Agricultural Risks in a Water-Short World:
Producer Adaptation and Policy Directions

A Workshop Summary
for an
Economic Research Service / Farm Foundation Workshop
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Workshop Organizing Committee
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Workshop Goals

With few remaining opportunities for large-scale water supply development, U.S. agriculture faces increasing competition with urban and environmental demands for water resources. The competition for water is most severe in the arid West, but increasingly evident in the more humid areas of the Eastern U.S. Drought conditions, coupled with mandated reallocations of water, strain the capacity of water storage and delivery systems and raise complex issues involving clarification of water rights and the reach of public water authorities.

The Federal government, as a major supplier and potential demander of water, plays an important role in implementing programs that affect water resource use and associated economic activity. Programs supporting conservation and information policies have helped to minimize agricultural losses resulting from water shortfalls. However, restrictions in water deliveries—whether drought or policy imposed—do occur and are not usually compensated. Further, crop insurance provisions do not cover yield losses from unanticipated water-supply shortfalls. Finally, institutions that govern water storage and allocation systems often restrict voluntary, market-based transfers that provide compensation to water right holders. As non-agricultural demands for water expand, agriculture is expected to come under increasing pressure to

reallocate scarce water resources, particularly in the western States. Minimizing agricultural income losses and the sustainability of regional agricultural systems are among the challenges for water reallocation policy.

This workshop provided a forum for interaction among those concerned with the nature and extent of potential water-supply restrictions, the farm-level response and resulting economic impacts of water shortages, and the policy and institutional responses to reduced agricultural water availability. The workshop brought together top academic researchers, water policy experts, agency decision-makers, and stakeholders to exchange information and perspectives on policy measures that reallocate water resources while minimizing or compensating agricultural income losses.

The workshop included presentations and discussion on a range of topics, including:

- Estimation methods and associated values of agricultural production losses from reduced water supplies.
- Alternative mechanisms to mitigate agricultural risk associated with uncertain supply and demand for water.
- Institutional issues concerning law, water systems, and financial markets.
- Stakeholder concerns, including environmental, water user, and state government perspectives.
- The future Federal role in the mitigation of water supply risk for irrigated agriculture.

The workshop was co-sponsored by the Economic Research Service and the Farm Foundation, with funding support from USDA's Risk Management Agency (RMA).

[*The following summaries were developed at ERS based on available workshop PowerPoint presentations. The information and policy suggestions are attributable to workshop presenters and do not necessarily represent the views of the Economic Research Service or the U.S. Department of Agriculture*.]

Workshop Session 1 - Monday, May 24, 2004

Opening Comments—Utpal Vasavada, ERS
Welcome to ERS—Kitty Smith, Director, Resource Economics Division, ERS
Welcome to the Workshop—Steve Halbrook, Farm Foundation

Marcel Aillery, ERS

Opening Workshop Overview

The ERS/Farm Foundation workshop received its study directive through the ***Farm Security and Rural Investment Act of 2002***. Specifically, this Act directed that:

> *"the Secretary of Agriculture shall conduct a study of the feasibility of expanding eligibility for crop insurance […] and non-insurance crop assistance […] to agricultural producers experiencing disaster conditions caused primarily by Federal agency action restricting access to irrigation water […]" (Title X—Miscellaneous, Subtitle B—Disaster Assistance, SEC.10108).*

The workshop's three primary goals were to: 1) broaden dialogue among USDA's Risk Management Agency-funded research cooperators, ERS staff, and water stakeholders on the economic impact and alternative/potential policy responses associated with the risk of irrigation water-supply shortfalls; 2) provide a forum for research cooperators to present preliminary findings on costs, farm-level adjustments and institutional responses to federally-imposed water-supply restrictions; and 3) obtain useful feedback for both cooperators to guide research projects and for ERS staff to develop a final RMA project report.

Understanding the impacts of water-supply risks to irrigated agriculture requires understanding the relationships among the primary factors underlying water-supply risk. The papers presented at the workshop will address these factors in varying degrees, including such factors as weather, hydrology, production technology and water-management decisions, institutions, and policy actions.

Potential income losses to agriculture and to rural economies will vary with the nature of the water-supply restriction. Factors influencing these losses include the magnitude of the water restriction, its timing, whether the supply restriction was anticipated prior to crop-year planting decisions or imposed unexpectedly after planting decisions, and whether the supply restriction is short-term (a within-season or single-year restriction) or whether the restriction is understood to be permanent.

Water-supply risk will vary significantly across a broad set of stakeholders, including: 1) irrigated producers—whose risks will vary across priority and junior water-right holders; 2) water-supply managers—whose risks vary depending upon reservoir storage and project delivery capability and flexibility; 3) environmental interests; 4) municipal uses; 5) hydroelectric power generation; and 6) input suppliers, output processors, and general community welfare interests.

Numerous policy measures exist to manage water-supply risk for irrigated producers. Potential policy options may include one or more or an integrated set of policy measures, such as: 1) variations of existing crop insurance and non-insured crop assistance; 2) buyouts of land and water rights; 3) agricultural water conservation; 4) creation of water banks; 5) creation of contingent water markets; and 6) use of tradable bonds to value and distribute economic impacts among participant producers.

Workshop papers will help to clarify the appropriate Federal role for water-supply risk mitigation. We anticipate that workshop papers will contribute information that helps to: 1) distinguish Federal actions to reallocate water from supply changes associated with natural variability in water supplies; 2) define Federal risk mitigation programs within the context of State water institutions and private water rights under State law; 3) evaluate Federal insurance mechanisms relative to other public and market-based mechanisms; and 4) assess compensation for Federal actions and potential budgetary liabilities.

Workshop Session 2

Water Shortages and the Current Federal Role in Agricultural Risk Mitigation

Moderator: Ron Marlow, USDA-NRCS

Jason Peltier, U.S. Department of Interior

Water 2025: Preventing Crises and Conflict in the West / Operations and Current Conditions of the Colorado River – May 2004

The 2001 Klamath Basin drought-induced water shortage and water conflict helped to focus national attention on the need for Federal leadership in addressing Western water-supply and water-management issues. The Federal government, through the Bureau of Reclamation (Reclamation), U.S. Department of Interior, manages 350 dams, and in the West, Reclamation dams supply water to around 10.0 million irrigated acres. In response to the need to ensure that scarce Western water resources meet the needs of growing urban populations, farmers and ranchers, Native Americans and fish and wildlife, the U.S. Department of Interior developed **Water 2025**. A proactive, problem-solving Federal initiative, **Water 2025** recognizes the long-run water interests of the American West, and is designed to provide Federal leadership in managing scarce water resources and fostering partnerships to nourish a healthy environment and sustain a vibrant economy.

For **Water 2025** to be a proactive, rather than a crisis-management program, it must recognize the water *realities* of the West, be guided by a set of *principles*, and implement *tools* that promote both conservation and water reallocation. The water realities of the West are: (1) rapid population growth rates for some areas (Phoenix, Las Vegas, Los Angeles, Denver, Salt Lake City, Boise, and Albuquerque); (2) in some areas, existing water supplies are or will be inadequate to meet all water demands even in normal water years; (3) actual water shortages generally lead to bitter conflicts, dividing neighbors and placing environmental resources at risk; (4) existing water-supply facilities are old; and (5) crisis management is not effective in dealing with water conflicts. **Water 2025** principles include the need to: (1) recognize and respect State, tribal, and Federal water rights, contracts, and interstate compacts or U.S. Supreme Court decrees that allocate water-use rights; (2) maintain and modernize existing water facilities; (3) enhance water conservation, water-use efficiency, and resource monitoring to make more effective use of existing water

supplies; (4) use collaborative approaches and market-based transfers to minimize conflicts; (5) improve water treatment technology to help increase water supply; and (6) additional water supply benefits can be acquired through more effective use of existing water-supply infrastructure. **Water 2025** implementation tools include: (1) improved conservation, efficiency, and water market structures; (2) use of cooperative approaches to help resolve conflicts; (3) improved irrigation technology, water distribution and water-management practices; and (4) removal of institutional barriers that limit/restrict conservation and market transfers, and increase interagency cooperation.

Virginia Guzman, Risk Management Agency, USDA
Role of RMA in Risk Mitigation for Irrigated Agriculture

RMA's mission is to promote, support, and regulate sound risk-management strategies to preserve and strengthen the economic stability of America's agricultural sector. In 2000, Congress extended RMA functions to include product development, expanded education and outreach programs, expanded non-insurance programs, and development of farm-level risk-management tools and information-based early-warning systems that ensure program integrity. RMA's Federal crop insurance coverage encompasses 22 different crop insurance programs covering 100+ commodities on approximately 218 million acres with an insured liability of approximately $40+ billion in 2004.

Irrigated agriculture is an integral part of RMA's program activities. Today, nearly 30.5 million irrigated acres are enrolled in Federal crop insurance programs (out of a total enrollment of nearly 217.5 million acres nationally). Currently, irrigated acres are enrolled under very restrictive requirements and generally at lower premium rates. First, irrigated acres are insurable only if there exist adequate facilities and water at the time of insurance coverage, or the "reasonable expectation" of receiving adequate water to irrigate successfully. Second, reduced water allocations that result from drought conditions during the period of coverage are an insured cause of loss. Third, reduced water allocations resulting from the diversion of water for environmental or other reasons are not an insurable cause of loss. For irrigators, "reasonable expectation" is the key characteristic for an insurable cause of loss. That is, "producers who know or have reason to know prior to the time insurance attaches that the water supply may be reduced before coverage begins or cut-off during the irrigation season, have no reasonable expectation of adequate irrigation water." For producers without an adequate water supply, they basically have four options: (1) to plant fewer irrigated acres; (2) to plant and insure acreage (for which adequate water is not available) under a non-irrigated practice, if available; (3) to report acreage (for which adequate water is not available) as prevented planting, if available, provided all prevented planting policy provisions are met; and (4) to plant and not insure acreage if there are no non-irrigated practices available.

Steve Peterson, Farm Service Agency, USDA-ERS
Water Shortages and the Current Federal Role in Agricultural Risk Mitigation: Current Disaster and Non-Insured Assistance Programs

USDA's Farm Service Agency (FSA) implements four risk mitigation programs that are primarily "natural disaster" oriented. These include: (1) the non-insured assistance (NAP) program; (2) the emergency conservation program (ECP); (3) the crop disaster program (CDP); and (4) the emergency loan program. The *non-insured crop disaster assistance program (NAP)* provides a "catastrophic" level of coverage to producers who suffer more than a 50-percent loss due to a natural disaster. Program participation requires only a $100 service fee per crop insured, with payments by farm operation not to exceed $300 per county or $900 for a multi-county producer. The program's payment rates are based on 55 percent of the established commodity market price. The *Emergency Conservation Program* provides emergency funding and technical assistance to farmers and ranchers to "rehabilitate farmland damaged by natural disasters" and for "carrying out emergency water conservation measures" in periods of severe drought. Local county committees authorize implementation of the ECP for all disasters, except for drought; here, the ECP is authorized at the national level. Conservation cost-share assistance to mitigate a natural disaster can amount up to 75 percent of the cost of the conservation practice. The *Crop Disaster Program*, authorized under the Agricultural Assistance Act of 2003, reimburses producers for qualifying losses due to weather-related damages greater

than 35 percent (or greater than 20 percent for quality losses). Producers are paid at 50 percent of the established price (for those who obtained NAP or crop insurance), or at 45 percent for those without coverage in the year of loss. Producers who obtain crop insurance or NAP can receive a payment for the same loss under this program. The *Emergency Loan Program*, authorized by a Presidential or Secretarial disaster designation, provides low-interest emergency loans (at 3.5 percent) to help producers recover from production and physical losses due to drought, flooding, other natural disasters, or quarantine. Producers must have suffered at least a 30-percent loss in crop production or a physical loss of livestock, livestock products, real estate, or chattel property.

In two 2001 cases, the Klamath Basin and the Rio Grande Valley, FSA risk-mitigation programs were applied to situations involving agricultural losses due to reduced water supplies. For the *Klamath Basin*, the Bureau of Reclamation cut-off water supplies to farmers of the Klamath Project to ensure water flows needed to protect endangered species (the Short-Nosed and Lost-River suckerfish and Coho salmon). FSA determined the area's drought to be the source of the water-supply loss and therefore considered the loss of crops attributable to a natural disaster. FSA risk-mitigation benefits included: (1) $392,000 in drought assistance for watering livestock; (2) low-interest emergency loans to producers; (3) $4.3 million in NAP coverage for producers that grew crops not insurable under crop insurance, and $1.1 million for losses due to drought under the Crop Disaster Program; and (4) "economic injury and disaster loans" for small businesses (through the Small Business Administration). For the *Rio Grande Valley*, FSA determined that many farmers shifted irrigated production to less-valued, lower water-consuming crops due to Mexico not providing an annual average 350,000 acre-feet of water required under the 1944 U.S.-Mexico Water Treaty. Therefore, FSA authorized a grant of $10 million to the State of Texas, Department of Agriculture to compensate producers for losses associated with lower-valued crop production.

Workshop Session 3-A
Costs of Limiting Water Supplies – Part I
Moderator: Donald Negri, Willamette University

Rich Adams and Dannele Peck, Oregon State University

Costs of Drought to Irrigated Agriculture: Case of the Klamath and Vale Irrigation Projects

The multi-year drought cycle for the Klamath and Vale Oregon irrigation project areas highlight the importance of water to agriculture and the need for both policy and institutional changes to more effectively manage reduced water-supply conditions for the welfare of agriculture, the environment, and society. The Klamath Project, situated along the Oregon-California border area, is a Bureau of Reclamation project which supplies 450,000 acre-feet of water to irrigate 220,000 acres of row, hay, and grain crops across Oregon and California. The Vale Project, situated in the Malheur River Basin in eastern Oregon, consists of 35,000 irrigated acres of row and grain crops (an additional 80,000 acres are irrigated in the Warm Springs and Owyhee Projects). In 2004, both the Klamath and Vale Project areas were in their 4th year of a multi-year drought cycle. Both projects also depend upon snow pack for their water supply. For the Klamath Project, water requirements for three endangered species were the reason Reclamation cut off water supplies to irrigated producers in 2001. Water supplies to irrigators were curtailed to meet the needs for Lost River and Shortnose sucker fish (ESA-listed as endangered in 1988) and for Coho salmon in the lower river (ESA-listed as threatened in 1996). For the Vale Project, to date, Reclamation has not restricted water supplies to agriculture. However, the Malheur River and its reservoirs contain the ESA endangered Bull trout (ESA-listed in 1997), which could become the focus for water-supply restrictions to agriculture in the future.

Across the Klamath Project, drought conditions for 2001 resulted in producer losses of $50-60 million. Under the government's mitigation response, impacts varied across agriculture and the community at large. For example, hay producers outside the Project received benefits through increased prices. Between $40-50 million in Federal and State emergency payments were delivered, while the 2002 Farm Bill allocated an additional $150 million for Klamath Basin mitigation. For the Vale Project (during 2001-03),

producer losses amounted to a 25-50 percent reduction in gross farm revenue for each one-foot reduction in agricultural water supply.

The Klamath and Vale Project drought experiences revealed important lessons learned, including: (1) in the case of irrigated production, existing insurance programs do not work well for multi-year drought situations, nor are they flexible enough for areas characterized by diverse resource conditions; (2) current use of "emergency" payment programs as a response to natural or man-made drought (such as water-supply restrictions for environmental needs) is likely not sustainable; (3) broader use of water banks and water markets can be effective drought-mitigation strategies; (4) water conservation can often be an important element of drought mitigation, but in some cases, use of water-conserving technologies may not be a "silver bullet," depending on the level of third party impacts; and (5) a definite need exists for improvement in water-supply forecasts for snow-fed hydrologic systems.

Ray Supalla, Scott Nedved, University of Nebraska-Lincoln, and Glenn Schaible, USDA-ERS
Economic Risk from Water Shortages in the North Platte Basin

The North Platte River basin provides water for irrigation, hydropower and recreation, primarily in Wyoming and Nebraska. The Basin includes 375,000 irrigated acres, with 75 percent of the acres using some storage water and 25 percent depending exclusively on natural flow. Most of the acreage is irrigated with gravity flow systems. Basin-wide, delivered water supplies have ranged from just less than 500,000 acre-feet to about 800,000 acre-feet. The annual amount of surface water available for irrigation is being threatened by drought, stream depletions from groundwater pumping, and downstream flow requirements to protect endangered species. This analysis used a non-linear optimization routine to assess the economic risk to North Platte basin surface-water irrigators from uncertain water supplies, including risk due to both weather variability and policy changes. The impact of water markets on risk mitigation was also analyzed.

Although nearly all canals in the basin are chronically water short, the long term water supply has been relatively stable, with a basin-wide coefficient of variation of 0.12. Assuming average water deliveries, regional gross crop revenues average about $165 million, ranging from $148 million to $175 million. The marginal value product of water for irrigated crop production varies widely across canal systems, from nearly $0 per acre-foot to $234 per acre-foot. However, basin-wide crop revenues were estimated to be less than 90 percent of the average only 2 percent of the time due to water-supply variability. This level of stability was reflected in the estimated level of insurance payments required to insure average producer revenues. Basin-wide insurance payments necessary for guaranteeing average crop revenues, assuming constant crop prices, were estimated at $12.81 per acre annually, with canal-specific costs ranging from $2 to $28 per acre annually. The probability of water shortages due to policy changes could not be quantified, but an “if this-then” analysis suggested that even a modest 25-percent reduction in the average water supply would reduce crop revenue by 9 percent and net economic returns to irrigation by 41 percent. A policy-induced 50 percent within-season, water-supply reduction would result in a basin-wide crop revenue decline of 24 percent, with net economic returns to irrigation declining by 105 percent.

Water markets were found to be a reasonably effective method of mitigating the consequences of water-supply shortages. In a water-short year, a perfect water market was estimated to increase gross revenues by $54 per acre-foot traded, resulting in a gain in net returns to land and management of about 23 percent, relative to “without market” conditions.

In interpreting these results it is important to keep in mind that the analysis assumed sudden unexpected shortages and, thus, did not incorporate shortage-induced changes in crops, irrigation technology and water distribution systems. The economic consequences from the same size of shortage might be much less if the shortage is anticipated and/or sustained over the long term. This issue will be addressed in subsequent research.

Workshop Session 3-B
Costs of Limiting Water Supplies – Part II
Moderator: Donna Lee, University of Florida

Michael R. Moore, University of Michigan, and Donald H. Negri, Willamette University
Empirical Results on Reclamation-Served Lands

Across the West, the Bureau of Reclamation oversees the operations of 355 water-storage reservoirs, 254 diversion dams, and thousands of miles of water-supply canals. Annually, Reclamation provides about 25 million acre-feet of water to 9-10 million acres of cropland for roughly 150,000 farms. In recent years, Federal water-management responsibilities have been extended to meet the needs of Federal water quality and environmental objectives. Two recent case studies of Federal environmental-based water management include: (1) the Central Valley Project Improvement Act (CVPIA), which reallocated a minimum of 800,000 acre-feet of water for fish and wildlife purposes. In addition, the CALFED Bay-Delta Program (a joint State/Federal program) initiated in 1995, may further impact California water allocations in order to restore the ecological health and improve water quality for the Bay-Delta. (2) The Pacific Northwest Electric Power Planning and Conservation Act (1980) required that wildlife needs be treated equally with other river-management objectives. In 2000, the Federal government's "Salmon Plan" (Biological Opinion) sets forth measures to be adopted by all Federal agencies with river-management responsibilities in the Columbia-Snake Basin (including Reclamation).

This research used a panel data set on crop supply, land allocation, and water use by 509 Reclamation-served irrigation districts for 1979-92, to investigate the feasibility of geographically-refined estimation at the level of a Reclamation project. Econometric-based multi-output production models were estimated for Pacific Northwest regional agriculture (including field crops, vegetables, fruits, and nuts) and for the Boise and Yakima/Columbia Basin Project areas. Land and water were assumed to be fixed and allocatable resources. For each regional model, both crop-specific land allocation and crop-supply functions were estimated as functions of crop prices, variable input prices, climate, weather, and soils characteristics, and both land and water constraints. Functions were developed for eight crops − barley, corn, wheat, alfalfa, hay, silage, irrigated pasture, and sugar beets.

Preliminary research results demonstrate that the marginal effect of a water constraint on land allocations across crops varies significantly across Reclamation projects, i.e., crop substitution effects are generally project unique. In addition, for the Pacific Northwest, producer-based crop substitution effects will likely help to mitigate the impact of environmental-based water-supply restrictions. In general, the marginal effect of a restricted water supply will be for producers to increase irrigated acreage for corn, wheat, and alfalfa by reducing irrigated acreage for barley, pasture, and sugar beets. These results demonstrate that water, modeled as a quantity-rationed input, can provide a basis for econometrically-measured water conservation impacts associated with potential Reclamation water-supply risks. Future research in this area will involve improved model estimation and implementation of conservation simulation analyses in response to water-supply restrictions for other basins, such as the North Platte basin, western Colorado, central Utah, northern and southern Great Plains, and California.

Michael Haneman, Larry Dale, and Wolfram Schlenker, University of California – Berkeley
A Hedonic Model Approach for California: Estimating the Value of Surface Water Availability

From a global perspective, humans currently appropriate about 54 percent of available surface-water runoff, which is expected to reach 70 percent by 2025. In the U.S., with growing non-agricultural demands for water, the value of water to agriculture becomes an increasingly important policy concern. For California, nearly 75 percent of surface water is used for irrigated agriculture. As urban and environmental demands for water in California increase, so also do pressures for reallocation of existing supplies. In addition, surface water availability in California is likely to become a more serious issue with climate change. Increased precipitation with climate change will likely lead to earlier runoff in California, which will likely decrease the effective supply of water available to California users, thus seriously increasing the importance of the value of these supplies to California agriculture.

California agriculture gets its water supply from three parties: (1) private individuals and irrigation districts; (2) the Central Valley Project (CVP – Federal water); and (3) the State Water Project (SWP – water moved from northern to southern California). The CVP has storage capacity of about 12 million acre-feet

(maf) and annually supplies via contracts about 9.3 maf. The largest share of SWP water goes to municipalities in southern California. SWP total water contracts average about 4.2 maf annually, with 2.5 maf exported to southern California, and 1.3 maf exported to irrigation districts in the San Joaquin Valley.

Given the numerous characteristic differences in surface-water supply in California, a hedonic model of farmland values was estimated and used to evaluate the effect of surface water availability on the value of irrigated production. This study integrated a series of primary data sources with data from USDA-NASS's June Agricultural Survey to evaluate the contribution of surface water availability to the value of irrigated cropland. Profits from planting a specific crop for a specific farm and geographic location were evaluated as a function of crop prices, input costs, crop fixed costs, and farm characteristic data. Crop-, farm-, and location-specific land values were then examined as a function of discounted profits for the farm, with the crop-specific profits parameter measuring the capitalization rate, and farmers assumed to plant the most profitable crops.

Preliminary research results show that for private and Federal surface water supplies, surface water availability is a significant determinant of California farmland value (ranging from $780 to $880 per acre-foot/acre). Water availability from the SWP had no significant effect on farmland values, probably because this water was not subsidized; that is, it was already more expensive. Results also demonstrate that: (1) decreasing water availability will have a significant effect on California irrigated agriculture; (2) larger impacts will likely be borne by junior water-right holders; and (3) study results appear to be rather robust across different model specifications.

Workshop Session 4

Water Markets as a Risk Mitigation Strategy for Irrigated Agriculture?

Moderator: Ari Michelson, Texas A&M

Rodney T. Smith, Senior Vice-President, Stratecon Inc. [Editor of Water Strategist]

Emerging Water Markets and Economic Opportunities for Agriculture

The emergence of water markets in the western United States provides new economic opportunities for agriculture. With the largest amount of the most senior water rights established under state law and recognized by federal law, agricultural areas will find themselves at the nexus of an inevitable reallocation of water from agricultural to urban and environmental uses. Transaction opportunities provide the economic incentives for investment in irrigation technology, changed management practices, shifts in cropping patterns, and even exit from agriculture through land conversion or retirement. The conserved water can provide the water necessary to meet the urban demands in established and, increasingly more important, new communities.

Since 1996, monthly water trades within Colorado's Big-Thompson (CBT) Project have ranged from less than 100 units (a CBT unit = .6 of an acre-foot) to nearly 1,400 units, with prices averaging $10,000 per unit since 1999. Quarterly trades of Truckee River water rights in northern Nevada have ranged from near zero to 2,700 acre-feet, averaging near $4,000 per acre-foot. Developers within the Reno/Sparks growth area are paying upwards of $10,000 per acre-foot of water. Since 1994, quarterly purchases of Middle Rio Grande water rights by Albuquerque have ranged from 30 to 250 acre-feet, with recent prices ranging from $5,000 to $7,000 per acre-foot. In California, long-term water conservation and transfer agreements involving Colorado River water have been arranged between the Imperial Irrigation District (IID) and the San Diego County Water Authority (SDCWA), and between the Palo Verde Irrigation District (PVID) and the Metropolitan Water District (MWD) of southern California. For the IID/SDCWA agreement, water transfers from the IID to the SDCWA begin at less than 25,000 acre-feet for 2003 and increase to 100,000 acre-feet annually between 2013-2017, and to 200,000 acre-feet annually between 2021-2047. Initial contract water prices for 2003 are at $258 per acre-foot, but could rise to $420 per acre-foot in 2017. In addition, the IID/SDCWA agreement embodies a "shortage premium" option, or potential surcharge on the base contract price that could be triggered under varying water-supply conditions for the Colorado River, dry

conditions in northern California, or the need for the SDCWA to impose mandatory rationing or conservation requirements. However, shortage premiums are suspended after 2017. Under the PVID/MWD agreement, for a period of 35 years, the MWD could pay the PVID to fallow irrigated acres, allowing up to an annual water transfer to the MWD of 110,000 acre-feet. The MWD pays the PVID an up-front payment of $3,170 per acre, and then when acreage is left fallow, an additional $620 per acre (which escalates over time).

The imperatives for the unfolding of water markets and economic opportunities for western agriculture are no mystery: clear definition of property rights, institutional changes concerning decision-making in the water industry, and manageable transaction costs. The economic value of water will become increasingly realized in market prices as economic fundamentals overrun the politics of the status quo. Development pressures in the West will not only increase the municipal demand for water but, more importantly, will not tolerate continued delay in the evolution of western water from bureaucratic control toward markets.

Ron Cummings and Susan Laury, Georgia State University, and Charles Holt, University of Virginia
The Use of Auctions for Reducing Agricultural Water Use during Periods of Drought

In April, 2000, the Georgia Legislature enacted the Flint River Drought Protection Act, authorizing Georgia's Environmental Protection Division (EPD) to establish and conduct an "auction-like" process that allows irrigators to make an offer not to irrigate within a "drought" year for a given price. Georgia State University, using methods of experimental economics, developed experiments to design rules for an auction where farmers would offer to suspend use of a permit to irrigate a given number of acres for a bid price per acre. Designed as a discriminatory price auction with iterative bidding, the EPD, given their target acreage and a budget constraint, would tentatively accept a given number of initial offers. Subsequent to announced bids, all participants were given the opportunity to revise their bids. The bidding process continued until there were no revised bids, or the EPD Director arbitrarily chose to terminate the auction.

Droughts for the area occurred during 2001 and 2002. EPD, with assistance from Georgia State University, conducted two different irrigated land-retirement auctions. For 2001, an online bidding procedure was used. A farmer's bid and EPD's response were exchanged in real time. About 33,101 acres were retired from irrigation at an average cost of $135.85/acre, with bid prices ranging from $0.01/acre to $200/acre. However, the 2001 auction was determined to be flawed because participants learned that a successful strategy involved holding-out until after EPD announces a final acceptable bid price. For the 2002 drought year, a sealed-bid with a reservation-price auction mechanism was established. The EPD Director announced upfront the maximum acceptable bid price ($150/acre) and that EPD would accept offers up to EPD's target acres (unknown to farmers). About 40,386 irrigated acres were retired at an average price of $126.05/acre, with offers ranging from $74/acre to $145/acre. Comparing bid results of 2001 auction participants who also participated in the 2002 auction, their average 2001 bid price was $170.12/acre compared to $126.05/acre for 2002. Researchers concluded that auction markets can work to reallocate water resources during a drought period.

Timothy H. Quinn, Metropolitan Water District, California
Supplying Urban Needs with Water Markets

For California, hydrologic and endangered-species (ESA) regulatory risks, together with growing urban and environmental water demands, are increasing pressures for market-based solutions to water demand/supply imbalances. Given present water demand levels, water shortfalls due to ESA regulatory risks are largest when annual water-supply reliability ranges between 40-60 percent. Generally, increased risks of State Water Project (SWP) shortfalls can be increasingly attributed to dry-year conditions that reduce SWP supply reliability for both urban and environmental requirements. The integrated nature of California's water-supply system affords it the opportunity to use different water market arrangements to meet its urban and environmental water needs.

A few of these market arrangements include the following: (1) in 1987, the Yuba County Water Agency (YCWA) began to transfer water through re-operation of the Bullards Bar Reservoir (transferring about 1.1 million acre-feet from 1987 to mid-2004). Water transfer revenues are used to fund flood control

and other local infrastructure. (2) In 1991, the Drought Water Bank for southern California secured 820,000 acre-feet in less than 2 months in which sellers were paid an average of $125 per acre-foot. (3) Local districts for the Arvin-Edison and semi-tropic groundwater basins own and operate stored water supplies for the Metropolitan Water District (MWD). (4) In Kern County, the MWD has invested $75 million in a water transfer/storage partnership that provides 700,000 acre-feet of stored water capacity, with MWD having access to a 147,000 acre-foot dry-year water supply. (5) The Palo Verde Irrigation District (PVID) and the MWD have partnered to operate a full-scale, $94.3 million, 35-year land-fallow/water transfer program. (6) For 2003, eleven water districts participated in Sacramento Valley water transfers, involving up to 110,000 acre-feet from eight Sacramento River districts, and up to 57,000 acre-feet from three districts along the Feather and American Rivers. While total options were placed on 167,000 acre-feet, final purchases involved about 120,000 acre-feet, averaging about $125 per acre-foot.

There are several core lessons from these more recent southern California water market transactions. First, water markets are here to stay. Water transfers are a viable, competitive mechanism for mitigating drought-related water shortages involving agriculture, urban, and environmental interests. Second, negotiated transfers that create local value, including value for the supply area, are more often successful. Third, the environment is and will continue to be a major buyer in the California water market. Fourth, contract terms, conditions, and alternative market mechanisms that transfer water will continue to evolve. Agriculture will continue to be a significant player in the evolution of these transfers.

Steven Parrett, Oregon Water Trust

Supplying Environmental Needs with Water Markets: Using a Market-Based Approach to Benefit People and the Environment

Oregon's 1987 Instream Water Rights Act recognizes instream uses of water as beneficial and allows for a gift, lease, or purchase of water rights for instream use to improve aquatic health. The Oregon Water Trust (OWT), formed in 1993 utilizing provisions of the Act, was the first American, private non-profit water trust dedicated to improving stream flow for improved aquatic habitat using a free-market approach. In the Pacific Northwest, use of water markets to meet environmental needs is steadily increasing with the recognition that de-watered streams are impeding salmon recovery. Water markets present equitable opportunities for the agricultural producer to lower regulatory risk while improving stream conditions for his community.

The OWT, represented by agriculture, industry, economics, law, and business, had 2003 operating revenues totaling $523,460 [42 percent from government (largely Federal), 36 percent from foundations, 11 percent from mitigation sources, 6 percent from donations and in-kind sources, and 5 percent from earned income]. OWT's mission involves improving stream flows by: 1) making deals with water-right holders to leave water instream; 2) conducting education and outreach programs on the value of stream flows and how participants can enhance stream flows; 3) developing and supporting favorable State policies contributing to stream flows; 4) advising on local, State, and Federal projects that affect stream flows; 5) funding stream flow projects; 6) conducting stream flow monitoring; and 7) supporting the activities of other water trusts.

OWT's acquired water activities have steadily increased over the years, beginning with 2 water trust deals in 1994 [totaling less than 5 cubic feet per second (cfs) of flow], and annually averaging about 120 cfs of flow during 2001-2003 with 81 deals in 2001, 83 deals in 2002, and 82 deals in 2003. Based on the 1987 Act, OWT has made use of numerous stream-flow enhancement techniques, including: 1) short-term instream leases (quantity leases for up to 5 years, accounting for up to 90 percent of OWT's acquired water for stream flow); 2) instream transfers, which can be permanent or time-limited (i.e., 10, 25, 99 years), and which can be combined with a source switch to maintain productivity; 3) reallocation of conserved irrigation water to instream uses; 4) use of forbearance agreements (which are based on flow conditions for a specified date); 5) use of diversion reduction agreements where the diverter agrees to take less than their full diversion right; 6) use of stored water contracts where unallocated stored water is released to enhance stream flow; 7) use of incentives to establish metered water use to improve self-compliance (reducing withdrawals consistent with actual water right quantities); 8) use of an "enhanced" Conservation Reserve Enhancement program

(OWT offers additional payment incentives to CREP participants); and 9) use of "point of diversion" change, involving movement of the point-of-diversion downstream to allow re-watering a stream reach.

Both OWT's average annual cost of water and the units of water transferred vary by type of transfer agreement. For *permanent water transfer agreements*, OWT's cost per unit averaged $52,714 per cfs, or $1,088 per acre, or $154 per acre-foot. For *leased water*, OWT's cost per unit averaged $5,092 per cfs, or $74 per acre, or $18 per acre-foot (based on a 5-year running average). For *conserved water*, OWT's cost per unit averaged $311,765 per cfs, or $2,585 per acre, or $748 per acre-foot.

In the future, "environmental water markets" hold a good deal of promise for the West. However, these markets will need to become more creative and dynamic. Increasing water scarcity in the West will make bidding much more competitive (particularly so for environmental needs). This trend will be influenced by: 1) the fact that the supply of water from senior right holders will decline as acquisition of irrigation water rights to meet mitigation requirements for power plants, wastewater discharge, and municipal needs continue to increase; and 2) the increasing value of water in the market place will likely greatly exceed the ecological value of water instream, significantly increasing flow-restoration costs to environmental non-profits, even though such transactions may become more financially attractive to irrigation water-right holders.

Tuesday, May 24, 2004

Workshop Session 5

Institutions: Law, Water Systems, and Financial Markets

Moderator: Richard Morrison, Attorney, Phoenix, AZ

Ray Huffaker, School of Economic Sciences, Washington State University

Existing and New Legal Paradigms for a Water-Short World

The "prior appropriation" doctrine has been the foundation of western law for over 100 years. The basic tenants of the doctrine identify a water right as a "usufructory (user's) right" to use "publicly-owned" water diverted to a "beneficial use" on a fixed tract of "appurtenant" land. The "water duty" of a right is the quantity of water measured as the amount of diverted water sufficient to irrigate an average mix of crops with the irrigation technology prevailing when the right was established. Every water right is based on the "priority date" of the right, that is, the date of first diversion and use. In water-short years, senior rights are protected from appropriation by junior right holders. In any year, junior right holders are protected from expansion of appropriation by senior right holders. Finally, the "use it or lose it" criterion of prior appropriation requires that a right holder actually use the water duty for a beneficial use. If the water duty is not used, the right holder can lose the right.

The prior appropriation system has a number of traditional and modern benefits. Traditionally, the system has promoted economic development of the West by providing secure water rights. The system has also promoted the full utilization of water where needed without tying use to ownership of riparian land. It has also discouraged wasteful use of water with its "beneficial use" requirements. Today, prior appropriation continues to provide water-right security that encourages economic development. It also allocates water across multiple uses in a fair way with relative ease of administration.

In more recent times, because the prior appropriation doctrine is believed to have encouraged the over use of a scarce resource by encouraging claims to appropriative rights (often beyond the natural system's ability to supply water quantities demanded), and because the system has failed to provide a reliable water supply for emerging non-appropriative uses (water quality, recreation, and the environment), the system has been referred to as the "Lord of Yesterday" or "a government of the living by the dead." The changing water supply/demand environment of the West has demonstrated that the prior appropriation doctrine is effectively a "net with many holes." These holes in the system's ability to meet the needs of

emerging uses reflect: 1) an erosion of the security of appropriative rights, and 2) the inflexibility of the water reallocation system.

With respect to security of appropriative rights, legal challenges to the interpretations of such concepts as exclusive ownership, specified rights, transferable rights, and enforceable rights have all tended to erode the historical security perspective. In more recent times, it has become clearer that under prior appropriation, appropriators do not hold an exclusive property right. A water right is only a "user's right to use publicly-owned water." In addition, both the "public trust doctrine" and "Federal reserved rights and regulatory programs" are often used to "condition" the use of appropriative rights to meet public interests in navigable waters, clean water, endangered species, etc.

Water rights have generally been for a specific priority date, water duty, place, purpose, and time of use. However, in a dynamic world, a water right may become less specific given that parameters of water use shift over time in response to changing circumstances. Both transferred water rights and the adoption of improved irrigation technologies may alter the specificity of a water right. These factors can also weaken third-party rights by altering the downstream supply available for appropriation when rights are transferred or when changes in drainage alter the quantity and timing of downstream flows. In some cases, the hydrologic, agronomic, and efficiency conditions may be such that increased field-level irrigation efficiency increases both water distribution uniformity and crop consumptive-use, resulting in less drainage, and therefore, negatively impacting downstream appropriative rights.

There are several factors that can impact the quantity of rights transferable under prior appropriation. One, both high transaction costs of transfers and the "use it or lose it" principle tend to encourage the status quo in water use. Two, opposition to water transfers by local communities, due to expected regional economy impacts, often induces uncertainty into the question of transferable rights. Three, uncertainties associated with the protection of transferred water from other downstream appropriators often hinders the transferability of rights.

Several factors also impact the enforceability of water rights under prior appropriation. One, water spreading, which refers to the use of conserved water on additional irrigated acres, is common practice across the West and tends to promote an illegal enlargement of appropriative rights. Two, un-metered groundwater pumping makes water rights difficult to enforce. Because most agricultural water is un-metered, significant illegal appropriation likely occurs. In a 1993 survey of Whatcom County, Washington, 500 water users were taking water without a valid water right. Three, legal suits such as *Rettkowski versus Department of Ecology* (Washington, 1993) and *Estate of Steed versus New Escalante Irrigation Co.* (Utah, 1992) have demonstrated inconsistent judicial enforcement of appropriative rights.

Because the prior appropriation doctrine was not designed to identify or remedy impairments in water rights due to changed conditions, water users have looked to alternative paths for guidance. In Washington State, water right holders have sought the use of judicially-established "uninterrupted" water rights as a means of water rights protection. Alternatively, water users have pressed for public sector financial support for new water storage projects and/or legislative bailouts of curtailed water rights.

Given the ever-increasing non-agricultural demands for water, it is appropriate that the broad institutional question be addressed, that is, should society continue to rely heavily on the prior appropriation doctrine for the 21st century? If not, modernizing the institutional framework for western water allocation could include: 1) restructuring prior appropriation principles to enhance system flexibility, including redefining "water duty" on the basis of consumptive use, and eliminating both the "use it or lose it" principle and the actual diversion requirement to perfect a water right; 2) reducing transaction costs of water transfers by streamlining administrative procedures, allowing the development of specialized water transfer arrangements, and protecting transferred water from further appropriation; and 3) providing enhanced enforcement of the water rights system by banning water spreading, noncompliant use, and use of water without a permit, banning the creation of water rights outside the statutory system, and avoiding the use of public bailouts of curtailed junior rights. Finally, a more effective institutional framework could implement prior appropriation more in conjunction with parallel allocation doctrines suited to protecting non-appropriative public uses. Greater acceptance and legal weight will need to be given to Federal and State

public water rights, and to the public trust doctrine for addressing the needs of both private and non-appropriative public uses.

Richard Howitt, Siwa Msangi, and Arnaud Reynaud, University of California, Davis, LEERNA-INRA, University of Social Sciences Toulouse, and Keith Knapp, University of California at Riverside.
Assessing Water Supply Risk from the Water Delivery System: A California Case Study in Reservoir Management

Agricultural risks from water-supply shortages are invariably inter-temporal in nature. The aim of this presentation is to explain the objective function specification and parameters that give the best results for a dynamic stochastic model of agricultural water allocation for a reservoir manager.

The stochastic inter-temporal utility of water-supply allocations depend on three primary parameters: 1) the rate of time preference; 2) whether water allocation managers have constant relative risk aversion; and 3) the elasticity of inter-temporal substitution. These parameters are key components to determining the cost of a resource manager's inter-temporal uncertainty associated with water-supply risk.

The analysis for this research examined the differences in a resource manager's expected net present values given alternative utility function specifications under both myopic and forward-looking (dynamic) functional forms. The analysis applied dynamic estimation methods to a data set of reservoir management decisions [for the Oroville Reservoir, Northern California (1974-96)] to determine the importance of changes in producer risk-related parameter values under alternative risk-preference utility specifications. The analysis assumes that management decisions inherently optimize a stochastic dynamic path of resource use and consequently maximize agriculture's dynamic stochastic utility associated with water-supply uncertainty.

Study results demonstrate that the data on dam storage and releases (for Oroville Reservoir) are consistent with a risk-averse manager with recursive preferences. These preferences are also stationary over the observed 23-year study period. The hypothesis of time-additive separability of resource-manager risk preferences is rejected, whether the utility preference model is specified with or without risk-aversion. In addition, a recursive utility preference model out performs alternative risk model specifications, with or without accounting for risk aversion. A fully-recursive model specification of reservoir storage and release management decisions is robust over a range of discount values, and model parameter estimates appear to be stationary over the study period.

When allowing inter-temporal preferences to be recursive, results show that the role of risk aversion in explaining resource management behavior is reduced. Results for this study also demonstrate that imposing time-additive separability on dynamic preference decision models may have more severe implications for behavioral analysis than most researchers realize. Finally, results demonstrate that the inter-temporal specifications of a risk-preference decision model will be critical to results, particularly when evaluating the impacts of alternative policy mechanisms addressing water-supply risks for irrigated agriculture.

Chad Hart, Scientist, Center for Agricultural and Rural Development (CARD), Iowa State University
Revenue Insurance, Bonds, and Financial Instruments

This presentation outlined the current array of government programs that provide some compensation for water reallocations or restrictions (limited to drought-related natural disasters). Current programs could be modified to provide coverage in other cases, such as water-use restrictions due to urban demands or endangered species. Alternative risk management programs are examined and the advantages and disadvantages of each are discussed.

The Federal government is both a major supplier and demander of water. In the past, the Federal government has focused most of its attention on water conservation, not water compensation. Under current Federal programs, a limited number of water risk-management tools are available to producers, including crop insurance, disaster assistance, and the use of water banks.

Federal crop insurance has existed since the 1930's. Currently Federal crop insurance covers over 100 agricultural commodities, with $40 billion in liabilities, based on an enrollment of over 215 million acres (of which 30 million are irrigated acres). Over the past 10 years, producers have paid $10 billion in

premiums, but the Federal government has paid out $20 billion in liabilities. Currently, impacts associated with water restrictions are covered under Federal crop insurance programs only if they result from an insurable cause (drought). Impacts associated with water restrictions linked to a non-insurable cause (for example, endangered species protection) are not indemnified.

For disaster assistance programs, Congress has provided disaster assistance in the past to cover drought impacts, but money is only available when Congress specifically provides for it, and its use is usually restricted to weather-related events.

Use of water banks to mitigate the impacts of restricted water supplies is becoming more widespread. Water banks are used to broker deals among water users and to help coordinate short-term water transfers. California adopted extensive use of water banks to mitigate the impacts of its 1991-92 droughts. Currently, the Bush Administration has proposed the creation of a water bank to mitigate future water restrictions for the Klamath River Basin.

The Federal crop insurance program could be expanded to allow coverage for additional crop-loss reasons (including losses associated with non-natural disaster water reallocations). The question is, at what cost? An expanded crop insurance program would require a re-rating of insurance policies to account for the probability of a non-natural disaster (that is, an imposed water-supply restriction). Incorporating the risks of a water-supply restriction into crop insurance programs would also affect the private/public partnership in the provision of crop insurance, that is, the loss-sharing arrangement between crop insurance companies and the Federal government. (Currently, only 14 companies implement USDA's crop insurance programs.) In addition, because of a lack of risk-exposure information associated with water-supply restrictions not related to drought disasters, miss pricing this type of insurance could likely affect producer production decisions, and induce production shifts which may need to be offset by crop costs, deductibles, and transition yields. Finally, with a modified crop insurance program, an important point of concern is that the Federal government, as a water supplier/demander/restrictor/compensator, would be insuring against its own actions.

Several other policy approaches exist to mitigate the impacts of Federally-imposed water-supply restrictions. These approaches include the use of direct payments, tradable bonds, use of more effective water banks, buyouts, and use of contingent water leases.

Use of direct payments is much like a drought assistance program. This approach could also affect producer production decisions. However, program effects will depend upon the producer's knowledge of the program and implementation of program parameters. Alternatively, a tradable bonds program would pay a set amount if water is restricted. Under this type of program, the Federal government would know its costs upfront (the total value of the bonds sold). Using tradable bonds, if auctioned, market forces would set the price of the bonds. In addition, producers choose their "coverage level" by their bond purchases. For a tradable bonds program, there should be no direct production effects because the program is not crop specific. In addition, the program has the advantage of being utilized by many types of agents. However, use of a tradable bonds approach to impact mitigation would require the Federal government to set bond amounts (equivalent to potential mitigation costs) and to set the specific bond market rules. This approach also requires that a new market be created for such bonds, and it would require transparency of water restriction decisions.

Extending the use of water banks to mitigate Federally-imposed water-supply restrictions would facilitate temporary water transfers among alternative water users. However, this approach has several disadvantages, including requirements for extensive planning, participation from a set user type, and protection of transferred water from downstream diversion.

Water-right buyouts may also be used to mitigate the impacts of Federally-imposed water-supply restrictions. A buyout approach can be utilized to transfer water for any reason. In addition, a buyout approach can emphasize either temporary or permanent water transfers. Issues associated with a buyout program that need serious attention involve program costs, secondary effects on rural communities, and program implementation to avoid interception of water by unintended users.

Contingent water leases are another approach to mitigating impacts of Federally-imposed water-supply restrictions. A contingent water lease involves establishing a contract between users to temporarily transfer water-use rights under set conditions. Contingent water leases can be specifically tailored to the

parties involved in the contract. They can also be self sufficient, but such leases also require matching incentives among the contractual water-use parties.

In conclusion, the results of this study demonstrate that many program approaches exist (at least in theory) to address mitigation of water-supply restrictions. However, it is also likely that no specific program will be the perfect fit for all interested parties, or all regions. Most program alternatives will likely come with significant costs (financial, regulatory, and information requirements).

Workshop Session 6
Stakeholder Concerns
Moderator: Betsy Cody, Congressional Research Service

Tom Graff, Environmental Defense

An Environmentalist Perspective on Water Transfers

The expanded use of water markets is an essential tool for protecting and restoring aquatic ecosystems in the American west. All voluntary transfers of water, however, are not equal. Unconstrained, they may cause devastating harm to environmental resources and to agriculturally-based rural communities, workers, businesses, and public services. The challenge for policy makers is in how to minimize the potential adverse consequences while not unduly restricting what is an ever more crucial mechanism in allocating the West's scarcest resource. Several recent water market developments involving high profile transfers were examined during this session that helped to illuminate what approaches are useful in addressing this difficult challenge. [However, no additional written comments were available for this summary.]

A Water User's Perspective on Water Transfers

[No written comments were available to summarize for this presentation.]

Shaun McGrath, Western Governor's Association

National Drought Preparedness Act of 2003 and the National Integrated Drought Information System (NIDIS)

This presentation began by reviewing the latest available information on drought conditions across the Western States using U.S. Drought Monitor maps (as of April 2004). Based on historical data on the percent of area of the U.S. in severe and extreme drought (January 1895 – September 2003), drought is a normal part of the climate for the U.S. Droughts also are very often costly. Nationally, annual average losses attributable to drought range from $6-8 billion, compared to flood losses at $2.41 billion and hurricane losses ranging from $1.2 to $4.8 billion. The worst (highest cost) natural disaster conditions in recent history ranged from $39 - $40 billion for the 1988-89 droughts, $15 - $27.6 billion for the 1993 floods, and $25 – $33.1 billion for the 1992 "Andrew" hurricane. Because water shortages are generally ignored until conditions become dire, and then we "yell for help and beg Congress" for emergency funding assistance, the National Drought Mitigation Center refers to the current approach to addressing drought as the "hydro-illogical cycle."

Based on the May 2000 report of the National Drought Policy Commission, Senators Domenici and Baucas, and Representatives Hastings and Rehberg introduced the National Drought Preparedness Act of 2003. Key objectives of this bill are: 1) to improve coordination and integration of Federal drought programs; 2) to encourage and facilitate drought preparedness and mitigation; 3) to improve drought monitoring and prediction; and 4) to establish reliable drought funding mechanisms. The Act establishes the National Integrated Drought Information System (NIDIS) – a comprehensive system that: 1) collects and integrates information on the key indicators of drought, including stream flow, ground water levels, reservoir levels, soil moisture, snow pack, and climate (including precipitation and temperature); and 2) forecasts, in order to make usable, reliable, and timely assessments of drought, including its severity and potential impact.

The NIDIS vision – is to create and maintain a dynamic and accessible drought information system that provides users with the ability to determine potential drought impacts and associated risks, and the decision support tools to better prepare for and mitigate the effects of drought. NIDIS goals are: 1) for NOAA, as lead agency, to develop leadership and partnerships to ensure implementation of NIDIS; 2) to foster and support a research environment; 3) to create a drought early-warning system; 4) to provide for interactive delivery systems; and 5) to provide a framework for interacting with and educating decision makers and the public.

NIDIS is expected to build upon and extend the capabilities of the current "U.S. Drought Monitor" initiative – a joint effort across Federal, State, and University partners to synthesize multiple weather/climatic indices in order to capture changing conditions across a wide spectrum of drought conditions. Drought Monitor syntheses will integrate such indices as the Palmer Drought Index, reservoir storage indices, the soil moisture index, spring/summer stream flow forecasts, precipitation/temperature indices, and vegetation health indices. The Drought Monitor will focus on broad-scale conditions; however, both geographic- and time-scale resolutions are critical at local levels for assessing impacts and making timely management decisions. The new system is intended to make new weather syntheses available at much smaller scales, including the watershed level.

A system designed similarly to the Oklahoma Mesonet weather monitoring system is the NIDIS goal across the U.S. This system packages weather information at a very micro-level for many users. The Mesonet system includes approximately 3,300 weather-related sensors and 250 linked computers which collect and record about a million observations a day across Oklahoma (98.5% of these observations are available in real time). The system allows for 2-way communication with all weather sites (monitors are solar powered, running on the energy of a nightlight). The system also allows for 30-day storage in on-site data-loggers. Using tables and graphics, the Oklahoma Mesonet system provides users basic daily weather statistics, an historical perspective, and a sense of the "unusualness" of an event.

The new NIDIS will allow both policy makers and individuals to become more proactive with respect to drought through better informed decision-making.

Workshop Session 7

Future Federal Role in Risk Mitigation for Irrigated Agriculture

Moderator: Benjamin Simon, Office of Policy Analysis, U.S. Department of Interior

This session included three presentations covering "**An Institutional/Agency Perspective**," "**Research Needs and Future Directions**," and a "**Workshop Wrap-up**." However, written comments for these presentations were not available for this summary.