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David H. White
ASIT Consulting, Canberra, ACT, Australia

Donald A. Wilhite
University of Nebraska - Lincoln, dwilhite2@unl.edu

Bruce O'Meagher
Department of Industry, Science and Resources, Canberra, ACT, Australia

Graeme L. Hammer
Agricultural Production Systems Research Unit, Toowoomba, Queensland, Australia

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David H. White,[1] Donald A. Wilhite,[2] Bruce O'Meagher,[3]

and Graeme L. Hammer[4]

1. ASIT Consulting, Canberra, ACT, Australia
2. University of Nebraska-Lincoln, Nebraska, USA
3. Department of Industry, Science and Resources, Canberra, ACT, Australia
4. Agricultural Production Systems Research Unit, Toowoomba, Queensland, Australia

Abstract

Patterns of water supply and use in Australia and the U.S.A. differ in many ways. This results in different perceptions concerning the nature of drought and policy approaches to its management. This paper discusses the differences and similarities and explores lessons that policy makers in both countries can learn from one another. A key difference between the two countries is that whereas drought is perceived in Australia essentially in terms of its impact on agriculture, in the U.S. both perceptions and policy are also heavily influenced by the impact of drought on urban communities. This has led to different policy emphases. In 1992 Australia established its National Drought Policy; the U.S. is presently considering the adoption of a national drought policy. These policies highlight drought being accepted as part of natural climate variability, rather than as a natural disaster. They also emphasize the protection of the natural resource base.

Keywords: drought policy, water management, climate variability, risk management

Introduction

Country comparisons can assist in policy development and implementation, particularly if attention is focused on how different policies have evolved and their relative merits and deficiencies (O'Meagher et al., 1998; Wilhite, 2001). Policy assessment and implementation can be difficult, however, if key elements of a policy change.

Climate and Topography

The climate and agriculture of Australia and the United States of America differ in many ways. Australia is a predominantly arid country with the most variable rainfall and runoff of any continent in the world (McMahon et al., 1992); one consequence is that the volume of dam storages needed to give a set level of reliability for supply needs to be much higher. McMahon et al. found that the level of storage capacity required in Australia to meet 80 percent of demand with a 95 percent reliability was 3.75 times that of North America.

An examination of the hydrological balances in both countries is enlightening. At a national level in Australia the allocation of incoming precipitation to evapotranspiration, river runoff, and groundwater recharge is 88, 11, and 1 percent, respectively (Smith, 1998). This compares with about 66 percent of precipitation in the U.S. being lost through evapotranspiration (U.S. Geological Survey, 1993). These balances ignore the substantial spatial and temporal variability, an average surface-water runoff of 776 mm per annum in Tasmania contrasting with less than 0.7 mm from the Western Plateau. In terms of annual river runoff per unit area (306 mm from 3,210 km^2), Australia is indeed the driest continent.

Smith (1998) estimated 12, 9, and 79 percent of water in Australia to be used for domestic, industrial, and agricultural purposes, respectively, compared with 12, 46, and 42 percent in the U.S. (Gleick, 1993). In Australia only 0.31 percent of the land area (24,000 km^2) is irrigated; half of this is pasture. By comparison, 255,000 km^2 in the U.S. were irrigated in 2000 (Annual Irrigation Survey, 2000).

Agriculture in much of the U.S., particularly the primary grain growing areas to the east of the Great Plains, experiences much greater and more reliable rainfall than is experienced in much of Australia. However, variability in annual rainfall is very high in parts of the southwest (Ripley, 1992), and certainly appreciable over much of the Great Plains that extend through the midwest of the country from eastern Montana and North Dakota in the north to Texas in the south. Both countries are at opposite ends of the Southern Oscillation so that El Niño and La Niña climatic events are associated with drought in Australia and to a lesser extent in the U.S. The principal linkages with drought in the U.S. are between La Niña and the southwestern and southeastern portions of the country.

Rainfall, together with varied temperature ranges and a variable geology, demarcates a host of natural agro-ecological zones within both countries from highly productive arable land to arid grazing lands of low carrying capacity and productivity. Australia is predominantly low-lying, apart from the Great Dividing Range in the east. Rainfall above 600 mm per annum is confined to the northern, eastern, and southeastern coastal regions and the southwestern tips of Australia. The south is characterized by a Mediterranean-type climate

with cold, wet winters and hot, dry summers. Annual pastures in the south usually germinate between March and May in response to autumn rains, growth being most active in spring before senescence in October to November. The north experiences a monsoonal climate, most of the rainfall occurring in late summer to autumn.

The continental U.S. (excluding Alaska and Hawaii) lies entirely within the temperate zones, between the Tropic of Cancer and 50 degrees north. Thus any climatic extremes occurring in the country are the result of altitude, orographic factors or continentality (Macquarie World Atlas, 1994). Annual rainfall varies from near zero in the inland desert states, such as Nevada and Arizona, to more than 1,000 mm along the northwest and eastern coasts. Considerable moisture can be deposited as snow, particularly in the northern states and mountainous regions. The humid East Coast is characterized by warm summers, reliable and well-distributed rainfall, and growing seasons ranging from 120 to 200 frost free days. Rainfall in the humid Pacific Coast is concentrated during the winter months and summers are generally dry, becoming classically Mediterranean in areas of California. The western intermontane region receives a very low rainfall, as a consequence of both orographic and continental factors, although only a small area is true desert. To the east of the Rockies lies a transitional zone that was once tall grass prairie. This area, known as the Great Plains, is characterized by temperature extremes resulting from continentality and experiences erratic rainfall from year to year. The 500 mm rainfall isohyet closely follows the 100° west meridian, separating the high plains grazing lands from vast areas under crop. The mountains in the west of the country have an extraordinarily complex range of climates, from near-Arctic conditions to savanna-covered valleys. Drought has also been a recurrent feature of the American landscape, resulting in significant impacts in many sectors of the economy, including agriculture, transportation, energy, recreation, and health. It has also had adverse environmental consequences.

Land, Water, and Population Distribution

Australia is dominated by ancient, fragile soils that have been deeply weathered and leached, whereas the U.S. has vast areas of deep fertile loams of mostly glacial origin. Australian agriculture is therefore predominantly extensive and, with the exception of drought assistance, largely unsubsidized. In the higher rainfall areas of southern and eastern Australia, agriculture is characterized by dairy and beef cattle, horticulture, and prime lamb production. Most wheat production, in association with sheep, is located in the southeast and southwest, between the 300 and 600 mm annual rainfall isohyets, though wheat production further north moves to higher rainfall areas. The balance of Australia's wool and beef production takes place in the pastoral zone, most of which has considerably less than 600 mm rainfall a year. A large part of the center of Australia is desert or very arid rangelands that in most years are able to support relatively few grazing animals. For example, carrying capacities over vast areas are typically less than four head of cattle per km^2.

Agriculture in the U.S., on the other hand, is typically more intensive than in Australia, livestock production being dominated by feedlot beef production, and large pig and poultry enterprises. Cereal production is dominated by maize and wheat, with widespread production of oilseed and legume crops such as sorghum, sunflowers, and soybeans.

People tend to settle in close proximity to water and productive land. Rainfall and natural or manmade water storages and distribution systems are therefore all important. In Australia about 85 percent of the population live in urban areas (Macquire World Atlas, 1994), mostly in coastal cities within the high rainfall zone—indeed, Australia is one of the most heavily urbanized nations in the world. In contrast, the extensive areas of high rainfall and fertile soils of the continental U.S. have resulted in 39 percent of the population being located in the inland states.

Water use patterns in both countries are heavily influenced by a combination of seasonal and cyclical meteorological factors and by population distribution patterns. A significant difference between the two countries in times of drought is that in Australia, the emphasis is generally on agriculturally related problems; whereas in the U.S., the more dispersed distribution of heavily populated areas and of associated industrial areas means that a broader range of concerns are raised. In addition to the impacts of drought on agriculture, the pressures of a larger and more urbanized population result in significant impacts on transportation, energy, and industrial sectors in the United States. Recreational uses of water also suffer during drought periods. In addition, environmental concerns also bear heavily on water use during droughts, as noted during 2001 in the Klamath Basin in the Pacific Northwest. Drought policy in the Delaware Basin, for instance, can be dominated by the interests of several heavily populated urban centers, including New York City, rather than by agriculture. Urban drought in Australia is seldom a problem, despite the variability in the rainfall, because of the earlier emphasis on building water storages, almost regardless of cost.

Political, Legal, and Administrative Influences

The political, legal, and administrative systems influence approaches to drought management in both countries. Both are federations whose political and legal systems are characterized by the separation of powers characteristic of most modern, democratic political systems. Responsibility for water and drought management rests principally with the states, although increasingly the national governments of both countries are exercising influence on these matters. In Australia, a well-known intergovernmental instrument for water management is the Murray-Darling Basin Commission (Murray-Darling Basin Ministerial Council, 1990). Similarly, in the U.S. the Delaware Basin water management arrangements represent a significant intergovernmental initiative (Hansler, 1991). In Australia, the national government has played a significant role in shaping drought policies for some decades although a national drought policy was only adopted in 1992. The involvement of the national government in drought management policy is also becoming more significant in the U.S., as discussed below.

There are some significant differences in water management policy generally and in drought management policy in particular. While the political, legal, and administrative systems of both countries are influenced by the activities of a plurality of interest groups, that influence is rather more pronounced in the U.S. A further difference is the relatively heavy litigious character of that activity in the U.S.

These differences in relation to approaches to drought management are intensified by the different patterns in population distribution and water use between the two countries. Whereas in Australia, for instance, drought management is largely a matter determined by the interaction of agricultural interests, the civil service, and the political system generally, the situation in the U.S. is a rather more complex one in which a variety of interest groups and the courts are more heavily involved. In an attempt to minimize the cost and political risks associated with litigious activity, emphasis has been increasingly placed on community consultation mechanisms in the U.S. than is generally present in Australia, where outcomes have continued to be more of an "administered" nature.

Nevertheless, there has been a growing recognition throughout the Australian community that water is a scarce resource that needs to be managed effectively if community benefits from its use are to be maximized. This has come at a time when there is a greater degree of environmental interest group activity and when uses other than for agriculture have been of growing importance. Competition for scarce water resources between agriculture and the mining sector, though not a major issue nationally, has been an issue in some areas. The inappropriate use of water resources by the agricultural sector, including in times of drought, has also become increasingly apparent, highlighting the need for a greater degree of community involvement in water and drought management decision making. The recent codification of COAG-based (Council of Australian Governments) water reforms introduces the use of economic instruments such as market value and transferable water entitlements to promote more efficient use of water. Economic rationalism is being tempered by recognition that environmental flows should be included as a water use (Smith, 1998). This already sensitive issue will become more so when Australia next has a major drought.

Evolution of Drought and Related Policies in Australia

The evolution of government responses to drought has been reviewed, among others, by Wilhite (1986), O'Meagher et al. (1998, 1999), and Heathcote (1999) for Australia, and by Wilhite (1986, 1993, 1997a) for the U.S.A. The process in Australia has been a fitful one dating from colonial times. The objectives of such intervention were to alleviate the adverse impact of drought on farm incomes and to attain longer-term productive capacity through the maintenance of core breeding stock. Policy instruments included rebates or subsidies on the transport of stock and fodder, low interest loans, and interest rate subsidies. In Australia, the cost, effectiveness, and adverse adjustment implications of existing policies were the main impetus for change, along with public concerns about the environment and equity issues in applying subsidies. The Commonwealth Government appointed a Drought Policy Review Task Force to undertake a comprehensive review of drought policy in 1989 following the decision to withdraw drought from the National Disaster Relief Arrangements (National Drought Policy, 1990). Its report provided the basis for development of a National Drought Policy (NDP) by the Commonwealth and State governments in 1992.

The objectives of the NDP are to encourage primary producers and other sections of rural Australia to be self-reliant in managing for climate variability and to maintain and

protect Australia's agricultural and environmental resource base during periods of extreme climate stress (White and Karssies, 1999). Key policy measures underpinning these objectives include increased funding for drought research and development; inclusion of drought risk management components within the whole on-farm Property Management Planning training element of the National Landcare Program; grants for training and professional advice which together are designed to develop farmers' capacity to better manage risk, including drought risk; savings incentives provided through the tax system to encourage the build up of reserve funds for situations such as drought; accelerated taxation depreciation for fodder and grain storage; interest rate subsidies (now being phased out) on debt during declared Drought Exceptional Circumstances for those farmers who could demonstrate long-term prospects for viability; and income support to eligible farmers (subject to income and asset tests) for any farmer whose operations are located in areas designated as experiencing Drought Exceptional Circumstances (White et al., 1998).

Research has a major role in the implementation of the NDP and in improving the level of self-reliance and risk management skills of rural producers. Products include improved seasonal forecasts; online access to climate information; decision support systems for analyzing climate data or using agronomic, livestock nutrition, and financial models to aid decision making on the farm; the breeding and management of drought-tolerant crops and pastures; and the use of remote sensing data, models, and geographic information systems to monitor and assess, both spatially and temporally, the extent and severity of drought (Hall et al., 1997; White and Karssies, 1999). The use and value of some of these technologies in minimizing land degradation and identifying sustainable yet financially viable, agricultural systems (e.g. McKeon and White, 1992; Hammer et al., 1996) requires even greater emphasis if the second aim of the NDP is to be properly addressed. This also requires better linkages with other policies emphasizing the sustainable development and use of the country's natural resources.

Evolution of Drought and Related Policies in the U.S.A.

In the United States, the federal government became the principal player in the provision of drought relief during the 1930s in response to a drought that was nearly nationwide in extent and coexisted with severe economic conditions. Before the 1930s, assistance had been provided primarily by the private sector but the level of assistance required during the 1930s "dust bowl" event far exceeded the response capacity of this sector. The federal government has continued to be the principal provider of drought assistance during subsequent drought events. Until recently, state governments assumed a relatively passive role in drought management. States are now assuming a greater responsibility for drought planning, but drought relief remains largely a federal responsibility.

Although federal drought assistance programs in recent decades have been directed increasingly toward short-term, emergency assistance programs, earlier response efforts were characterized by a combination of both short- and long-term assistance programs. The funds allocated by Congress in response to droughts in recent decades can best be categorized as post-impact government interventions that did little, if anything, to reduce the nation's underlying vulnerability to drought.

Agricultural interest in drought is important in much of rural U.S., particularly in areas such as the southwest and throughout the Great Plains where variability in annual rainfall is high. There is, therefore, considerable interest in indices that monitor agricultural drought and hydrological drought. The Standardized Precipitation Index (SPI; McKee et al., 1993) is gaining favor but is normally used in conjunction with other indices, including the Palmer (Palmer, 1965). The SPI was developed to give a better representation of abnormal wetness and dryness than the Palmer indices, but because of data limitations, SPIs with time scales longer than 24 months may be unreliable (Guttman, 1999). Overall, because the water requirements of urban populations inevitably dominate much of the debate on drought policy in the U.S., hydrological drought over much of the country is of increasing concern because of its impacts on surface and subsurface water supplies.

The contributions of Wilhite (1993, 1997b) have had a dramatic impact in stimulating discussions on the need for drought policies and plans in the U.S. and many other countries. These contributions, particularly the ten-step drought planning process (Wilhite 1991; Wilhite et al., 2000), have greatly influenced the development of drought plans at the state level in the United States. The number of states with drought plans has increased from three in 1982 to 30 in 2000, with several states currently developing drought plans.

Current Drought Policy Efforts in Australia

A recent review has reaffirmed the aims and commitment of the Commonwealth, State, and Territory governments to the NDP. There was agreement on encouraging farmers to further increase the level of self-reliance and profitability of their businesses, while also ensuring that the environment is protected. However, political pressures have led to a relaxation of criteria for the provision of financial support from the commonwealth government, despite some AU$698 million ($370 million US) having already been invested by the commonwealth in Exceptional Circumstances (EC) Assistance since 1992.

New EC declaration procedures are in place. The criteria include a rare and severe event, the effects of which must result in a severe downturn in farm income over a prolonged period. Furthermore the event must not be predictable or part of a process of structural adjustment. A rare event is still one that occurs on average once in every 20 to 25 years. It is considered severe if it lasts for a prolonged period and is of sufficient scale to warrant government involvement as measured by assessing the impact on the sector, number of producers, size of area, and overall value of production. Considerable difficulties are already being encountered, as O'Meagher et al. (1998) anticipated, in ensuring that such a multicriteria approach remains objective and that government interventions are rare events indeed. Each year comprises a unique combination of events, so that such combinations are difficult to place in historical context. The coarse spatial resolution and limited duration of available data on farm incomes are also inadequate for an income-based approach to EC determination.

Not surprisingly, a large number of applications for EC, each emphasizing combinations of exceptional factors leading to a severe downturn in farm income, are currently being received. If the process of declaring EC is based on rare combinations of events, then it becomes very difficult to constrain government financial support to the rural sector, so

that agriculture effectively becomes significantly subsidized and the process of long-term structural adjustment unduly impeded. This is not in the interests of developing and sustaining a viable and healthy rural sector within the Australian economy.

Current Drought Policy Efforts in the U.S.A.

As a result of the 1996 drought and its effects in the Southwest and southern Great Plains regions, a series of policy initiatives was developed to improve federal and state drought management efforts. One of the most significant of these policy initiatives was the introduction in 1997 of the National Drought Policy Act in the U.S. Senate in January. Both the Federal Emergency Management Agency (FEMA) and the Western Governors Association drought task force recommended the development of a comprehensive, integrated national drought policy to reduce the risks associated with future drought events and improve emergency response to drought catastrophes when they occur. The introduction of this bill in the Senate led to a lengthy discussion but support for the bill was bipartisan since it was aimed at improving the efficiency of government. This bill was passed by the Senate in November 1997; a modified bill was passed by the U.S. House of Representatives in July 1998. President Clinton signed this bill into law on July 16, 1998.

The major tenet of this bill was the establishment of an advisory commission (National Drought Policy Commission/NDPC) to provide advice and recommendations on the creation of an integrated, coordinated federal policy designed to prepare for, mitigate the impacts of, respond to, and recover from serious drought emergencies.

The NDPC, under the leadership of the U.S. Department of Agriculture, submitted its recommendations of drought policy needs to the U.S. Congress and the President in May 2000. Its recommendations, broadly stated, were to:

- Incorporate planning, implementation of plans and proactive mitigation measures, risk management, resource stewardship, environment considerations, and public education as the key elements of effective national drought policy;
- Improve collaboration between scientists and managers to enhance the effectiveness of observation networks, monitoring, prediction, information delivery, and applied research and to foster public understanding of and preparedness for drought;
- Develop and incorporate comprehensive insurance and financial strategies into drought preparedness plans;
- Maintain a safety net of emergency relief that emphasizes sound stewardship of natural resources and self-help; and
- Coordinate drought programs and response effectively, efficiently, and in a customer-oriented manner.

The report also called for the creation of a more permanent national drought council to carry out the NDPC's recommendations. Following the submission of this report to Congress in 2000, the Secretary of Agriculture created an interim National Drought Council to

begin to address these recommendations. Congress will likely consider establishment of a more permanent council in 2001 or 2002.

Key Challenges and Policy Considerations

For both countries, the key challenge is to continue the process of developing policy responses to drought, land, and water management that will foster appropriate changes to attitudes and behaviors on the part of users and political decision makers. The latter is critically important since inappropriate signals from political leaders are likely to reinforce the view that water remains a semi-free good and that governments will continue to come to the rescue of those in trouble, especially farmers, but also other water users. Nevertheless, at the end of the day, the solution to the problems of drought is acceptance by those living in climate-sensitive sectors that climate variability is an integral part of their environment and one that they must plan for, adapt to, and manage as responsible stewards of their land.

Ongoing research that helps to deepen our understanding of climate variability will be critical to meeting this challenge. The outcome of such research not only informs policy development but also provides the basis for informing the community of the impacts of our individual and collective attitudes and behaviors.

Such research will probably need to maintain the emphasis on improving our understanding of both regional and global climate systems and of the interactions between and implications of our land and water use and management activities. This is perhaps particularly important in the case of Australia because of the sharper natural limits on food and fiber productivity combined with economic and international pressures on population growth.

It is unlikely that such efforts alone will result in the kind of attitudinal and behavioral changes required to yield improved drought management and economic and natural resource sustainability. Governments in both countries stress the importance of greater self-reliance and improved water and land management on the part of farmers and industrial users. To achieve this, it will be necessary for governments to assist in the dissemination of information and techniques while avoiding the spread of counterproductive messages through inappropriate policy interventions. Governments should also facilitate a range of supportive policies fostering appropriate action on the part of water users and land managers. This raises the issue of how to introduce and maintain such policy initiatives without inciting a rural backlash that negates all progress to date.

Possible initiatives are reviewed by O'Meagher et al. (1999) for Australia and by Wilhite (1997a; 2001) for the United States. One area that requires further development is the role of private sector instruments/initiatives in supporting public sector activities. With much improved data fields in the area of climate variability, there is much greater scope for private insurance sector involvement in insuring for drought. While the United States is further along in this regard than Australia (through, for example, a variety of private sector crop insurance arrangements), there is scope for further development in both countries, resulting not only in less pressure on government purses but in reducing the pressures currently flowing from the electoral cycles in both countries.

That notwithstanding, there have been some considerable improvements in our collective understanding of the dynamics between climate variability and both public and private land and water management practices; the evidence points to both countries being some distance from long-term sustainability, particularly when seen against the increased pressures which are likely to placed on the resources involved. To secure the necessary commitment to ongoing learning and change required, greater attention may need to be paid to improving methods of involving relevant stakeholders.

Future Directions and Challenges

A review of drought management and policy needs for the western United States was recently completed by Wilhite (1997a; 1997b) at the request of the Western Water Policy Review Advisory Commission. In this report, Wilhite reviewed major studies that evaluated the role of federal and state governments in drought management and offered recommendations to improve future management efforts. These studies were reviewed to identify common themes that might help highlight future needs or actions that the federal government could take to improve drought management in the western United States. The common themes identified included:

- Create a national drought policy and plan;
- Develop a comprehensive, integrated national climate monitoring system;
- Incorporate drought in the National Mitigation Strategy;
- Conduct post-drought audits of federal/state response efforts;
- Establish regional drought forums; and
- Encourage development of state drought mitigation plans.

Progress on some of these themes has taken place in recent years. For example, discussions related to the development of a national drought policy were considered by the National Drought Policy Commission. A national, integrated climate monitoring system is evolving under the leadership of the NDMC, U.S. Department of Agriculture, and the Climate Prediction Center/NOAA. A joint drought monitoring facility was established in 1999 and has developed a suite of new products to help in monitoring the complex and evolving patterns of drought. A new map, the "Drought Monitor," which integrates many indices and variables in assessing and classifying drought severity, was developed. The newly developed Standardized Precipitation Index is included in this analysis and is also being used by a growing number of states in detecting and tracking emerging drought areas. Post-drought audits of federal and state drought response and mitigation efforts need to be routinely conducted to determine successes and failures. All states should be encouraged through the provision of incentives to develop comprehensive drought mitigation plans. Most of the 30 states with drought plans focus largely on response. Methodologies are now available for states to follow in placing emphasis on mitigation actions and programs. Examples from states that have emphasized mitigation (e.g., Utah, New Mexico, and Nebraska) should further facilitate this process. The lack of methodologies and models

has been one of the constraints to the adoption of an approach to drought management that emphasizes mitigation.

While, as previously noted, there has been some softening of the essentially science-based approach to triggering drought support mechanisms in Australia, the broad objectives of policy remain consistent with the original national drought policy framework adopted over a decade ago. The decision in 1994 to move to a frequency-based trigger for such support has had the positive effect of focusing the attention of many, if not all, farmers on the reality of variability and on the need for appropriate preparedness strategies.

Event-related triggers such as the support trigger used in Australia may also have relevance both for triggering support and for water management decision-making in the United States. The decision to impose water use restrictions in many cities and catchment areas, for instance, is still driven by essentially political considerations. Nevertheless, quite a few locations are now trying to take advantage of new triggers/indicators. For example, decisions on water allocations during drought years for the states of Florida, Georgia, and Alabama will be based on various time frames of the Standardized Precipitation Index and other indicators in the future. Thus a move to a more science-based decision-making approach is taking place. While it is unlikely that political considerations can be eliminated altogether, such an approach has the potential to lessen interest group pressure and encourage decisions more likely to facilitate short-term restriction decisions as well as long-term sustainability.

Similarly, the various approaches to community involvement in drought risk management adopted in some states of the U.S. offer a useful model as the debate about water use, particularly during drought episodes, becomes more intense in Australia (see, for example, Bidol-Pavda, 1998). The processes suggested by the National Drought Mitigation Center at the University of Nebraska for the various phases of the drought cycle (contingency/preparedness planning, pre-impact planning, and post-impact intervention; Wilhite, 1991; Wilhite et al., 2000), for example, could provide a useful framework within which to consider stakeholder involvement in Australia.

To be fully effective in achieving the goal of better water use and drought management, such a framework requires a greater degree of interaction between expert and community opinion than has been the case in either country. New processes need to be developed that enable the realities of the meteorological cycle to be more effectively integrated into the essentially political process of interest group accommodation. One particularly useful tool that could be more extensively utilized for this purpose is the "policy gaming" approach being used by the RAND Corporation in the design of appropriate responses to a range of social policy issues in the U.S. and elsewhere (Kahan et al., 1995).

Conclusions

These policies have implications for the behavior of rural and urban communities. Policy makers in both countries could learn from each other and further improve their policy approaches. This requires farmers to consider the likely occurrence of drought in their long-term planning, with emphasis on risk management and increased self-reliance.

Science has played a key role in developing the new risk management approach to coping with drought. It has an essential role in underpinning the development and implementation of policy (O'Meagher et al., 1998) which can only increase as the benefits of accessing and using relevant information become more widely recognized.

Although state and federal attention on improving drought management in the United States has been copious in recent years, including the National Drought Policy Act of 1998, little change in practice is visible to date, especially at the federal level. Federal response to drought conditions in 1999 and 2000 was reactive and short term in scope; in other words, business as usual. To fill the vacuum, states have continued to be the most progressive actors in drought management, a trend that began in the early- to mid-1980s. Regardless of progress by states, improved drought management requires an integrated approach between and within levels of government.

Federal agencies are now speaking the new language of drought management, and phrases like "improved coordination and cooperation, increased emphasis on mitigation and preparedness, and building non-federal/federal partnerships" have become commonplace. Existing institutional inertia of federal emergency response programs and the expectations of the recipients of assistance programs, however, encourage drought management to remain in a reactive, crisis management mode.

Nevertheless, the mentality of most state and federal government agencies remains response oriented. It is not yet apparent whether federal and state policy makers clearly understand the scope of the changes that will be required to invoke the new paradigm of risk management. When drought occurs, especially in election years, drought relief is one method that members of Congress use to send money home to their constituents. The true test of whether we are making progress will be if Congress and the administration enthusiastically embrace the recommendations of the National Drought Policy Commission and other groups, provide adequate funding to support commission goals and recommendations, and direct federal agencies to modify existing policies and programs to emphasize mitigation and preparedness, thus effectively shifting funding from crisis to risk management and implementing the new paradigm.

Only time will determine the dedication of the United States to this new approach to drought management. A continuation of widespread, severe drought in the next few years would certainly engender greater support for this new paradigm and help the country continue down the path to risk management. The political will to change the way the Unites States manages drought appears to be genuine but may evaporate quickly if the country experiences a series of wet years. Changing the momentum of the past will be difficult, but it is critical for the scientific community and the public to hold policymakers to this commitment.

About the Authors

Dr. David White is the Director of ASIT Consulting in Canberra, Australia. He was formerly a Senior Principal Research Scientist in what is now the Bureau of Rural Sciences and scientific adviser to policy makers on climate variability and the productivity, sustainability, and financial viability of agricultural systems, drought assessment, and risk management. He now provides consultancy and analytical services addressing a wide range of agricultural and environmental issues. Dr. White's mailing address is P.O. Box 328, Hawker, ACT, Australia 2614. Email david_white@acslink.net.au; website http://www.acslink.aone.net.au/asit.

Dr. Donald A. Wilhite is the Director of the National Drought Mitigation Center and International Drought Information Center and a Professor at the University of Nebraska–Lincoln, Nebraska, USA. His research interests include drought management and preparedness, the policy implications of climate variability and climate change, and the effects of climate on society. Email dwilhite@enso.unl.edu; website http://enso.unl.edu/ndmc/.

Mr. Bruce O'Meagher is a senior policy adviser within the Australian Public Service, based in Canberra. He has worked in the Australian Treasury, the Department of Primary Industries and Energy, the Department of the Prime Minister and Cabinet and the Department of Industry, Science, and Resources (DISR). He is currently head of DISR's Industry Policy Branch. Email bruce.o'meagher@isr.gov.au; website http://www.isr.gov.au/.

Dr. Graeme L. Hammer is coleader of the Agricultural Production Systems Research Unit (APSRU), which includes a staff of about 50 scientists and support personnel from the Queensland Departments of Primary Industries and Natural Resources and the CSIRO Division of Sustainable Ecosystems. APSRU is principally concerned with improving the profitability and sustainability of dryland farming systems in the Australian subtropics. Email hammerg@dpi.qld.gov.au; website http://www.apsru.gov.au/.

References

Annual Irrigation Survey Continues Steady Growth. 2000. *Irrigation Journal* 51, January/February: 12.

Bidol-Pavda, P. 1998. "Involving Stakeholders in Public Sector Planning Processes." Paper presented to workshop on Planning for the Next Drought. Fort Mitchell, Kentucky, USA.

Gleick, P. H., ed. 1993. *Water in Crisis: A Guide to the World's Freshwater Resources.* Oxford: Oxford University Press.

Guttman, N. B. 1999. "Accepting the Standardized Precipitation Index: A Calculation Algorithm." *Journal of the American Water Resources Association* 35, No. 2: 311–322.

Hall, W., K. Day, J. Carter, C. Paull, and D. Bruget. 1997. "Assessment of Australia's Grasslands and Rangelands by Spatial Simulation." *Proceedings of MODSIM 97, the International Congress on Modelling and Simulation*, Hobart, Tasmania, 8–11 December 1997: 1736–1741.

Hammer, G. L., D. P. Holzworth, and R. Stone. 1996. "The Value of Skill in Seasonal Climate Forecasting to Wheat Crop Management in a Region with High Climatic Variability." *Australian Journal of Agricultural Research* 47: 717–737.

Hansler, G. M. 1991. "Drought Planning and Response Experience in the Delaware River Basin." In *Drought Management and Planning*. D. A. Wilhite and D. A. Wood, eds. The International Drought Information Center, Department of Agricultural Meteorology, University of Nebraska–Lincoln, Nebraska, USA: 179–183.

Heathcote, R. L. 1999. "She'll Be Right Mate. Coping with Drought: Strategies Old and New in Australia." *Hazards and Disasters: A Series of Definitive Works*: Volume II: *Drought, A Global Assessment*. D. A. Wilhite, ed. London, United Kingdom: Routledge Publishers: 59–69.

Kahan, J. P., C. P. Rydell, and J. Setear. 1995. "A Game of Urban Drug Policy, Peace and Conflict." *Journal of Peace Psychology* 1, No. 3: 275–290.

McKee, T. B., N. J. Doesken, and J. Kleist. 1993. "The Relationship of Drought Frequency and Duration to Time Scales." Proceedings of the 8th Conference on Applied Climatology. *American Meteorological Society*, 17–22 January, Anaheim, California, USA: 179–184.

McKeon, G. M., and D. H. White. 1992. "El Niño and Better Land Management." *Search* 23: 197–200.

McMahon, T. A., B. L. Finlayson, A. T. Haines, and R. Srikanthan. 1992. *Global Runoff—Continental Comparisons of Annual Flows and Peak Discharges*. Cremlingen-Destedt, Germany: Carena.

Murray-Darling Basin Ministerial Council. 1990. Natural Resources Management Strategy. Canberra, Australia: Murray-Darling Basin Commission.

National Drought Policy Final Report. 1990. Drought Policy Review Task Force. Canberra, Australia: Australian Government Publishing Service.

O'Meagher, B., L. du Pisani, and D. H. White. 1998. "Evolution of Drought Policy and Related Science in Australia and South Africa." *Agricultural Systems* 57: 231–258.

O'Meagher, B., M. Stafford Smith, and D. H. White. 1999. "Approaches to Integrated Drought Risk Management: Australia's National Drought Policy." *Hazards and Disasters: A Series of Definitive Works*. Volume II: *Drought, A Global Assessment*. D. A. Wilhite, ed. London, United Kingdom: Routledge Publishers: 115–128.

Palmer, W. C. 1965. "Meteorological Drought." United States Weather Bureau Research Paper No. 45.

Ripley, E. A. 1992. "Water Flow." In *Ecosystems of the World 8A: Natural Grasslands, Introduction and Western Hemisphere*. R. T. Coupland, ed. Amsterdam, The Netherlands: Elsevier. 55–73.

Smith, D. I. 1998. *Water in Australia*. Oxford: Oxford University Press.

The Macquarie World Atlas. 1994. Macquarie Library, Macquarie University, NSW, Australia.

U.S. Geological Survey. 1993. *Estimated Water Use in the U.S. in 1990*. Circular 1081. Washington, DC, USA: U.S. Geological Survey.

White, D. H,. and L. Karssies. 1999. "Australia's National Drought Policy: Aims, Analyses, and Implementation." *Water International* 24, No. 1: 2–9.

White, D. H., S. M. Howden, J. J. Walcott, and R. M. Cannon. 1998. "A Framework for Estimating the Extent and Severity of Drought, Based on a Grazing System in Southeastern Australia." *Agricultural Systems* 57: 259–270.

Wilhite, D. A. 1986. "Drought Policy in the U.S. and Australia: A Comparative Analysis." *Water Resources Bulletin* 22: 425–438.

Wilhite, D. A. 1991. "Drought Planning: A Process for State Government." *Water Resources Bulletin* 271: 29–38.

Wilhite, D. A., ed. 1993. "Planning for Drought." *Drought Assessment, Management, and Planning: Theory and Case Studies*. Boston, Massachusetts, USA: Kluwer Academic Publishers: 87–108.

Wilhite, D. A. 1997a. "Responding to Drought: Common Threads from the Past, Visions for the Future." *Journal of the American Water Resources Association* 33: 951–959.

Wilhite, D. A. 1997b. "Improving Drought Management in the West." Report to the Western Water Policy Review Advisory Commission.

Wilhite, D. A., M. J. Hayes, C. Knutson, and K. Smith. 2000. "Planning for Drought: Moving from Crisis to Risk Management." *Journal of the American Water Resources Association* 36, No. 4: 697–710.

Wilhite, D. A., ed. 1999. "Drought: A Global Assessment (Volumes 1 and 2)." London, England, United Kingdom: Routledge Publishers.

Wilhite, D. A. 2001. "Moving from Crisis to Risk Management." *Forum for Applied Research and Public Policy* 16, No. 1: 20–28.