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Drought Policy, Monitoring and Management in Arid Lands

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Abstract: Climate variability is a feature of many arid and semi-arid lands, though only the most protracted periods without rain can correctly be described as droughts. Protracted droughts lead to pressure being put on vegetation and soils through over-stocking, and on governments to provide food or financial assistance. This paper discusses the evolution of drought policy in Australia and southern Africa, highlighting how people in these areas can become more self-reliant through being proactive rather than reactive in coping with drought. The importance of protecting the natural resource base is also emphasized, so that it can be productive in future years. However, an essential prerequisite to achieving increased self-reliance and to reduce the impact of drought is to put a national drought policy in place, and provide the necessary research and education infrastructure so that farmers, agri-business and rural communities can better anticipate and cope with droughts.

Key words: climate variability, drought assessment, drought assistance, drought management, drought monitoring, drought policy, risk management, self-reliance, sustainability.

Arid and semi-arid lands have probably never been under so much pressure, from climate variability, climate change, and the demands of ever-increasing livestock and human populations. In this paper I highlight the importance of drought policy, vegetation monitoring and land management in reducing the impact of drought, and where feasible improving the long-term productivity and sustainability of rangeland and veld ecosystems. This is based primarily on my experiences over many years in Australia and during brief visits to southern Africa.

Climatic and Agricultural Features of Arid and Semi-arid Lands

Arid and semi-arid lands have been defined as having mean growing periods of less than 75 and 180 days respectively (Seré *et al.*, 1996). In Australia these dominate the rangelands, defined as semi-natural ecosystems in which people seek to obtain a productive output by simply adding domestic livestock to a natural landscape (Harrington *et al.*, 1984). In this respect the rangelands of Australia are comparable with the veld of southern Africa.

Rangelands are characterized by low productivity associated with mainly natural vegetation, lack of water and nutrients, and variable rainfall. Global distribution of mean annual rainfall isohyets is shown in Fig. 1. Variability of annual rainfall increases as mean annual rainfall decreases, as latitude decreases, and as the influence of the Southern Oscillation increases (at least in tropical and subtropical latitudes) (Nicholls and Wong, 1990). Thus regions with the most variable annual rainfalls are tropical

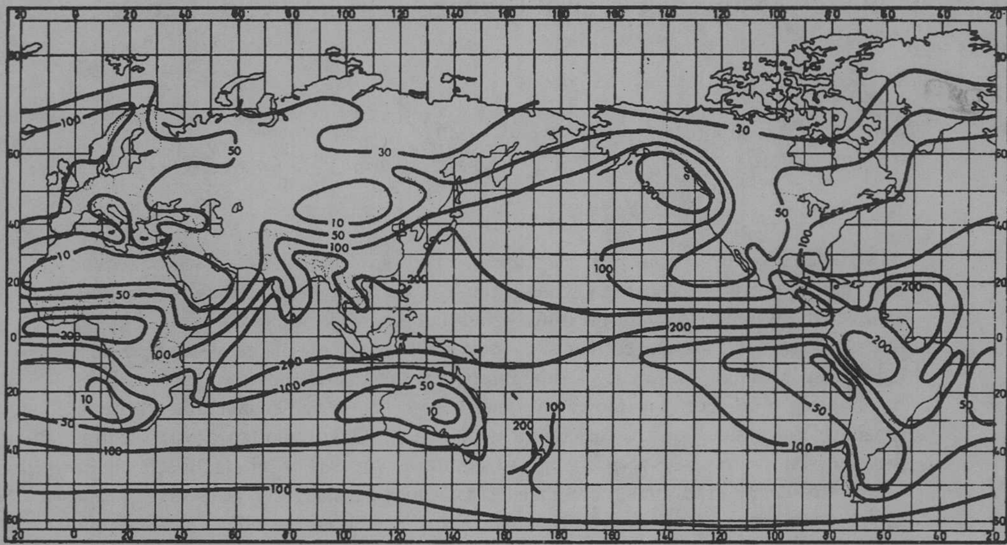

Fig. 1. Annual precipitation (cm) at the earth's surface (Ripley, 1992; adapted from Estienne and Godard 1970). Reprinted with permission from Elsevier Science.

deserts strongly affected by the Southern Oscillation. Regions of the world dominated by 'hot deserts', including arid and semi-arid rangelands (Fig. 2), and a high coefficient of variation of annual precipitation (Conrad, 1941; Fig. 3), include large areas of south-west and northern Africa, the Middle East, central Asia, Australia, south-west U.S.A. and the Atacama and Patagonian deserts of South America.

Although some rangelands are characterized by very hot temperatures for at least part of the year, cold temperatures can also limit rangeland productivity, as in northern Europe and Asia and in southern South America. Plant characteristics and ecosystems have evolved to facilitate their survival in these arid lands.

Australia and South Africa have large arid interiors dominated by rangelands, and experience a highly variable climate consistent with their location largely within the semi-arid subtropical latitudes of the southern hemisphere. They share the distinction of having the largest variability of rainfall and run-off of any countries in the world (McMahon *et al.*, 1992).

Drought differs from aridity in that the latter is restricted to low rainfall regions and is a permanent feature of the climate (Wilhite, 1993a). Drought, on the other hand, is a normal part of a variable climate, occurring in both high, as well as low rainfall areas. It originates from a deficiency of precipitation that results in a lack of water for some activity or group. The way in which water is used determines both the type of drought and its impact. Distinctions therefore need to be made between meteorological, hydrological and agricultural drought.

Cattle, sheep and goats in the arid and semi-arid rangelands are typically used for either commercial animal production or for subsistence farming. Other arid land enterprises include tourism and ecotourism, hunting and occasionally mining. Associated with the prevailing biodiversity are undoubtedly pharmaceutical and other biochemical opportunities. Common to all these enterprises is the need to protect the rangeland ecosystems to ensure that these regions remain productive and aesthetically appealing to future generations.

Vulnerability of Arid Lands to Drought and Desertification

Arid and semi-arid lands encompass a large variety of ecosystems, the plants having evolved different mechanisms to cope with the aridity, variable rainfall and temperature extremes. However, they are often poorly equipped to cope with overgrazing, and hence, too many livestock cause a loss of vegetation cover, decline in pasture species, loss of soil structure and ultimately extensive erosion.

The most common form of desertification in the arid and semi-arid lands of Australia is the loss of perennial grasses from grasslands savannas and open woodlands, often with a replacement by inedible shrubs (Ludwig and Tongway, 1995). Desertification arises when human mismanagement leads to overgrazing or excessive tillage of the land, or acts indirectly as through climate change. When

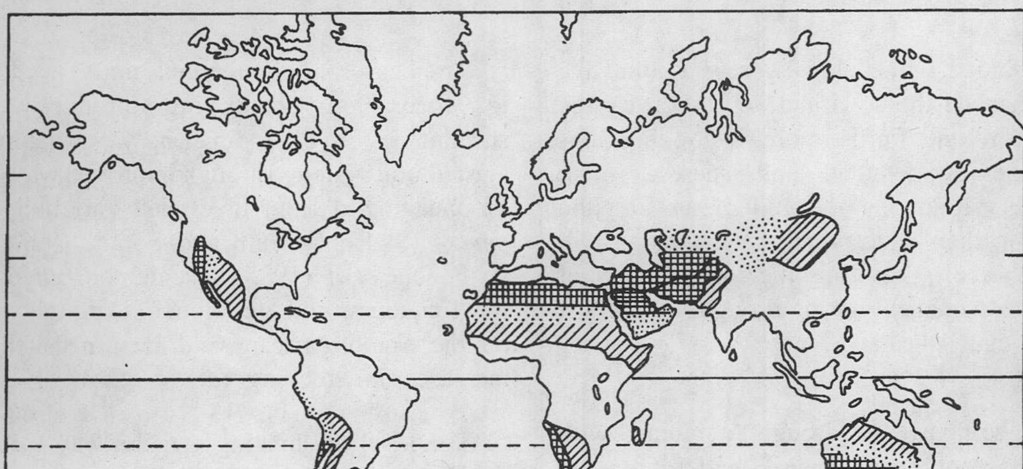

Fig. 2. Areas of hot deserts with summer rain, winter rain and their transition zones (Evenari, 1985; after A. Shmida). Reprinted with permission from Elsevier Science.

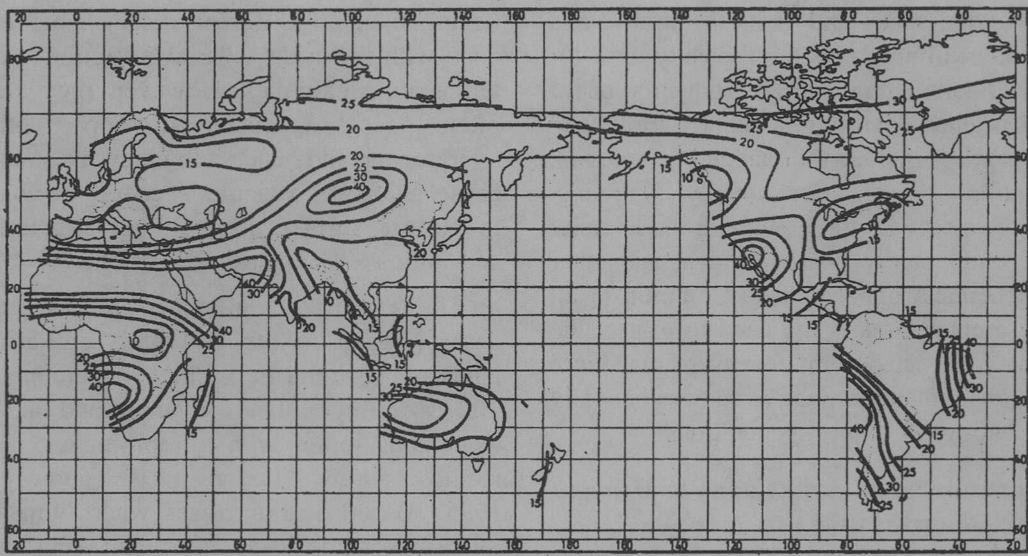

Fig. 3. Coefficient of variation of annual precipitation over the continents (Ripley, 1992; adapted from Barry and Chorley, 1976). Reprinted with permission from Elsevier Science.

combined with below-average rainfall the impact on the soils and vegetation can be catastrophic. Furthermore, if flooding rains impact on denuded landscapes, as often occurs following the end of an El Niño event, then widespread water erosion will also occur. Therefore, the consequences of mismanagement during drought can persist for many years.

The ravages of drought, combined with high stocking pressure, lead to loss of vegetation cover, followed by soil erosion, particularly on poorly structured and fragile soils. In Australia, continued widespread overstocking and associated environmental and natural resource deterioration have led to 42% of the 5 M km^2 of arid and semi-arid lands being assessed as degraded (Ludwig and Tongway, 1995).

Emphasis on commercial units needs to focus on identifying productive, sustainable yet financially viable agricultural systems through improved ways of managing to deal with climate variability *per se* (Stafford Smith and Foran, 1993). As Fouché *et al.* (1985) have demonstrated, the frequency and duration of 'droughts' on the South African veld increase with increases in stocking rate.

The level of stocking and the way that this is varied over time in the context of long-term stocking rate strategies is an important issue to many pastoralists (Buxton and Stafford Smith, 1996). This is because total grazing pressure from domestic, feral and native herbivores greatly influences pasture biomass and composition, which may then be reflected in livestock performance, and enterprise profitability.

It can also influence the extent to which the system becomes vulnerable to desertification. Very low stocking rates can avoid ecological risk but have so few stock as to be unprofitable.

The critical paradigm shift in relation to managing grazing pressure on arid lands has been to move away from static notions of optimal stocking rates, as on improved temperate grasslands (e.g., White, 1987), and to recognize that these inevitably vary through time (Stafford Smith, 1996). On the one hand, selling livestock in poor seasons when feed is in short supply and stock prices are low, and then purchasing in above- average seasons when prices are inflated, is a sure way to lose money (Arnold and Bennett, 1975). On the other hand, the more constant the stocking rate in regions exposed to a variable climate, the lower the long-term stocking rate must be (Stafford Smith, 1996). Dynamic models are being developed that help to identify the appropriate balance between the resilience of the vegetation to short-term overgrazing, the variability in the weather over time, the indebtedness of producers and their attitude to risk (e.g., Foran and Stafford Smith, 1991; Stafford Smith and Foran, 1992). These have highlighted the need to focus on identifying combinations of stocking rate and trading policy that mutually favor productivity, ecosystem sustainability and financial viability.

Need for and Characteristics of a Drought Policy

The establishment of drought policies around the world is a recognition by government of the need to deal proactively rather than reactively to drought (Wilhite, 1993b). It recognizes that most droughts are not disasters, but an integral part of a variable climate that will occur time and time again. Many governments are expecting producers and others working in climate-sensitive sectors to be more self-reliant, anticipate and plan for drought, and to more effectively manage risk. In fact, as Wilhite (1993b) emphasizes, vulnerability to drought has increased in some settings because of relief recipients' expectations for assistance from governments or donors. If farmers or other relief recipients expect government or donors to assist them during times of distress, this practice will discourage or be a disincentive for self-reliance, and may promote land use practices that are not necessarily sustainable in the long term.

The key to making the rural sector more self-reliant is to be proactive, construct a drought policy and plan (Wilhite, 1993b), and provide the necessary research and extension services and information flows that will assist those in the climate-sensitive sectors of the economy to plan for and reduce the impact of drought.

Drought Policy Development in South Africa

Environmental concerns in South Africa as to the perceived detrimental effects of overstocking, especially during prolonged droughts, led to the government establishing an official Stock Reduction Scheme during the drought of the latter half of the 1960's and early 1970's. During this period, government put into operation officially demarcated grazing capacity zones for the stock industry (Smith, 1993). These were detailed enough to use at the farm level, and were often an important consideration by banks when assessing applications from farmers for financial loans.

These developments served as the philosophical base for the 1984 White Paper on Agricultural Policy, further strengthened by the adoption of the National Grazing Strategy in 1985 (Anon., 1985). Under this policy, drought relief assistance was aimed at the preservation of the agricultural resources, notably veld. It differed fundamentally from previous policy with the introduction of (i) a more objective procedure for applying for disaster drought declaration, (ii) definitive drought declaration assessment criteria, and (iii) certain eligibility criteria.

A disaster drought was defined as a condition resulting from absolutely abnormal adverse climatic conditions, leading to farming conditions where the production and availability of grazing (veld and introduced pastures) and water resources were reduced to such an extent that excessive livestock mortalities could be expected. In general, a one in 10 year event was anticipated with this specific definition, although in practice support has been provided on the basis of 1 in 13 year events (White and O'Meagher, 1997). The assessment criteria consisted of rainfall, veld condition and availability of forage, availability of water for livestock, as well as stock condition and mortalities. A more recent innovation has been the use of various technologies to evaluate these meteorological and agricultural criteria, including agronomic models and remote sensing (du Pisani *et al.*, 1995, 1998).

Assistance during disaster drought periods was exclusively reserved for so-called conservation farmers, which required a commitment from the producer in terms of voluntary registration. Eligibility for registration required adherence to the official grazing capacity of the property, as determined by local representatives of the South African Department of Agriculture, by submitting monthly sworn statements of stock numbers to the relevant authority. Registered farmers were obliged to (1) adhere to the prescribed carrying capacity in normal years, and (2) reduce their stock numbers by two-thirds as soon as an area is declared disaster drought. The assistance provided during disaster droughts included rebates on transport costs of registered stock feeds and licks, monetary incentives for stock reduction actions, State contributions to feed costs for the maintenance of nucleus herds in the form of loans and subsidies, and State contributions for the finishing of stock in feedlots (Bruwer, 1990). Several ad hoc measures also applied from time to time, like financial assistance for the transporting of drinking water for livestock.

Post-apartheid South Africa with its unique juxtaposition of first and third world conditions, i.e. a well developed commercial farming sector operating alongside a subsistence farming sector, needs a more comprehensive policy to protect third world rural communities against the ravages of drought (Anon., 1993). Specific attention is now being focused on issues like household food security and rural water supplies, while promotion of self-reliance, the acceptance of drought as a normal environmental risk and risk management will be much more emphasized.

South Africa is currently aiming to integrate disaster management and risk reduction policies with development initiatives aimed at poverty reduction, land reform, housing, employment creation and service expansion in order to avoid costly losses at the household and national level (Ramabenyane, 1999). Emphasis on risk reduction is being targeted at the most vulnerable categories of the population by:

- commercial farmers being expected to submit tax returns;
- small-scale commercial farmers purchasing inputs and selling output, but not expected to complete tax returns due to low levels of income;
- farm workers vulnerable to losing not only their income but also productive assets including their access to basic rights such as food, water and health; and
- the rural poor - including subsistence producers.

Whilst most of the social objectives of these initiatives are laudable, a number of concerns must be raised. These include drought still being viewed as a disaster rather than an integral part of a variable climate, which must be proactively factored in to long-term planning. Of paramount importance is the need to retain the environmental policies and protective strategies that have evolved through decades of research and practice to ensure that the natural resource base remains productive in the years ahead. An integrated multi-disciplinary approach is advocated that involves agriculturists, meteorologists, hydrologists, information technologists, sociologists and health and welfare employees working side by side (du Pisani *et al.*, 1998). A strategy that focuses primarily on importing food during times of need will be vulnerable to escalating world prices, particularly for grain, during major El Niño events.

Drought Policy Development and Implementation in Australia

European settlement of Australia has been characterized by misguided optimism, following the discovery of vast native grasslands nearly 200 years ago. Early settlers and later generations failed to appreciate that what they thought of as drought was the norm. In hindsight, the application of assumptions and methods fashioned by European agricultural experience proved to be inappropriate in this new environment. This led to extensive land clearing and overstocking, initiating the serious and often irreversible natural resource and environmental degradation that is so evident today. Despite increased warnings from scientists (e.g., Ratcliffe, 1947) and other commentators, governments continued to support closer settlement, extensive clearing and expansion of production.

Australia has a federal system comprising three levels of government: Commonwealth (national), States and Territories, and local government. The national government's direct involvement in providing drought assistance dates from 1934. In the period to the 1960s, Commonwealth involvement was generally confined to the largely ad hoc provision of funding to support State-based assistance schemes to stabilize the financial position of farm businesses affected by drought. This assistance was usually through the provision of interest rate subsidies on debt, debt reconstruction, and transport, fodder and water subsidies.

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. The Commonwealth Government's decision to establish the Natural Disaster Relief Arrangements (NDRA) in the 1960s represented an attempt to rationalize ad hoc federal involvement on drought and other disaster relief measures. Under the NDRA, Commonwealth funding was provided to the States after a threshold of expenditures had been exceeded; this funding was supplemented by specific measures from time to time, such as the fodder purchase and interest rate subsidy schemes in 1982-83.

In 1989 the Commonwealth Government announced the withdrawal of drought from the NDRA and its intention to develop a national approach to drought policy. This was a consequence of increasing concern about the cost and effectiveness of drought support (e.g., Ratcliffe, 1947; Young *et al.*, 1984). It represented a belated recognition that drought was a normal feature of Australia's agricultural and climatic situation, and that mismanagement during drought was degrading the natural resource base on which agriculture depends.

The National Drought Policy (NDP) was first agreed to by Commonwealth, State and Territory Ministers in 1992, reaffirmed in 1994, and reviewed in 1997. Its aims were to encourage primary producers and other sections of rural Australia to adopt self-reliant approaches to managing for climatic variability, to maintain and protect Australia's agricultural and environmental resource base during periods of extreme climate stress, and to ensure early recovery of agricultural and rural industries, consistent with long-term sustainable levels (White *et al.*, 1993; O'Meagher *et al.*, 1998, 1999).

The NDP sees climate variability and drought as normal features of the Australian environment in which agriculture must operate. The main focus is on farm management that takes into account the risks associated with a variable climate and adheres to the principles of sustainable agriculture (O'Meagher *et al.*, 1999). This is being aided by research, extension and education, through providing economic instruments to reduce fluctuations in income from year to year, and taxation measures aimed at achieving more sustainable agriculture. Direct financial assistance is also provided when droughts are deemed to be exceptional.

Drought Exceptional Circumstances and Rural Communities in Australia

The recent drought in Australia accompanied a sequence of El Niño-based events, beginning in Queensland in 1991 and culminating in much of Australia experiencing abnormally low rainfall throughout 1994 and into 1995. In fact, large areas of central Queensland and western New South Wales did not have any respite until December, 1996, when a number of cyclones associated with the summer monsoon crossed the coast of northern Australia.

Agriculture in Australia at the commencement of the recent drought was arguably more vulnerable to a prolonged drought than it had been since the 1950s. High interest rates in the late 1980s, followed by a collapse in commodity prices, notably wool, led to a major increase in farm debt at the beginning of the 1990s. At the same time the Commonwealth government was determined to clamp down on excessive demands for drought assistance that had been identified as occurring under the National Disaster Relief Arrangements (NDRA) (Heathcote, 1991, 1999; Smith, 1993; Daly, 1994). The endorsement of the NDP in 1992, with its emphasis on increased self-reliance and risk management, and maintenance of the natural resource base, occurred concurrently with not only a background of high farm debt, but also a drought whose impact was increasing rapidly over time.

It was not until 1994 when the full extent and severity of the drought became apparent that it was acknowledged that conditions were becoming exceptional across large areas of Australia. An assessment process and framework for drought exceptional circumstances (DEC) had therefore to be determined and implemented.

If drought conditions became so intense and protracted that they were considered beyond the bounds of normal risk management practices, the Commonwealth Minister for Agriculture, Fisheries & Forestry can declare affected areas as experiencing 'drought exceptional circumstances'. This qualifies producers in these areas to apply for Commonwealth financial support (White and O'Meagher, 1995; White *et al.*, 1998). Declaration of DEC was based on an assessment process involving analysis of objective scientific information and independent advice from the Rural Adjustment Scheme Advisory Council (RASAC), which in turn seeks scientific advice from the Bureau of Rural Sciences (BRS). Final decisions were made by the Commonwealth Cabinet.

In October 1994, the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ, comprising Commonwealth, State and Territory Ministers for agriculture and resource management) agreed on six core criteria for DEC. These criteria were: meteorological conditions, agronomic and livestock conditions, water supplies, environmental impacts, farm income levels, and scale of the event. For the existing meteorological conditions to constitute a 'rare and severe event', it had to be established that they were likely to occur with a statistical frequency of only once in 20 to 25 years, and to be of greater than 12 months duration (White and O'Meagher, 1995). In 1995 ARMCANZ agreed that there be greater emphasis on estimating the effectiveness of rainfall and the impact of drought.

Queensland and parts of northern New South Wales were granted drought assistance as from 1992 under what was known as the Pilot Drought Program, declaration being the responsibility of the States. Late in 1994 the first objectively-based determinations of DEC were declared, this covering other areas

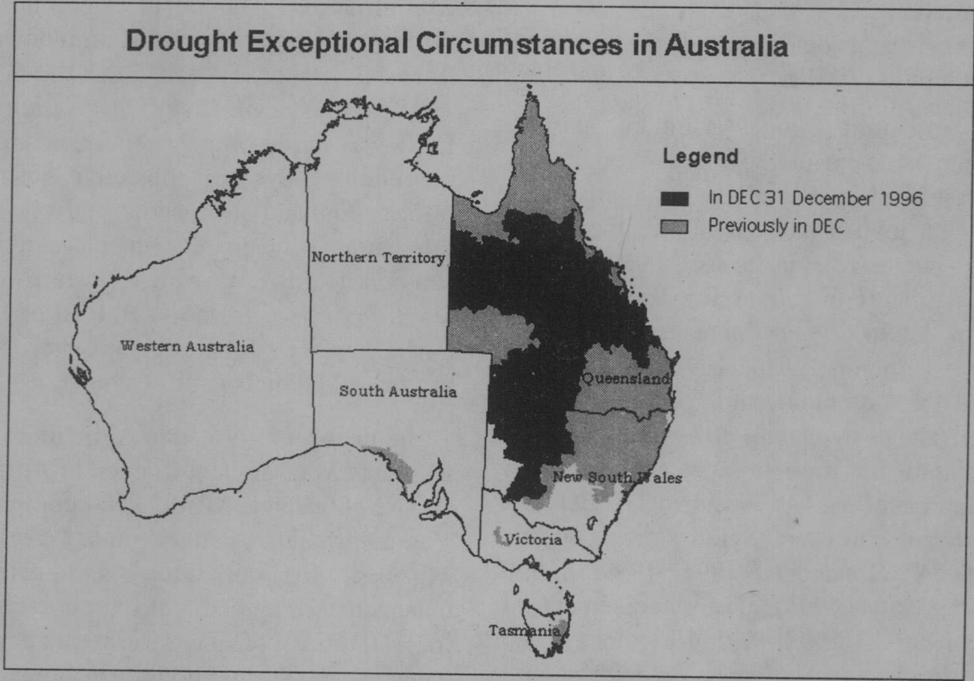

Fig. 4. Areas of drought exceptional circumstances (DEC) declared and revoked, 1995 to 1996 (Department of Agriculture, Fisheries & Forestry - Australia).

of New South Wales, the Eyre Peninsula of South Australia, and part of eastern Tasmania (Fig. 4). The reactions from farmers in many drought-affected areas that were not declared was one of disbelief. Thus began a campaign by many communities, individuals and farmers' associations to have their areas also declared as experiencing Drought Exceptional Circumstances, giving locals access to significant Commonwealth funding.

Achieving consistency in making recommendations on DEC declarations between areas that differed greatly in their climatic environments and farming systems was a considerable challenge. The further north, the higher the weighting on the summer months compared with the winter months, as areas were dominated more by monsoonal influences. The further inland and the lower the average rainfall, the longer the period between significant droughts. On light sandy soils in a cropping zone less significance would be placed on rainfall prior to sowing, because moisture would quickly percolate below the root zone. However, in all cases the aim was to determine which events of at least 12 months' duration and totalling 60 months within 100 years would qualify, and identify whether these included the current drought. The available information and tools would also vary, so that in some areas one was more reliant on rainfall data, whereas in others one was able to use the output from agronomic models, field data or remote sensing information to add to the reliability and credibility of a recommendation. It should be noted that model output was never used to prevent an area being declared as experiencing DEC. Model output helped determine that particular rainfall events were relatively ineffective, so that when placed in a historical context the current agricultural drought was indeed exceptional.

As the rural community (and the media) became better informed about the process, they attempted to exploit what they perceived to be weaknesses in the way that BRS and RASAC were assessing the available information. This included identifying areas where there was a low density of rainfall data, or arguing that rainfall intensity, temperature, soil type, topography, vegetation or characteristics of the local farming system were limiting the effectiveness of particular rains. A particularly contentious issue was 'lines on maps', in that the boundaries of areas affected by drought did not coincide with those of local government areas. In fact, what rain did pass through drought- affected areas was often associated with thunderstorm activity and very patchy in its distribution. In almost all cases these issues were well understood by the scientists involved, but not always by others involved in the evaluation process.

What did become apparent was that many people were remarkably unaware of the long-term rainfall patterns for their locality, and were therefore poorly equipped to deal with the severe droughts that occur every few years or decades in different parts of Australia. They also seemed to ignore the history of their region, particularly with respect to understanding and managing the risks.

There is no doubt that many farming families were highly stressed by the prolonged drought conditions (Stehlik *et al.*, 1999), some also being confused or angered by perceived declaration anomalies arising from the Commonwealth-initiated change to more objective and rigorous means of drought assessment. The aforementioned campaign to have more and more areas declared as experiencing Drought Exceptional Circumstances has persisted through and may have even contributed marginally to a change in the national government in 1996, including subsequently engendering support for 'populist politicians and solutions'. It inevitably led to a relaxation of the guidelines, as becomes evident later in this paper, but also highlights the difficulty of introducing risk management in a democratic society. Political candidates often find that it is much easier to get elected if they are offering considerable government assistance, than if they are advocating increased efficiency, risk management and environmental protection, even if a more self-reliant approach associated with structural adjustment and limited government intervention offers much greater benefits for the rural communities they wish to represent.

Assessment of Drought Exceptional Circumstances

BRS has developed and promoted the use of model-based methodologies to assess the effectiveness of rainfall and to improve the objective estimation of DEC. Rainfall and other climate data collected over the past 90 to 120 years were input into models of farming systems in order to characterize and rank past droughts, and determine appropriate indicators and criteria for estimating the severity and extent of future droughts (White *et al.*, 1998).

Studies funded by BRS of relevance to the grazing industries included using a model of a Merino ewe flock grazing an annual ryegrass and subterranean clover pasture in northern Victoria (White *et al.*, 1998); a model of an annual grass and subterranean clover pasture grazed by either Merino wethers or breeding ewes in the Central Tablelands of New South Wales (Donnelly *et al.*, 1998); and a rangeland model at Charleville (south-west mulga country, sheep) and Charters Towers (northern speargrass, cattle) in Queensland (Stafford Smith and McKeon, 1998). It was concluded that rainfall, soil moisture, grassland and crop production (or an index thereof), NDVI (Normalized Difference Vegetative Index) estimates based on data from NOAA AVHRR satellite-based sensors, liveweight gain, supplementary feed requirements, and net farm income or a measure of financial stress are all useful indicators of DEC. The feasibility of taking account of significant long-term climate shifts was also demonstrated.

As indicated above, an issue in DEC declarations has been determining the boundaries of exceptional droughts, in that the impacts of drought seldom align with the boundaries of Local Government Areas. Although not widely publicized, remote sensing was used extensively in the process, current satellite imagery being compared with that in previous years, and to assist in the spatial extent of exceptional droughts (McVicar and Jupp, 1998). It was particularly useful in determining whether there had been any significant changes in vegetation cover following rainfall events between the time that RASAC visited an area being considered for DEC declaration, and the decision being made by Cabinet.

Use was also made of a grasslands model to estimate changes in total standing dry matter across Queensland, and the spatial extent of drought (Hall *et al.*, 1997; Carter *et al.*, 2000). This approach, which has been extensively tested against field and remotely sensed data, was of considerable assistance to RASAC and BRS in evaluating the severity of drought across that State. For example, estimates of herbage cover or production could be viewed spatially in a historical context (i.e., as a map of percentiles).

The Future of Exceptional Circumstances in Australia

A 1997 review 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, whilst also ensuring that the environment is protected.

Increasing the self-reliance of farmers exposed to an ongoing cost-price squeeze exacerbated somewhat through trade liberalisation, with markets being demand- rather than supply-driven, with greater rewards for product quality, and with society demanding better protection of the natural resource base, is an immense challenge in itself. At the national level the Department of Agriculture, Fisheries and Forestry - Australia (AFFA, formerly DPIE, the Department of Primary Industries & Energy) is assisting the States and Territories to implement Property Management Planning, in which principles of farm and risk management are established for different environments and farming systems.

New declaration procedures for Exceptional Circumstances (EC, usually drought) were approved by ARMCANZ in March, 1999, to recognize that there are exceptional circumstances beyond the scope of normal risk management, and that in these exceptions the Government should provide assistance. Under these procedures income becomes the key measure for determining the impact of the event.

The criteria for EC 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. However, terms such as 'prolonged period' and 'of sufficient scale' are highly subjective. Compared to the previous DEC regime, this extension is much more difficult to base on verifiable, objective data sets. If the event is a drought then the previously described method for assessing DEC would essentially apply.

Considerable difficulties are already being encountered, as O'Meagher *et al.* (1998) anticipated, in ensuring that such a multi-criteria approach remains objective and that government interventions are rare events indeed. Each and every year comprises a unique combination of events, so that such combinations are difficult to place in historical context. Not only is there the problem of needing to set the maximum number of criteria that could ever be considered as eligible in advance, and an appropriate frequency for possible events, but for most of the events likely to be considered for inclusion, the data are unlikely to be available to test whether the nominated frequency has been satisfied. Not surprisingly a large number of applications for EC, each emphasising combinations of exceptional factors leading to a severe downturn in farm income, was received. If the process of declaring EC is indeed based on either farm income alone or 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 interest of developing and sustaining a viable and healthy rural sector within the Australian economy.

BRS is currently working to enhance government responsiveness to EC by improving its capacity to deliver evidence-based assessments to AFFA and the Minister. This is being done by researching new approaches to the analysis of climate variability and its impacts on agriculture, and developing an Integrated Toolset that will integrate scientific evidence from a range of sources so as to provide customized delivery of assessments of EC applications (G. Laughlin, personal communication). Emphasis will also be on identifying and implementing principles of good risk management at regional scales. CSIRO Land and Water are assisting BRS by relating combinations of enhanced AVHRR reflectances and brightness temperatures to useful measures of biomass production such as laser-based vegetation profiling, and the outputs from pasture simulations and pasture experiments, in collaboration with the Queensland Department of Natural Resources.

Policy implementation is continuing to be undermined by political demands for financial assistance, particularly in marginal electorates, and the lack of a clearly articulated vision. Stafford Smith and McKeon (1998) highlight the problem, viz., "As long as drought declaration is seen as an issue of psychological support ("times are obviously tough and society joins in recognising your efforts and expertise in staying on the land") or motivation ("your peers recognize this as a time when their planning for drought comes into play and you should think about what special actions you need to be taking too"), then almost any .. indices and calculation methods will suffice for identifying severely below-average conditions. But if the purpose is legally, politically and financially binding, then the question of balancing equity and objectivity becomes problematic". In this latter situation, the pressures on those involved in assessing the extent and severity of agricultural droughts to achieve levels of accuracy that are often at the limits of what can be supported by the data, and to justify their recommendations, can be considerable indeed.

Stafford Smith and McKeon (1998) make two further points. First, if, on the basis of a shared community responsibility for dealing with climate variability, the purpose of Exceptional Circumstances is to provide short-term targeted assistance to long-term viable farmers in times of rare and severe events, in the long run there may be less controversial ways of applying these resources. This could include putting all the resources into infrastructure, training and research to minimize the impacts of climate variability. Rural poverty could also be addressed through the channels of social security, consistent with those experiencing hardships in other sectors of society. Secondly, methodologies for assessing the extent and severity of drought could be extended to assess why there appears to be such a discrepancy between the frequency of need expressed by certain farmers (e.g., Daly, 1994) and what seems like a responsible level of public investment as expressed in the National Drought Policy. This also raises the appropriateness and consequences of previous policies associated with closer settlement and therefore smaller farm size, land clearing and development.

Other Research Initiatives Underlying Policy Development and Implementation in Australia

Initiatives are being undertaken within the national Climate Variability in Agriculture Research and Development Program (CVAP), administered by the Land and Water Resources Research and

Development Corporation (LWRRDC) and supported by AFFA, the National Farmers Federation (NFF) and other R&D Corporations (White *et al.*, 1999). The overall goal of CVAP is 'To work with the Australian agricultural sector to develop and implement profitable and sustainable management strategies which prepare it to respond to the major opportunities and risks arising from climate variability'. Within this overall goal, research and development are being targeted at: (a) improved climate prediction and reducing the impacts of climate variability; (b) adaptations to climate variability; (c) marketing climate information, including national and international workshops addressing farm management decision making and climatic risk; and (d) the extension and value of climate-related applications.

Australia, probably more than any other country, is sensitive to the influences of El Niño. Research and extension activities therefore aim to improve the use and value of climate information, including seasonal climate forecasts (Stone *et al.*, 1996; Nicholls *et al.*, 1997), the ultimate objective being to develop new farming systems better adapted to climate variability (McKeon and White, 1992; Buxton and Stafford Smith, 1996).

The influence of El Niño and the value of seasonal forecasts is particularly pronounced in north-east Australia, although even there one forecast in four can be inaccurate. It therefore follows that seasonal forecasting is likely to be less accurate elsewhere, both in other parts of Australia and overseas, and may be so inaccurate as to be of little value to producers. Furthermore, accuracy of forecasts does not equate with value to producers. The value of seasonal forecasts depends on their accuracy, marginal value compared with other information (e.g., recent rainfall; status of soil moisture, pasture and crop biomass; traditional indicators such as prevailing winds, the fruit production of particular trees, movement of wildlife or spider behavior), identifiable benefits in terms of productivity and protection of the natural resource base, and the capacity of farmers to respond to the additional information within a particular environment and farming system.

Some simulation studies with cropping systems have identified significant benefits to using seasonal forecasts (e.g., Hammer *et al.*, 1996; Marshall *et al.*, 1996), particularly in north-eastern Australia. However other studies, particularly with pastoral systems, have shown little financial benefit though some environmental benefits (e.g., more pasture biomass at critical times) to having even reliable seasonal forecast information (e.g., Bowman *et al.*, 1995; Stafford Smith *et al.*, 2000). In part this is a consequence of insufficient lead time and decision opportunities (e.g., annual cattle muster in very remote areas). Similar conclusions have been reached with respect to rangeland systems in southern Africa (du Pisani *et al.*, 1995). Consequently, farm surveys are being used in Australia to identify circumstances under which seasonal forecasts are more likely to be of value.

Improved seasonal forecasts may be useful to producers, but managing climate variability *per se* is of paramount importance in planning for drought. Decision Support Systems (DSS) are expected to have an ever-increasing role in aiding risk management and decision making by producers (White and Howden, 1991). Climate DSS include Australian Rainman developed by the Queensland Department of Primary Industries in collaboration with the Bureau of Meteorology and other organisations (Clarkson *et al.*, 1997), and MetAccess developed by the CSIRO Division of Plant Industry (Donnelly *et al.*, 1997).

Models of grazing systems, such as GRASP in northern Australia (McKeon *et al.*, 1990), and DYNAMOF (Bowman *et al.*, 1993, 1995) and GrazPlan (Donnelly *et al.*, 1997; Freer *et al.*, 1997; Moore *et al.*, 1997) in southern Australia, are of considerable value in determining appropriate long-term stocking rates, and supplementary feeding and stock trading strategies. In other words, they can be of fundamental importance in achieving sustainable grazing systems and improving the management of climate variability *per se*.

The rangelands of Australia cover over 70% of the continent, and pastoralism continues to be the dominant land use over about 60% of this area (Buxton and Stafford Smith, 1996). Given the vast geographic extent of the industry and the diversity of conditions under which it operates, it becomes particularly difficult to provide the detailed knowledge on how to profitably and sustainably manage the diversity of rangeland ecosystems for sheep or cattle production, and a highly variable climate and market prices.

Pastoralists and scientists have been involved in an exceptional degree of collaboration as part of a recent national project ('DroughtPlan') aimed at identifying the information needs for better decision-making in different regions (Buxton and Stafford Smith, 1996). A series of representative studies linking long-term stocking levels, tactical management of stock numbers and business management skills with economic outcomes was undertaken across the rangelands. These studies demonstrated that: (i) a reduction in current stocking levels can often improve cash flow; (ii) small adjustments in livestock selling tactics during drought can have large financial ramifications; (iii) it is financially advantageous to build stock numbers up quickly after a drought, even though this may conflict with long-term environmental values; (iv) while diversification can provide financial rewards, these can be matched by small improvements in the biological rates of the livestock; and (v) fine-tuning of the existing pastoral enterprise can provide a less risky means of increasing cash flow and reducing its variability than does diversification.

Better use of information was shown to help both profitablility and sustainability, although circumstances can occur where the interests of short-term profitability are in conflict with long-term conservation goals, as assessed by many pastoralists. As a consequence of these studies and associated surveys and discussions with pastoralists, a number of workshop materials and Decision Support Systems were developed. These included the Assessing Your Livestock Management Options module for Property Management Planning workshops, the BB-SAFe (Buy/Breed-Sell/Agist/Feed) tactics evaluator, the GrazeOn feed budgeting system, the Pasture Supply and Demand calculator, the 'Safe' Carrying Capacity Calculator, the Grasp Pasture

Production Database, case studies using the Grasp/Herd-Econ linked model, and the Decision Trees workshop and approach for farm business management.

In the meantime, the development of information systems to facilitate drought monitoring is continuing. Most States and Territories are involved in the National Drought Alert Strategic Information System, now known as Aussie GRASS, being developed by the Queensland Department of Natural Resources (QDNR), recent workshops having identified appropriate models of grassland and rangeland systems in southern and central Australia. This system should lead to more timely and informative feed deficit and land degradation alerts, and improved estimation of the extent and severity of drought. Further information is available at the Long Paddock World Wide Web site of QDNR, at http://www.dnr.qld.gov.au/longpdk.

Other research activities are focusing on the breeding, selection and management of drought-tolerant crops and pastures, how to manage drought-tolerant livestock such as *Bos indicus* cattle that can overgraze drought-stressed grasslands (under conditions in which *Bos taurus* cattle would probably die), the nutritional requirements of livestock during drought and the value of different supplementary feedstuffs, and other means of minimising rangeland degradation during drought (White *et al.*, 1999).

National Strategy for Rangelands Management in Australia

The second aim of the National Drought Policy is to improve the protection and maintenance of the natural resource base, particularly during times of drought. Today the wooded rangelands are much less productive than they were, primarily as a consequence of decaying infrastructure, bankruptcy, accelerated soil erosion, woody weeds, unpalatable grass build-up and palatable grass scarcity (Hodgkinson, 1995). Consistent with initiatives in South Africa to protect the veld, a national strategy for rangelands management is being developed in Australia (Foran *et al.*, 1990). This is to provide some real protection to many of the diverse and fragile ecosystems throughout the rangelands. Progress has at best been slow, largely because of entrenched opposition to proposed government legislation aimed at protecting the land.

It is imperative that the rangelands are monitored intensely to detect natural and human-induced threats. This can be done from satellite and airborne platforms as well as detailed monitoring in the field. Tongway and Hindley (2000) describe a structured procedure for assessing and monitoring desertification in landscapes based on detecting differences in the regulation of vital resources in time and space, by using indicators of soil surface processes that can be easily collected in the field.

Plant mortality is being investigated as an indicator of drought severity and the sustainability of perennial grasses within rangeland systems, its main determinants being identified for woolly butt (*Eragrostis eriopoda*) in the mulga (*Acacia aneura*) woodlands of western New South Wales, as a drought index (rainfall/evaporation for the past 3 months), grass height and basal therefore essential to have monitoring systems in place that enable such events to be interpreted in context, otherwise the political process will lead to inequitable or inconsistent assistance being given to groups of producers. This is unlikely to be to the long-term benefit of agriculture or to the economy as a whole.

Conclusions and Recommendations

Implementation of a national drought policy is difficult if it coincides with a sequence of either above- or below-average rainfall years. When there have been no severe droughts for at least a decade then coping with drought assumes a low priority in the public mind and on the political agenda. Associated with this is a declining local awareness of what constitutes typical long-term rainfall patterns within a region, and the likelihood and possible severity of drought. When severe droughts become established then local governments and farmer organisations attempt to exploit perceived short-comings in information and analytical systems in an effort to have more national or international funding channelled to local communities.

Information and analytical systems and processes for determining the extent and severity of drought need to be properly established and endorsed by all levels of government, and the community, at a time when drought is not widespread and obtaining access to government funding for drought relief is not a political imperative. The obstacles to achieving this goal are usually political rather than technical.

There is no doubt that the use of objective approaches for recommending declarations of areas as experiencing exceptionally severe drought have been largely successful, both in Australia and South Africa, this being of considerable assistance to policy makers and politicians in directing financial assistance. The evidence suggests that scientifically based recommendations have been largely consistent with the extent and severity of drought in different areas of these countries.

Attention in rural Australia now needs to focus on ensuring that farmers and others are much better educated in the National Drought Policy, in areas ranging from a better appreciation of the nature and causes of climate variability, to ways of achieving increased self-reliance through improved risk management, including ways of using climate records, seasonal forecasts, and computer- based DSS (climatic, biophysical, financial, whole-farm). Farmers are being encouraged to invest and save during the good times so that they will be financially more secure when droughts become established. Investment in research will help ensure that these activities are properly supported, and that there is better appreciation all round as to the nature and causes of and trends in climate variability, and how such information can be used to better manage agriculture and protect the natural resource base. Priority needs to be placed on clarifying the vision and removing policy anomalies and political pressures from the process, particularly with respect to determining those areas and persons in need of some financial support during exceptional droughts, and the mechanisms and government departments (agriculture vs. welfare) through which such support is delivered (Botterill, 1999). In this way a proper integration of drought policy, assessment and management can be achieved.

Drought policy development and implementation need to be integrated with other national policies and strategies being developed or in place. Management of drought in many regions and countries will remain the key to managing for sustainability. Drought policy and managing climate variability should therefore be an integral component of any national strategy for the management and productivity of arid and arable lands, for maintaining the biodiversity of native fauna and flora, for maintaining carbon sinks so as to minimize greenhouse gas emissions, for maintaining water resources and the health and welfare of humans and livestock, and for contributing to the national economy and food security. Maintaining the natural resource base is not an option, because the productive capacity and financial well-being of future generations is threatened as soon as the natural resource base is exploited in a non-sustainable manner for short-term monetary gain.

This paper has highlighted initiatives in Australia and southern Africa, many of which should be equally applicable in other arid lands. Nothing is more certain than that droughts will continue to have devastating impacts on agriculture, many lands becoming more vulnerable through mismanagement associated with increasing human and livestock populations and inappropriate land uses, and probable influences of climate change. All too often lack of planning has led to relatively minor droughts having tragic impacts on large numbers of people and livestock. Droughts must be regarded as natural phenomena and planned for accordingly. The way in which arid landscapes function must be better understood. Government policies must favor planning and preparation for droughts well in advance, backed up by appropriate research and farmer education, so that the impacts of drought on rural and urban communities and on the natural resource base are kept in check.

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