction enterprise" as a *process of interactions* among individuals, institutions, values, perspectives, interests, resources and decisions. The climate prediction-policy partnership that I refer to is a variant on this model with an emphasis on strengthening both the usefulness of the climate information and the individual, institutional and programmatic relationships that support the integration of climate information into well-established decision-making/policy frameworks. Based on a number of pilot/demonstration projects in the Asia-Pacific region, I think there are a few particularly critical issues on the policy side of this partnership, for example:

- *Leadership* is essential; there must be "champions" on both sides of the partnership;
- Adopting a new technology likely requires change in existing systems/frameworks; *embracing change requires demonstrating value* which, in turn, requires:
 - *Building and sustaining trust* in both the information and the providers;
 - Clear understanding of the policy context and specific information needs; how will this help me do my job;
 - Integration with traditional knowledge and practices;
 - Information products that are useful, usable and delivered at appropriate times in appropriate formats;
 - Support for capacity-building;
 - Flexibility in policy/management structures;
 - Opportunity to fail.

- Most decision-makers address issues along a *continuum of weather and climate timescales*; remember the special significance of extreme events;
- Can you help me *address today's problems while planning for the future*?

Climate forecasts will be integrated in the context of existing decision-making frameworks that often involve a myriad of interacting stresses, considerations and constraints. Recent experience in the Asia-Pacific region emphasize the importance of understanding those individual policy/decision-making frameworks as a first step toward determining how and in what ways forecasts of climate variability can most effectively be applied to enhance the resilience of governments, communities, businesses and natural resources. We must also be willing to accept that other considerations – economic, social, political or cultural – may win the day (over climate information) in any given decision.

Question (2): How can the policy/decision-making framework be improved?

For the purposes of answering this question, I would like to focus specifically on the climate prediction-policy partnership in which the scientific and forecasting communities are partners with decision-makers in a process of shared learning and joint problem solving. Recent experience in the Asia-Pacific region (and, I suspect, elsewhere) suggest that there may be a set of guiding principles that we might consider as we strive to improve the kind of climate prediction-policy partnership we might envision.

During the March 2003 Symposium on Climate and Extreme Events, participants suggested the following:

- *Utilize a team or network approach* with decision-makers, forecasters and scientists engaged in a sustained, participatory, iterative process:
 - Building and sustaining trust is essential; continual interaction is necessary
 - Encourages responsiveness to user needs
 - Process as important as products;
 - Facilitate integration of new scientific insights and capabilities
 - Learn-by-doing; shared responsibilities for continuous evaluation and adjustment.
- *Build on existing systems, institutions, programs, relationships and networks* and recognize the important *role of trusted knowledge brokers*, e.g.:
 - Industry associations
 - Private-sector
 - Community leaders
 - Local research, education and outreach institutions
 - Local forecast offices
 - NGOs
- *Training, education and outreach* essential and continuous

So, what near-term steps can we take to advance the emergence of a more effective climate forecasting-policy partnership? In the spirit of getting the ball rolling, I might offer the following:

- Consistent with the NRC report “Making Climate Forecasts Matter” (National Research Council, 1999), *document and evaluate/review experiences* in ENSO-based climate forecast applications in various geographic regions and sectors and attempt to “*scale-up*” the lessons from these individual projects in the context of a climate prediction-policy partnership;
- Continue individual demonstration projects in individual sectors, nations and regions and develop mechanisms for ensuring that insights are routinely integrated in climate services discussions at national, regional and international levels;
- Provide opportunities for continued science-policy dialogue focused on climate-sensitive sectors to identify critical information needs, enhance understanding of vulnerability and improve assessment methodologies, explore response strategies, and increase awareness of current and emerging forecasting capabilities and decision-support tools; and
- Identify one or more “grand challenges” that provide a strategic focus for organizing our shared efforts to advance the mainstreaming of climate information in policy formulation in the near-, medium- and long-term (e.g., climate risk management?)

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How can US policy makers take advantage of climate science?

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Over the past two decades, scientists have achieved remarkable advances in the probabilistic forecasting of seasonal and interannual climate variability associated with the El Nino Southern Oscillation (ENSO). Utilization of this capability by the policy making apparatus towards enhanced social benefits, however, has lagged far behind. Pressure to optimize performance have not led to the incorporation of forecast information in decision making. A majority of policy and decision makers, across sectors as varied as water resources management, fire prevention and winter tourism, avoid using probabilistic forecast information in their planning and policy making.

This note proposes that a key challenge facing the climate community is the need to co-evolve a socially meaningful partnership with policy makers on the utilization of seasonal and interannual climate forecasts. In this background note we propose to begin this process by engaging a diverse set of policy makers in a process of problem definition towards the utilization of climate forecasts. It is clear to us such a process is not guaranteed by the production and distribution of seasonal forecasts alone, however good they may be. Even regional forecasts, carefully tailored to the needs of specific policy making apparatus will not guarantee their (continued) usage. There needs to begin an appreciation of the nature of institutions and of the challenges involved in their adoption of techno- scientific solutions including issues of scale, legitimacy, reliability and uncertainty. In order to catalyze discussions at the Forum, we identify some of the key issues that, we believe, have prevented the routine use of climate forecasts in resource allocation settings. They are: (a) Deficiencies in climate forecasts/outlooks that inhibit use; (b) Issues with the use of climate forecast information; and (c) Cultural and institutional barriers to change. The key challenges are discussed in the following sections.

This note, we hope, will catalyze a more comprehensive reflection of the issues at the Forum, and signal the beginnings of a new process of mutual partnership between the US climate community and the users of climate science.

A. Deficiencies in climate forecasts and outlooks that inhibit use

(1) Lack of spatial and impact specificity

Climate forecasts are generally spatially unspecific with respect to the mission of departments and agencies. The scale of information is generally too large vis a vis

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resource management decisions. Resource managers are unlikely to use forecasts that lack spatially relevant climate information. Effective utilization by policy makers also requires targeted information on likely consequences of the climate information. Downscaling from regional-scales to specific-watershed scale is often possible. The models, however, are often based on general assumptions about physical processes rather than a accurate understanding of processes at the specific locale. Lack of historic data, is often a key constraining feature in formulating location specific models. In addition, climate outlooks are not in of themselves sufficient for use in complex decision-making processes. To be effective, the climate information needs to be understood in terms of impacts on the variables that are of interest to a decision-maker. Scientific understanding of the relationship between climate forecasts/outlooks and the resulting response in ecosystems, water resources and quality, fire potential etc. is in its infancy. It is, therefore, not surprising that routine regional forecasts have little attraction to policy makers who are concerned, for example, with managing specific watersheds.

(2) Predicting social system dynamics

Utilizing climate forecasts effectively depends on understanding the responses of the target system. As noted above, downscaling holds some promise. Recent climate forecast applications work has paid a good deal of attention in detailing the biophysical and economic impacts and responses as a consequence of changes in climatic input. However, work has been woefully inadequate in understanding the social and political responses of complex target systems.

(3) Managing temporal risks

Seasonal climate forecasts are probabilistic statements. They provide opportunities for the policy maker to review future decisions to reduce risks or to take advantage of opportunities. They can be used to make a case to generate either a gain or a loss when compared to a status-quo decision. However, forecasts are average conditions over a 3 month average (season) and are silent regarding variability within the season. Climatic departures from the forecast, within a season, can confound the average expected risk level for the season and render management of the system difficult.

B. Issues with the use of climate forecast information

(1) Opaqueness of complex knowledge

Most policy makers have limited exposure to climate modeling. The computational complexity involved in making seasonal climate forecasts creates barriers (“opaqueness”) that may hinder the understanding of model outputs. Explanations of modeling procedures or of probabilistic forecasts themselves tend towards the abstract. The language of a long term probabilistic seasonal forecast is often incomprehensible to the uninitiated. Policy makers may find it difficult to truly grasp the meaning in “model output statistics.” This potential lack of understanding may leave the policy makers feeling vulnerable.

Adoption of climate forecasts may hence require placing faith in science that is out of the experiential for most policy makers. It requires the adoption of unfamiliar (and uncertain) knowledge -- a path that most institutions are structured to avoid. Institutions prefer instead to use a “second best” (but tried and tested) solution.

(2) Knowledge translation and communication

Climate information is no more uncertain than many other issues that are routinely considered by policy makers in strategizing risk management. However, in order to be of use to the policymaker, that uncertainty needs to be characterized and quantified in order to be managed.

Most policy makers are not climate scientists. The use of new scientific knowledge (especially of a probabilistic nature) requires intermediaries to translate the knowledge content into usable bytes. Researchers from universities and think tanks (as well as the private sector) are central in tailoring forecasts to specific needs. Such translation requires active two-way interaction between the scientists and policy-makers in order to understand where and when the science is needed in their decision process and to enhance trust in the use of the climate forecast. The perceived absence of reliable intermediaries or knowledge brokers may force officials to be translators, resulting in enhanced exposure to potential failure.

Finally, communicating probabilistic information needs to be done using a variety of methods and techniques. A skill score on a climate forecast may be of little value to a policymaker because of the lack of experiential knowledge of what that skill score implies. Research, in partnership with the users, on the multiple ways to effectively translate and communicate probabilistic information is needed.

(3) Tolerating system inefficiencies

Resource management systems have built-up over time buffers to external vicissitudes (including climate variability). Hydropower utilities, for example, can routinely draw on a number of back-up systems. This is a good feature if it can maintain system resiliency at comparable efficiency levels. However, in many cases that is not so (and often due to sound political reasons). Most public institutions are not structured to penalize system inefficiencies. Lacking disincentives, institutions tend to maintain high tolerance for inefficiency and to forego increases in system efficiencies (such as by utilizing probabilistic climate forecasts).

C. Cultural and institutional barriers to change

(1) Institutions matter

Many enthusiasts of climate forecasts relegate the complexity of utilizing forecasts by institutions to the domain of “application.” The assumption is that having overcome the difficulty of the production of a climate forecast, its application is a simple matter and without cost. For a number of reasons, many of which are discussed in this note, uptake of forecasts by institutions is a complex process. The need to design new sub-routines, change customary practices familiar to the rank and file, evaluate social and environmental practices in light of the new scientific understanding, all impose a huge burden on

institutions. The learning that is required within institutions is often ignored to the peril of climate forecast adoption.

The use of climate forecast, may require the overhaul of long-held beliefs and the adoption of new and innovative procedures. Institutions, in the absence of sustained external pressure, generally avoid sweeping changes to practice. They tend towards conservatism, in adopting practices and technologies that are familiar to members and can be related through experience.

(2) Managing uncertainty

Bureaucracies, much like humans, manage uncertainty by seeking to reduce system complexities to those dimensions of core interest to their mission. To manage uncertainty, civil engineers, for example, create infrastructure solutions (controlling nature and creating buffers while ignoring biodiversity complexities) while economists pursue property right allocations (to enable market based solutions that potentially have socially unjust outcomes). In climate-sensitive sectors such as agriculture, the use of climate forecasts has been generally limited to the coupling of climate and bio-physical models oriented towards enhancing production for a potentially narrow range of stakeholders (those well resourced and able to exercise alternate choice). Such usages have left a climate science information gap for the relatively under-resourced parts of the sectors which potentially contributes to an increase in social inequity.

Aversion to risk is a hall mark of all institutions. Most policy makers look for solutions to problems that are expected to yield results that are no worse than those from current practice. They are unlikely to rush to change current organizational procedures, and embrace probabilistic climate forecasts that may yield a range of different results. Programs that utilize long-term climate records (a continuation of current practices) are favored, even though such practice offers a greater likelihood of an undesirable outcome than the use of probabilistic forecasts, which take into account the long-term record and uncertainty.