DRAFT
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Proposed Needs and Options from the National Drought Policy Commission's Monitoring and Prediction Working Group in Reference to The National Drought Policy Act of 1998, Public Law 105-199

The assessments, comments and recommendations given below are specifically aimed at addressing the monitoring and prediction component within each of the duties or objectives of the National Drought Policy Commission and its working groups. Some of the options given are specific to the Commission's study while others are directed at actions or activities that could or should be implemented following the development of a national drought policy.

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Summary: A comprehensive integrated drought monitoring and data acquisition system needs to be established in order to provide early warning of impending drought and other climate related events so that local, state, tribal and federal officials can implement appropriate mitigation and response measures in a timely manner. A national drought assessment product and report should be prepared on a bi-weekly (or weekly during the growing season) basis for use by decision makers at all levels. The foundation for all monitoring and prediction activities is predicated on the continued or enhanced support of our nation=s data collection networks. The most fundamental need is for better geographic coverage and timely access to spatially detailed observational data, especially from sites with a long, well-documented history. Easier access to data will allow for quicker assessments and decision-making at all levels.

Sec. 4(b)(1) "determine, in consultation with the National Drought Mitigation Center in

Lincoln, Nebraska, and other appropriate entities, what needs exist on the Federal, State, local, and tribal levels to prepare for and respond to drought emergencies; "

NEEDS:

1) data collection systems need to be modernized to allow for both timely aggregation and dissemination of products and assessments
2) sufficient support, expansion and maintenance of various data gathering networks located across the country
3) data need to be in a standardized format to allow for easy assimilation among all users
4) centralized access paths to existing drought products, and to create new derived products which specifically address and portray the most important components of drought
5) research, develop and improve current monitoring and prediction abilities

1) data collection systems need to be modernized to allow for both timely aggregation and dissemination of products and assessments

The most fundamental need is simply for easier access to spatially detailed observational data from long-term sites which can furnish the needed historical perspective. Many of these data sources exist already, and others need to be initiated. Access to timely data will allow for quicker assessments and decision making at all levels.

2) sufficient support, expansion and maintenance of various data gathering networks located across the country

There is a critical need for nation-wide integration of the numerous unique existing climate, hydrologic and soil moisture/temperature monitoring networks, as well as integration of data from new sites, to provide a comprehensive coverage nationwide. These networks in turn will feed essential data into a coordinated national drought monitoring system and will be used to make timely assessments of both current and expected conditions.

3) data need to be in a standardized format to allow for easy assimilation among all users

Data and metadata (information about the data) standards need to be established, and older sites and systems modified, to meet requirements allowing for consistent current and historical data sets which in turn drive analyses, assessments and model predictions. The utility of these sources for effective drought analysis is severely limited by non-universal data standards, unreliable and inconsistent data availability and no integrating source for the information.

4) centralized access paths to existing drought products, and to create new derived products which specifically address and portray the most important components of drought

Currently, drought monitoring, assessment and prediction products are spread out over several Federal agencies. A centralized web location for the posting and dissemination of this information would strongly benefit the monitoring and awareness effort.

The various and often conflicting federal information sources dealing with drought must be eliminated. A centralized coordinating entity would provide "one official voice@ derived from a consensus of all federal information sources and serve as an efficient source of critical information and analyses related to drought. A web based interface needs to be employed to allow for easy access by users. The users can then also provide useful and essential input back through the interface.

A basic need exists to supply the media and all concerned parties with a suite of drought information products, projections and assessments of current conditions. Consolidated climatological, meteorological and hydrological product(s) generated by a number of Federal and State agencies would increase public and private awareness on drought as a disaster while also informing them of current or emerging drought conditions across the nation. Establishing generalized definitions of terms used in the monitoring, assessment and prediction of droughts would be most useful.

5) research, develop and improve on current monitoring and prediction technology

Deficiencies in drought monitoring and prediction products can be improved with more research and technology development into new types of data, new and improved instrumentation, and new methods of analysis and modeling using the latest in state-of-the-art technology. Users with specific needs, from agricultural producers to navigation interests, would be included as partners in researching and developing products so that they are truly useful to the sectors affected by drought.

OPTION:

Support a national entity to acquire, assess, inform and educate the citizenry of the status of drought, its risks, and how they can prepare to mitigate economic, natural resources, and impacts. The desired outcome is an entity to coordinate a nation-wide effort that would integrate various partners and resources to provide data and drought education in an easily accessible way that is of consistent and certified quality. This entity must have firm recurring funding and a defined role in the nation's infrastructure of drought monitoring and assessment activities.

Sec. 4(b)(2) "review all existing Federal laws and programs relating to drought; "

A thorough review and inventory of existing Federal laws and programs pertaining to monitoring and prediction of drought was undertaken by this group and others. These are identified in the list of programs maintained by the NDPC staff.
Most drought programs provide good emergency response and relief with economic stability as the desired end result. In many cases, such programs are activated by law when certain data and/or derived parameters pass a threshold level. Ironically, the accuracy and existence of the

data collected and used to trigger these actions is seldom addressed by the various laws and federal programs currently in place. The data often lack common units, standard formats, metadata, ready access, quality control, historical records, consistent resolutions, and the consistency of record that should be used to place a current drought within the context of historic droughts.

These shortcomings are evident in nearly all of the current programs reviewed and described in the Inventory of Federal Drought Programs compiled for the National Drought Policy Commission by the Western Drought Coordination Council and the National Drought Mitigation Center. The resultant incomplete, inconsistent, and disparate data sets need improvement to support routine and special assessments of drought risk or effective information efforts for users. Correction of this data deficiency is basic to any improvement in federal assistance to the public.

Sec. 4 (b)(3) "review State, local, and tribal laws and programs relating to drought that the Commission finds pertinent; "

Until very recently, many States as a matter of policy placed primary responsibility for drought action (including monitoring and assessment) with the Federal and local governments. (Walker, W.R. and others, 1991)

In those states that have drought plans (approximately 30), there are typically a series of trigger mechanisms which initiate different degrees of response as drought worsens or ameliorates. Without exception, an implicit assumption, seldom stated, is that the necessary physical data will (somehow) be available to make the determination as to wether circumstances are declining, maintaining, or improving.

In practice, nearly all climate records of the necessary length have been gathered under the auspices of the federal government, primarily the Department of Commerce for the past half century, and the Department of Agriculture prior to that. A few state and local records span the necessary length of time, but these are not usually stored with, and accessible by means of the same vehicles as, the federal data.

It is thus a dangerous assumption that these same federal records will be available when needed. In addition to generally being shorter, state and local records are often under heavy pressure when budget shortfalls appear. At the local level, monitoring is often viewed as something of a luxury, an expendable activity when budgets tighten, and harder to justify when competing against potholes and schools for dollars.

In addition, the resources needed to analyze and interpret state and local climatological and hydrological observations or predictions, and place them in context, are scarce, and often not present.

A second type of monitoring is often lacking as well, the monitoring of impacts ("assessment"). It is crucial for the credibility of drought monitoring efforts that hydro-climatological evidence be corroborated by impact evidence from the field, of those systems--human and natural--that are being affected. Understandably, there is extreme nervousness about recommending emergency actions on the basis of climate and water information alone. Confirmatory testimonials from those impacted are needed. In many cases, this local information, even if it exists, does not readily and automatically make its way into the regional and national impact assessment process.

The proposed three-tiered National Climate Services infrastructure (state/regional/national) should be promoted and utilized to connect the data and information needs and flows between these different scales.

The lack of a coherent system for feeding accurate and timely impact information up through the local/state/regional/federal hierarchy, as the consequences of drought unfold, acts as a deterrent for effective reaction and results in an early warning system which is tilted toward climatic evidence rather than practical impacts.

Because similar national pressures occasionally lead to federal monitoring cutbacks (witness recent closures of many excellent long-term USGS streamflow gages), we often encounter federal and state/local entities trying to leverage the efforts of each other, a sort of shell game that leads to no real improvement in the quantity, quality, or timeliness of the information needed by both, but looks good on paper.

Local and state responses to drought need locally detailed climate information from dense networks, placed in historical perspective, to be of any value to local decision-makers. In recent years there have been several instances in western states of national-level products based on limited data and spotty observations (or even no data, relying on interpolations from neighboring regions) being preferred as decision aids, in the face of contradictory field evidence from impacts, or of climatic information (both as raw data, and as indices) from different sources indicating both wet and dry conditions for the same area at the same time. In these cases, the climatic information was thrown out altogether.

This is indeed unfortunate, as regulations, laws, past practices, and common sense require substantiating evidence in order to justify drought assistance. Since the basic unit of drought relief is often the county, a basic commitment should be made that every county has at least one active climate station (more for larger, or more populated, or climatically diverse counties), and that their observations be transmitted to the regional and national data repositories at least once each day.

Though not specifically mentioned so far, the same problems affect the tribal regions. The biggest void found on a map of western climate stations is always the Navajo Reservation. Very few reservations have adequate long-term climate monitoring sites. Many (most) have had a difficult time committing to long-term, high-quality monitoring programs, a reflection of a number of historical factors tracing back a couple centuries or more. At the same time, the tribes are a, and perhaps ***the***, key player in the resolution of a number of fundamentally important water

issues; in spite of this, desired information pertinent to their water supply and demand is sorely lacking.

Sec. 4 (b)(4) "determine what differences exist between the needs of those affected by drought and the Federal laws and programs designed to mitigate the impacts of and respond to drought; "

NEEDS:

1) better dissemination of assessments and products that meet users needs
2) continual need for improved prediction (forecasting) capabilities
3) better ways of incorporating feedback from users into products
4) thorough assessment to determine future monitoring and prediction needs

1) better dissemination of assessments and products that meet users needs

Better interpretative and impact assessment products are needed to evaluate droughts (location, intensity, etc.) occurring across the United States. Basic soil moisture, soil temperature, crop stress, hydrologic and climatic information is sorely inadequate. Information systems are not available to process the available data into readily available and useful products and the data collected is not in a standard format that can be shared easily.

Improvement in real-time data collection and dissemination is essential so that there can be reliable input into drought monitoring and assessment as well as in decision making.

2) continual need for improved prediction (forecasting) capabilities

Improved, timely forecasts are needed in order to give users the best available information at the earliest possible time so that mitigative decision making and policy implementation can take place.

Some progress has been made on the prediction of rainfall on a daily time scale using numerical weather prediction methods, and also on multi-seasonal time scales related to the impact of El Niño. However, research efforts are needed to yield a meaningful suite of monitoring products, instruments, or predictions that are relevant to the needs of agricultural producers and water suppliers and others. These needs span the time continuum from days to decades.

Verification of drought forecasts should be made readily available. Some educational capacity needs to be built in to these predictions so that the meaning and limitations of the forecasts are clearly understood by users. At this time, current products are not flexible enough to be adjusted for specific user needs.

This is coupled by a need for more accurate and more quantitative forecasts of precipitation as well as better forecasts of runoff and streamflow. Forecasts giving the probabilities of recording various precipitation totals would also be useful. A forecast of the number of hours temperatures will remain above or below freezing would help in forecasting snow pack and runoff.

3) better ways of incorporating feedback from users into products

Reforming products to meet the needs of users, expressed through their feedback, is a major missing component in both monitoring and prediction products. A needs assessment study would help to determine what products are used most or need improvement and to help recognize a need for additional products that may fill a void.

Improved relevant assessment and prediction tools need to be developed and implemented. Information dissemination is not consistent but becomes an event related matter, thus, it is generally delivered too late for most affected users or producers to utilize.

Present laws and programs do not provide for the infrastructure, or essential agency integration systems, to develop and efficiently deliver the right information, in the proper medium and format, that is both useful and available to those affected most by drought. Many so-called formalized ADrought Programs@ provide only for reactive emergency relief, not pro-active mitigation actions.

Current formalized research is insufficient to address needs or opportunities for optimizing preparedness efforts. Research and technology development are needed to help the various sectors affected by drought maximize water-use efficiency before the onset of drought. This in turn can affect what is monitored and how predictions will be made.

A need exists for continual monitoring of hydrological, climatic and other parameters such as soil moisture and soil temperature. This provides for a consistent base level of historical information from which to assess droughts.

4) thorough assessment to determine future monitoring and prediction needs

Information contained in any monitoring and prediction product, report or assessment to a user needs to allow for user feedback. Information from the managers should flow back to a central, official drought monitoring and assessment entity in an organized fashion, providing information such as reservoir stores (if possible with some degree of historical perspective) and the details of implemented drought management measures when they occur. This entity would also serve to both monitor and record impacts in order to better understand why and when they occurred during the evolution of the drought.

Current drought education is not effective enough in changing agricultural practices, water conservation technology or techniques, or in changing user perceptions of drought and its role in the overall use and sustainability of our natural resources.

OPTION:

Implement as described in **Sec. 4 (b)(1)**

Sec. 4 (b)(5) "**collaborate with the Western Drought Coordination Council and other appropriate entities in order to consider regional drought initiatives and the application of such initiatives at the national level;** "

NEEDS:

1) To develop a drought information system that integrates climatic, hydrologic and soil moisture information from various sources for local, regional or national use. Assessments of current conditions and better forecasts of drought as well as risk assessment are also needed locally and regionally.

The Western Governors Association sponsored Western Drought Coordination Council (WDCC)
brought together the primary agencies or groups involved in monitoring, assessing and predicting demonstrating the effectiveness of an integrated approach, but also defining clearly, the serious requirement for soil climate monitoring and assessment to support effective predictions.

The WDCC drought monitoring, assessment and prediction group activities were well coordinated among many Federal, State and local agencies. A method of data acquisition, assessment and risk analysis was followed that could serve as a blueprint for a coordinated national effort. The WDCC=s monitoring effort clearly showed a necessity to have a regional focus in order to provide interpretations that were accurate and meaningful at all levels and by all users.

OPTIONS:

Support implementation of a national monitoring effort that utilizes the existing state climatologists, Regional Climate Centers, various federal agencies involved in monitoring and the National Drought Mitigation Center in order to assess and monitor regional drought differences. The network should produce regional assessments that can be integrated into a national product.

Initiate a drought user/research/operations web site to determine needs of various users.

Sec. 4 (b)(6) "**make recommendations on how Federal drought laws and programs can be better integrated with ongoing State, local, and tribal programs into a**

comprehensive national policy to mitigate the impacts of and respond to drought emergencies without diminishing the rights of States to control water through State law and considering the need for protection of the environment; "

NEEDS:

1) An entity should be authorized to fully integrate the various drought monitoring and prediction technologies and information resources, to provide quality, unbiased, standardized, consistent and easily accessible current information and historical data.

2) States, tribal governments and others need to be taught how to interpret and use data and analyses to meet their decision-making needs. New products may also need to be developed in response to their needs. Establishing the drought information entity described above will provide the methodology foundation necessary to carry out local, state and tribal laws and environmental programs.

OPTIONS*:*

An intergovernmental forum could cooperatively integrate drought laws, programs and policy. Such an entity could also serve to help establish better data standards and the sharing of such data. This could become a basic part of the national infrastructure of resource information that would be available to all.

For a federal entity to integrate the technologies, resources, and needs to provide quality, standardized, consistent, and easily available historical and current data along with analysis.

Provide assistance to states, tribal governments and others on the interpretation and use of the data and analyses to meet their needs as decision-makers.

Conduct research to help agricultural producers and municipalities prepare for drought

Sec. 4 (b)(7) "**make recommendations on improving public awareness of the need for drought mitigation and prevention; and response on developing a coordinated**

approach to drought mitigation, prevention, and response by governmental and non-governmental entities, including academic, private, and nonprofit interests; "

NEEDS:

1) education of the public and decision makers about the nature of drought and its continual monitoring needs as well as better understanding prediction and risk assessment tools
2) to significantly increase the public's awareness on the status of identified drought(s) and the likelihood for amelioration or intensification
3) to efficiently organize and disseminate monitoring, assessment and prediction information dealing with drought
4) direct research to provide better tools to understand, monitor and predict drought

1) education of the public and decision makers about the nature of drought and its continual monitoring needs as well as better understanding prediction and risk assessment tools

Unfortunately, drought is an ill-defined concept that is based on the impacts of water shortages. Education and preparedness are the keys. Coordinated efforts among public, private and educational institutions are needed in several areas:

$ Development of short and long range, local, state, regional and tribal drought monitoring, mitigation and response plans that are in place and tested before a drought occurs

$ Better awareness of the services of the National Drought Mitigation Center whose mission it is to make the public aware of the need for drought mitigation and preparedness

2) to significantly increase the public's awareness on the status of identified drought(s) and the likelihood for amelioration or intensification

There is a significant need to educate the public on the subtle nature of a drought=s onset, its devastating impacts, and probabilities for recovery.

The best observation, monitoring and forecast information should be incorporated into a new drought product. The national drought status and forecast product should be concise and timely, issued at intervals that meet the users needs. It should be distributed as widely as possible, using the Internet and official government communications procedures.

Toward this end, a new drought classification product or index scheme should be seriously considered. Similar to the schemes or index values used (by decision makers and recognized by the public) for tornadoes and hurricanes, a 4 or 5-category drought classification scheme would

more easily convey pertinent information on drought to the public, decision makers and emergency workers.

A national drought classification product, prepared by experts from various Federal agencies in concert with the National Drought Mitigation Center, would likely be used by governmental and various private services, such as The Weather Channel, enhancing the potential for widespread use by the public and appropriate state, local, tribal, and other entities interested in drought. Better access to observational data coupled with the latest forecast technology, including the use of model ensemble output of temperature, precipitation, and soil moisture, should be used to project significant changes in a drought=s severity level, potential duration and spatial extent.

3) to efficiently disseminate comprehensive information, or products, on drought from a coordinated site

Tribal, county, municipal and state governments need access to timely information and forecasts about drought, as well as a system through which inter-governmental coordination for drought monitoring and/or response can take place.

As to better coordinated approaches in information dissemination, efforts have been underway in the form of the National Drought Mitigation Center, USDA Water Supply Forecasts (NRCS), UCAN/UWAN, NOAA WX radio, and development of web clearing houses in order to get out timely data and products.

4) direct research to provide better tools to understand, monitor and predict drought

Efforts and resources must always be dedicated to improving our existing knowledge and capabilities in monitoring and predicting droughts. Different tools and methods are needed in different regions across the country.

Historical Aproxy@ data sets are a valuable tool in helping us understand past droughts. Research in this area helps us to characterize and define our experience with the drought phenomena as it occurred in pre-instrumental times.

OPTIONS:

Implementation of proposals in **Sec 4 (b)(1)** would provide an entity responsible to achieve the concerns raised in **Sec 4 (b)(7)**. The desired outcomes include:

- **$** Consistent data sources and appropriate monitoring, assessment and prediction tools provide a platform upon which to build the education and awareness tools that are necessary
- **$** Change public awareness to show that drought is a normal part of climatic and can have lasting impacts well after the event has ended
- **$** Make all information and education awareness information available through web

services and other appropriate dissemination vehicles

Sec. 4 (b)(8) "**include a recommendation on whether all Federal drought preparation and response programs should be consolidated under one existing Federal agency and, if so, identify such agency.** "

NEEDS:

1) coordination of monitoring and prediction efforts of all agencies under the leadership of one entity with a comprehensive policy and a framework process that will allow for flexibility and timeliness in responding to changing drought conditions

"Consolidated" as used in **Section 4 (b)(8)** is interpreted to mean the bringing together of the significant, complementary, and effective monitoring, assessment, and prediction activities, tools and functions of the various programs, and entities currently involved under one entity with federal identity, official status, reoccurring fiscal resources, and adequate staff and technology available.

APPENDIX

Preface

To define for the purposes of PL 105-199 the meaning of Amonitoring@ and Aprediction@ as related to drought:

- **$** ***Monitoring includes all activities related to collecting, acquiring, managing, archiving and assessing moisture conditions as reflected by the data parameters collected***
- **$** ***Prediction is the outlook, or forecast, of future climatic or soil moisture conditions that could cause a drought to emerge or enhance or decrease the severity or extent of an existing one***

Introduction:

Drought to a climatologist or meteorologist is generally associated with lower than normal precipitation followed by a decrease in available soil moisture. To the groundwater hydrologist it is declining water tables and aquifers. For other users, it is a negative impact on his or her ability to: operate an economic agricultural operation, manage and assess the risk of wildfires, generate power, provide recreation, manage wildlife resources, sustain a viable resource without damaging its sustainability, maintain adequate water supplies, or satisfy a lifestyle.

Using an index to gauge the severity of drought and to initiate and terminate responses is a well established practice. When the index value is used solely to discuss droughts, it is usually called an index; when used as an administrative action indicator, the term Atrigger@ is used.

There are several considerations in determining whether to apply a specific index or trigger in a particular situation: Is the index available? Can it be calculated quickly, or is it reported two weeks or a month after all data are gathered? Is it reliable? Can it be meaningfully correlated with actual conditions?

For large geographic areas (ranging from continental, to multi-state and to sub-state levels) there are at least eight recognized indices. Indices provide a way to quantitatively compare present conditions with the historic record and present a relative magnitude of the drought condition. The indices each use a limited number of basic raw data: precipitation, snowpack, temperature, soil moisture and/or reservoir storage. The most common of these indices are: Percent of Normal Precipitation, Palmer Drought Index, Standardized Precipitation Index, Deciles, Surface Water Supply Index, Crop Moisture, Rainfall Index and Dependable Rain. Advances in technology have also led to a number of indices that can be derived from remotely sensed data collected from satellite sensors.

For local water utilities, these indices are supplemented or replaced with more localized information. The local indices may be as simple as a flow measurement at the point of

diversion on a river, the depth to water in an aquifer, the projected reservoir storage at some point in the future, a notification from a water supplier of the potential, or actual decreases in, delivery, or the ratio of potential demand to potential supplies.

Some response programs, particularly at the Federal level, rely on triggers that relate to actual impacts from the drought event, such as crop losses or reductions in income.

In several cases, response programs at the Federal and State levels require a very specific trigger, a declaration of Drought Emergency, by the Governor and/or President. The basis for the declaration varies across government units.

1. What is drought?

Drought is broadly defined as a condition of water shortage. This succinct definition is good for its simplicity and generality in that any user can relate to the concept of supply and demand. However, the mission of monitoring and prediction entails much more than just the problem of "water shortages", but the water supply in general. In the West especially, water is akin to a commodity for many users, trading the rights to use or consume set quantities today or at a future date. Such decisions require knowing both the risks for water shortages and water surpluses, both locally and regionally.

Drought to a climatologist or meteorologist is generally associated with lower than normal precipitation followed by a decrease in available soil moisture. To the groundwater hydrologist it is declining water tables and aquifers. For the citizen, municipal manager, and land operator (users) it is a negative impact on his/her ability to: manage and assess the risk of wildfires, operate an economic agricultural operation, generate power, provide recreation, manage wildlife resources, sustain a viable resource, maintain adequate water supplies, or satisfy a lifestyle.

Any purely mathematical and/or meteorological definition of drought will be unsatisfactory because drought is defined first and foremost by the amplitude of its impacts. The degree to which such impacts respond to the meteorology and hydrology differs markedly from place to place, and indeed even from season to season in the same place.

The notion of a single drought classification scheme has been proposed with the justification that it would offer a unified assessment of national water shortages for media, public, and institutional consumption. The scientific merits of such an approach are less clear, however, and for several reasons a single drought classification is arguably incomplete due to the diversity of users. Therefore, a combination of measures that apply to specific drought interests such as planning, mitigation, response and prediction over varying time and spatial scales is the only way to satisfy all interests. Once people have all of the available information, interested parties can discuss and assess the drought situation by considering all the meteorological and hydrologic parameters, indices, and impacts, and then make human decisions.

2. Monitoring

From a political point of view, the need for a simple single metric of drought is clear in light of the Federal commitment to underwrite State, Local or Tribal losses related to State declared drought emergencies. For example, Texas Governor Bush had declared a state of emergency related to drought in 170 of the state=s 254 counties as of Mid-April 1999. An objective measure of drought would certainly be valuable in such situations in order to substantiate the State's claim.

But for other purposes, the notion of a local index of drought seems too simple. On the one hand it takes no account of the water supply available to a region. The semi-arid West again serves as a good example. Here, a local water shortage is less relevant for agricultural, municipal, and industrial concerns than is the remotely stored water that resides in adjacent high terrains of river head waters.

On the other hand, fire weather services and open range management would be more sensitive to local water supply through its affect on timber and grasslands, and a local index of that supply would again be valuable. There are many examples on both sides of the ledger, and the point being made here is that there needs to be a diversity of products that address the informational needs of users with regard to water supply.

3. Monitoring Needs

A. Observations

Observation networks that take and transmit measurements of temperature, precipitation, and other meteorological and hydrological variables enable the detection of anomalies that lead to drought. Routine and reliable observations are also required to initialize the forecast computer models at the National Centers for Environmental Prediction (NCEP) and other forecast centers around the world. There are a number of networks operating on federal, regional, and state levels, many automated and some manual. Of special note are the several hundred first order stations operated by the FAA and the NWS, the several thousand cooperative network stations, and a number of automated networks operating regionally or statewide. While most stations take surface weather observations, a recent network established by USDA's Natural Resource Conservation Service (NRCS) takes explicit measurements of various parameters, including soil moisture, from around 30 sites across the country. In addition, there are many regional, state, and locally sponsored networks. The data collected are needed in a real-time from an easily accessible centralized data base to allow for up-to-date monitoring of current conditions.

The U.S. Geological Survey (USGS) operates nearly 7,000 streamgages nationwide, more than 4,500 of which use satellite telemetry to provide river stage and discharge information in real-time. It also monitors groundwater conditions at several thousand wells. Although not all groundwater data is directly relevant to management activities during drought, there are several

hundred wells that do provide information of potential value. The usefulness of these groundwater data is constrained, however, because they are not yet being provided in real time.

A USDA, NRCS, National Water and Climate Center (NWCC) 1992 inventory of existing Soil Moisture-Soil Temperature data sites and systems is attached. It lists over 1600 separate activities. The utility of these sources for effective drought analysis is severely limited by non-existent data standards, unreliable and inconsistent data availability and no integrating source for the information.

Limited soil-climate information can be obtained from the various disparate sources across the nation. It is also true that even after exhaustive efforts to gather this information from numerous uncoordinated sources have been conducted, applying various processes to "normalize" it for analysis over large areas and regions, it is still inadequate to support the growing demands of drought /resource assessment and management and risk assessment models. The existing data sets tend to be application specific, short-term in scope, incomplete, and limited in their coverage area. Many include nonstandard sensors with varying degrees of quality control applied.

There is a critical need for nation-wide integration of the numerous unique existing climate and soil moisture/temperature monitoring networks, as well as utilizing data from new sites to provide for a comprehensive coverage of the nation while also providing data pertinent to individual farmers and other small entities using smaller areas on the landscape. Data standards need to be established, and older sites and systems modified, to meet requirements allowing for consistent, current and historical data sets to drive analysis and risk assessments.

B. Assessment

Water users, institutional authorities, and the media will not be uniformly familiar with drought indices to use them to develop useful information on drought. Different stakeholders (e.g., the agricultural community, government agencies at different levels, industries, environmental managers, etc.) will require different types of indices and context information to be able to make rational decisions regarding mitigation or response. Thus, simple communication of indices to different stakeholders will not be enough information to constitute Aassessments@ of drought. Putting the index value of a current or projected drought into historical context enables a user to interpret the severity and likelihood of the event. For example, water suppliers or crop insurers probably would find recent precipitation records, soil moisture measurements, or other quantitative but simple indices alone inadequate as Aassessments@ on which to base decisions. Although the quantitative indices are a starting point for communications dealing with drought, their use as triggers in planning or decision making is minimal without historical and geographical context.

Monitoring efforts should be extended to assessments to include compiling surface or soil measurements into maps or tables that summarize weather conditions over time or space. This information can then be used to develop context statements as assessments of the extent of significant anomalies. Currently, there are a number of drought indices that are disseminated in

tabular and map form via the Internet, DIFAX, and/or publications. The indices generally use temperature and precipitation data to estimate soil moisture anomalies at various depths. Among those indices used the longest are the Palmer Drought Index (PDI) and the Crop Moisture Index (CMI), both of which are disseminated via publications such as the Weekly Weather and Crop Bulletin and over the Internet and DIFAX. A newer index is the Standardized Precipitation Index. Both the PDI and the SPI have been calculated for all the U.S. climate divisions back more than 100 years, making these indices especially useful for historical analyses and comparisons. Historical data on precipitation, temperatures, and drought are maintained principally by the NOAA/NESDIS National Climatic Data Center (NCDC) and their Regional Climate Centers (RCCs). Both the RCCs and NCDC disseminate recent and historical data and information via hard copy, magnetic media, and the Internet.

A number of federal agencies produce publications or Internet reports analyzing current or recent climatic variations or extremes, including drought. NCDC, the RCCs, and the NOAA/NWS Climate Prediction Center, for example, issue periodical reports that can be used to monitor dryness, as well as special reports on extreme weather events on an ad hoc basis. The NOAA/USDA Joint Agricultural Weather Facility's (JAWF) Weekly Weather and Crop Bulletin is especially useful for monitoring U.S. weather conditions, as it includes considerable weather data and information on weekly, monthly, and seasonal time scales. The Web sites operated by CPC, NCDC, the NWS Hydrologic Information Center, and NOAA's Climate Diagnostics Center offer considerable information on current anomalies, including drought. This is also true of the USGS web sites that provide both current and historical streamflow data on a state-by-state basis. USGS is also adding a new national daily streamflow index map to its web site to complement its monthly National Water Conditions report, as well as the hydro-climatic index products of other agencies.

Although many of these drought indices can be used as triggers, values to be used as triggers by different stakeholders for different purposes must be identified by placing them in spatial or historical context. Thus, efforts must be made not only to develop improved indices or use existing ones more efficiently, but also to improve ways of relating the values to the decision process. Improved drought mitigation will depend as much on easily communicated assessments as on the techniques of actual quantification of drought conditions.

C. Dissemination

Disseminating better information on the magnitude of ongoing droughts as well as their outlook will help to improve public awareness of the need for drought mitigation and prevention. The current myriad of products that relate to drought should be consolidated into a single national suite of products that contain credible and timely information on all existing dry areas that may evolve into drought or have already become drought. The best observation, monitoring, and forecast information should be incorporated into the drought product, which should be disseminated as widely as possible, using the Internet and official NWS communications procedures. Such a national product, prepared by experts from various agencies in concert with the National Drought Mitigation Center, would likely be used by various private services, such as

The Weather Channel, enhancing the potential for widespread use by the public and appropriate state, local, tribal, and other entities interested in drought. The latest forecast technology, including the use of model ensemble output of temperature and precipitation, should be used to project significant changes in a drought's classification. The goal is to significantly increase the public's awareness of the status of a current drought along with the prospects for amelioration or

Information to the end users needs to be a two-way street. Information from the managers should flow back to a central, official drought monitoring and assessment entity in an organized fashion, providing information such as reservoir stores (if possible with some degree of historical perspective) and the details of implemented drought management measures when they occur. This would also serve as a medium to monitor and record impacts, along with when and why they occurred.

A centralized coordinating entity is needed to provide "one official source" of the critical information and analyses. The various and sometimes conflicting information sources on drought must be eliminated. Web based technology needs to be employed to allow easy access by users who can also provide efficient feedback to the centralized coordinating entity.

There is a significant need to educate the public and decision makers on the nature of drought, the subtlety of the onset of drought, the devastating impacts, and probabilities for recovery of economic opportunity and environmental security. Emphasis on a more pro-active approach such as public information, public involvement, and drought prediction may be three good tools to improve public awareness. Drought prediction alerts the public and the decision makers of impending drought, drought severity, or the termination of drought. Public information such as school programs could familiarize the public with mitigation techniques. Public involvement in the mitigation and response activities incorporates all the stakeholders.

D. Prediction

Some progress has been made on the prediction of rainfall on daily time scales using numerical weather prediction methods, and also on multi-seasonal time scales related to the impact of El Niño. However, research efforts are needed to understand the basic drought meteorology. A better understanding of drought will yield a meaningful suite of prediction products pertaining to water supply that span the time continuum from days to decades.

Specifically, there is a need for more accurate quantitative forecasts of precipitation to better forecast runoff and stream flow, for longer range forecasts to be issued more frequently, for verification scores for all forecasts to be made readily available, for a forecast of the number of hours temperatures will remain above or below freezing (to help in forecasting snow pack and runoff), and for forecasts giving the probabilities of recording various precipitation totals would be useful.

Other thoughts and responses relative to sections 1-8:

Sec. 4(b)(1) "determine, in consultation with the National Drought Mitigation Center in Lincoln, Nebraska, and other appropriate entities, what needs exist on the Federal, State, local, and tribal levels to prepare for and respond to drought emergencies; "

Three policy shifts need to be made: (1) anticipate and assess risk, not simply react to disasters; (2) focus on mitigation that builds resilience at the earliest planning stages, not as an afterthought, and deal with mitigation comprehensively rather than piecemeal; and (3) implement warning and dissemination systems that allow society to bring its resilience in to play. (Razzaghi, A.)

Whether the drought is real or perceived, putting a current event into historical context enables a user to interpret the likelihood and severity of the event. Perhaps a more important individual need is to provide water supply interests and crop insurers (government and private) with the current status of a drought. Quantitative measures are needed, such as precipitation, soil moisture and drought indices, because these thresholds are often used to trigger drought mitigation action, or responses, for entities having contingency plans or programs.

DATA ACQUISITION:

Expand support of the Soil Climate Analysis Network (SCAN) effort proposed by the USDA, Natural Resources Conservation Service (NRCS). In the area of drought monitoring this is one of the parameters that lacks the most observed data for. SCAN would integrate information from existing soil-climate date networks and establish new data collection points through partnerships with other federal, state, local, and tribal entities. SCAN will focus on the agricultural areas of the U.S. and is completely compatible with other major federal data collection efforts such as the modernization of the NOAA Cooperative Observer Climate Network. NOAA is initiating a process to modernize data collection from long-standing climate stations by establishing a Climate Reference Network (CRN). It is expected that SCAN will complement NOAA's effort by providing soil moisture/temperature data on a scale of coverage never before possible. This soil climate data would also be of great benefit as an input to help improve forecast models at all spatial scales. Other significant USDA partners include the WAOB, NRCS, FS, ARS, ERS and NASS.

The Forest Service (FS), Bureau of Land Management (BLM), National Park Service (NPS), and Fish and Wildlife Service (FWS) all collect data for fire/drought management using Remote Automatic Weather Stations (RAWS). These stations could possibly be up-graded or modernized allowing for an expansion of monitoring sites fitted to the NRCS SCAN or SNOTEL networks in order to assess conditions in forested and upper elevation locales. Information from this network is relied upon heavily by foresters and range managers. Coordination also needs to

occur between the FS and NRCS in looking at the development of the Forest Service National Forest Systems monitoring system called the National Resource Information Network (NRIS). Coordination would allow for systems to share data between them in times of drought.

DATA ANALYSIS/DELIVERY OF INFORMATION AND PUBLIC EDUCATION ON DROUGHT:

Support the Unified Climate and Water Access Network (UCAN-UWAN) under development by USDA (NRCS) to ensure Internet delivery of drought, climate and water resource information to all interested parties nationwide. Data deliverables include near real-time observed climate, soil moisture, soil temperature, and other hydrologic data for assessing drought potential, monitoring drought development, mitigation, response and recovery, as well as appeals and legislative briefings, climate and water data products to meet real-time natural resource management, and all necessary spatial climate data sets, as well as climate generation data sets and technology for climate change and variability scenario development.

UWAN is a newly conceived USDA, NRCS, NWCC initiative proposes that partnering with the USGS to standardize the format of their water resource data records using a modified time series structure used by climate. USGS would partner with UCAN members in providing Internet access to this data. Due to the similarity in streamflow and climate information, it is proposed that the climate software developed for UCAN be made available to the USGS in a collaborative effort to improve streamflow interpretations. The NRCS also proposes that the USGS allow the UCAN members to quality control and database the climate information collected at streamflow sites.

RESEARCH:

Better prediction skill provided as early as possible is considered an essential need. Information needs to be given early enough in order to plan for or mitigate the impacts of drought. Forest and rangeland managers would benefit greatly from long-term drought predictions, and thus, research on drought prediction modeling would be useful to the federal land management agencies. A better understanding of soil water and forage production potential in rangeland ecosystems would also be useful, especially if it can be linked with models to predict soil moisture weeks to months or seasons in advance.

Improved easy to use science-based indices need to be developed to aid the average decision maker in planning.
There needs to be more research on remote sensing and drought monitoring. Resources and equipment only stretch so far. Remote sensing technology allows us to efficiently and economically monitor large areas on a relatively frequent basis.

Instrumentation and data acquisition technology advancements are needed to provide more accurate, less costly, and more dependable data.

Assessment and drought risk models need to be perfected and transferred to the decision makers as a ready to implement tool for local assessment and interpretation.

Sec. 4(b)(2) "review all existing Federal laws and programs relating to drought; "

In the area of drought monitoring, current programs are limited to data acquisition functions of the NOAA Cooperative Observer Network, NRCS's Soil Climate Analysis Network (SCAN), Soil Moisture- Soil Temperature (SM-ST) Pilot Project, Snow Telemetry (SNOTEL) systems, the Forest Service=s Remote Automatic Weather Stations (RAWS), and several scattered state climatologist and regional networks, such as the High Plains regional network in the Midwest and the Oklahoma Mesonet state network to name only a few, plus many disparate climate and soil moisture sites and systems serving local needs. These monitoring and assessment activities can be authorized (but are not limited to) under various state and multi-stage agreements with supporting state legislative authorities.

DATA COLLECTION: Drought monitoring functions of the USDA, NRCS, supporting the Soil Climate Analysis Network (SCAN), Soil Moisture- Soil Temperature (SM-ST) Pilot Project, Soil Climate Analysis Network (SCAN), and snow telemetry (SNOTEL) systems, and Climate Services (including Surface Water Supply Indices, drought assessments, and Streamflow Water Supply Forecasts) are authorized by:

[Code of Federal Regulations]
[Title 7, Volume 6, Parts 400 to 699]
[Revised as of January 1, 1998]
From the U.S. Government Printing Office via GPO Access
[CITE: 7CFR612]

[Page 564-566]

TITLE 7--AGRICULTURE

CHAPTER VI--NATURAL RESOURCES CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE

PART 612--SNOW SURVEYS AND WATER SUPPLY FORECASTS

Sec.

612.6 Application for water supply forecast service.
612.7 Forecast user responsibility.

Authority: 26 Stat. 653; Sec. 8, Reorg. Plan No. IV of 1940, 54
Stat. 1234 (5 U.S.C. App. II); 5 FR 2421, 3 CFR 1938-1943 Comp. P. 1288.
Source: 40 FR 12067, Mar. 17, 1975.

The data collection activities of the National Weather Service networks including the Cooperative Observer Climate Network, are authorized by the National Organic Act of October 1, 1890:

AThe Secretary of Commerce shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rain-fall conditions for the cotton interests, the display of frost and cold wave signals, the distribution of meteorological information in the interest of agriculture and commerce,, and the taking of such meteorological observations as many be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties.@
(Oct. 1, 1890, ch. 1266, & 3.26 Stat. 653; May 20, 1926, ch. 344. & 5 (e), 44 Stat. 571; June 23, 1938,ch. 601. Title XI, 1107 (k), 52 Stat. 1029; 1940 Reorg. Plan No. IV. & 8 eff. June 30, 1940. 5 F.R. 2421, 54 Stat. 1236; 1965 Reorg. Plan No. 2,&& 1. 2. Eff. July 13, 1965. 30 F.R. 8819, 79 Stat. 1318.)

Some of the hydrologic data collected by the U.S. Geological Survey is mandated by interstate compacts, treaties, Supreme Court and other court decrees. These instruments call for the Federal government, often the Secretary of the Interior or the Director of the USGS in particular, to provide impartial hydrologic data to meet the needs of the affected parties. Issues and concerns associated with drought are at least implicit in most, if not all, of these documents. The instruments include: the Colorado River Compact, Upper Colorado River Basin Compact, Lower Colorado River Supreme Court Decree (1964, Arizona vs. California), Arkansas River Compact, Belle Fourche River Compact, Republican River Compact, Pecos River Compact, Rio Grande Compact, Delaware River Supreme Court Decree (1954, New Jersey vs. New York), and the Columbia River Treaty.

Prediction activities are found within NOAA=s various centers and/or forecasts offices. USDA-NRCS also issues streamflow forecasts for the western states.

Sec. 4 (b)(3) "**review State, local, and tribal laws and programs relating to drought that the Commission finds pertinent;** "

No additional comments at this time

Sec. 4 (b)(4) "determine what differences exist between the needs of those affected by drought and the Federal laws and programs designed to mitigate the impacts of and respond to drought; "

Drought is too often mistakenly treated like the very short-term traumatic natural disasters, such as floods or earthquakes, with both programs and resources focusing on emergency response rather than on assessment, preparation, and mitigation. The public is poorly served when we are not able as scientists to adequately convey to them the impending disastrous consequences. Technology is available to do the appropriate monitoring across the nation and proposals have been presented as new budget initiatives over the past ten years without authorization or funding being secured. Emergency programs offer relief in the aftermath, usually providing little in the way of mitigation, however, to the real losses such as the enormous cost to agricultural production, the soil resource, sustainable soil productivity, environmental damage, and socio-economic distress that dwarf the fiscal payments extended.

In response to comments heard from participants at over six drought workshops conducted by the National Drought Mitigation Center and the Bureau of Reclamation across the United States, Mexico and Brazil in the last two years, a common question asked has been one calling for advance warning in order to make decisions and plans when there is still time to do something about it. Suggested optimal time needed to incorporate the forecasts into planning or decision making was on the order of three to six months. They also wanted to know how confident in and how well the forecasters are doing with these predictions. Anything better than 50-50 chance can be enough reason for a decision maker to hedge their bets or plan accordingly. An assessment should be made to determine if there is a need to have seasonal (long-lead) forecasts issued on a bi-weekly basis.

Many citizens affected by drought are also limited in resources, particularly on several of the Native American holdings. This can eliminate them from cooperating in new data acquisition or risk assessment. In spite of growing needs by this sector, downsizing of federal programs has made it impossible for many government agencies to serve their needs (and others as well) because that requires a contribution of funding to leverage limited federal resources. Their only aid is usually found in the aftermath in the form of emergency relief. Many of the impacts could possibly have been lessened or prevented entirely if provided with advance information and proper mitigative actions.

The Bureau of Reclamation's drought Law (P.L. 102-250) and programs are excellent in coordinating the needs with emergency assistance. The needs are determined from those affected and then mitigation is provided as available. This is a very good example of an effective Law.

Sec. 4 (b)(5) "collaborate with the Western Drought Coordination Council and other appropriate entities in order to consider regional drought initiatives and the application of such initiatives at the national level; "

No additional comments at this time

Sec. 4 (b)(6) "**make recommendations on how Federal drought laws and programs can be better integrated with ongoing State, local, and tribal programs into a comprehensive national policy to mitigate the impacts Of and respond to drought emergencies without diminishing the rights of States to control water through State law and considering the need for protection of the environment;** "

The State, in most situations, represents the unit of government that has the authority to allocate water, to set policy objectives that are concerned with water-use efficiency and equality, to consider inter-boundary and external issues associated with matters such as minimum in-stream flows, and to coordinate the activities of local governments in meeting water-supply needs during times of severe water shortages (Walker, W.R. and others, 1991). States also have defined resource and economic thresholds that define Adrought@ and Atrigger@ preventative, mitigation and response efforts.

Following the drought of 1976-77, the Comptroller General of the United States recommended that a national plan be developed for providing assistance in a more timely, consistent, and equitable manner. Issues to be considered in the development of such a plan are: (1) identification of respective roles of agencies involved to avoid overlap and duplication of activities, (2) Need for legislation to more clearly define agency roles and activities, and (3) need for standby legislation to permit more timely response to drought-related problems (Comptroller General of the United States, p. 21). To date, none of these recommendations have been acted upon.

Sec. 4 (b)(7) "**make recommendations on improving public awareness of the need for drought mitigation and prevention; and response on developing a coordinated approach to drought mitigation, prevention, and response by governmental and non-governmental entities, including academic, private, and nonprofit interests;** "

No additional comments at this time.

Sec. 4 (b)(8) "**include a recommendation on whether all Federal drought preparation and response programs should be consolidated under one existing Federal agency and, if so, identify such agency.** "

One coordinating entity responsible for drought monitoring and prediction would make the system efficient. This entity will be dealing with understanding and predicting drought, agricultural impacts, local and regional water supply impacts, energy impacts (hydroelectric),

economic interests (commodity markets), and sustainability of economic and environmentally safe agriculture, which transcend the focus of any one department or agency. From a program viewpoint, we are dealing with education, drought assessment, drought mitigation (pre-drought planning), drought response, disaster relief, research (scientific and social), etc. Therefore the entity must be chartered with a scope and capability for operations and interactions equal to this complex departmental crosscutting challenge.