Australian Government
Bureau of Meteorology

Agricultural Competiveness Green Paper

Bureau of Meteorology Submission

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Introduction

The Agricultural Competitiveness Green Paper has highlighted drought, water and natural resource management as key policy development areas (Policy Ideas 16, 17, 18 and 19) to improve Australian agricultural productivity and profitability.

The recurrent and pervasive nature of drought and increasing demands on water and natural resources in Australia means that there is also a strong influence in several other key policy areas outlined in the Green Paper, including:

- Working with the States and Territories
- Education, Skills and Training
- Research Development and Extension.

The Bureau of Meteorology's mission is to provide Australians with environmental intelligence for safety, sustainability, well-being and prosperity—the information and insight needed to manage and live within Australia's highly variable environment. Specifically in relation to agriculture, the Bureau has a long and proven record of providing critical and trusted information to farmers, and the agricultural sector more generally, to inform production decisions and assist the management of the risks posed to production by our challenging climate.

The Bureau of Meteorology's submission discusses its broad capabilities in providing water information and drought related services, and considers whether enhancements can be made in the following areas in particular:

- Drought definition, including through events that are historically extreme.
- Early warnings of drought onset and cessation.
- National monitoring and prediction services.
- Tools, skills and advice to enable farmers to better adapt and respond to risks.

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Drought Information Services

The Bureau provides weather, climate and water information that can assist farmers in preparing for and assessing and managing risks associated with drought through a range of products and services. The core elements of the existing service are:

- the Drought Statement, which monitors and reports on the extent and severity of drought on the basis of rainfall deficiencies. It is issued monthly when extended abnormally dry periods are occurring in Australia;
- various other rainfall and soil moisture monitoring products that are updated regularly; and
- seasonal temperature, rainfall and streamflow outlooks, issued monthly for the upcoming three months.

These products and services provide timely information for decision-making across a range of agricultural planning horizons by:

- monitoring and reporting on past and current conditions;
- analysing and explaining climate variability and trends; and
- providing forecasts, warnings and long–term outlooks.

The Bureau strives continuously to improve the value of these products and services by seeking to enhance their accuracy and relevance based on the best available science and ensuring they best meet user needs.

Benefits of an enhanced drought information service

Beyond more generic climate, weather and water information, a specific need for enhanced services exists in the area of drought. An enhanced drought service would minimise the decision burden of farmers and governments when preparing for and adapting to current and expected drought conditions. Improved use of climate and water information in managing drought, including from multi-week and seasonal forecasts will lead to more informed decision-making, which in turn reduces input costs and optimises outputs. Alerts around rapid drying can assist farmers in making changes to practices to conserve water, feed and other resources ahead of a potential drought period. Early warnings about likely extreme climatic conditions, such as those that have occurred in spring 2014 in south-eastern Australia, can guide farmers to make informed decisions that minimise crop and stock losses. Collectively these informed farm decisions, guided community actions and regional strategic responses will reduce the impact of drought events to the national economy.

A comprehensive drought intelligence platform could inform farm decisions around crop selection, modifying stocking rates, feed supplies, water availability and vegetative cover which would result in more resilient environmental and economic systems and more profitable agricultural industries. To accommodate the needs of all agricultural sectors, such a potential enhanced service could also incorporate streamflow forecasts and landscape

water balance information. Irrigators, water managers and water market operators would benefit from improved coverage of forecasts and early warnings of impending low flows, reductions in storages and declines in groundwater levels across the country. There would also be benefits to urban and town water supply agencies in improving their seasonal to yearly management of water supply systems and also modifying demand through early community and industry engagement around water restrictions.

The development of Australia's tropical north is likely to be subject to significant climatic constraints due to recurrent drought conditions and dry season aridity. These droughts are primarily associated with variability in the monsoon and other tropical rainfall drivers such as the Madden- Julian Oscillation. Developing a climatology and analysing trends of the better defined agricultural drought conditions in Australia's north is a crucial step in sustainable development of broad scale agriculture in Northern Australia. The development of an improved national drought information service should help ensure that the expanding industries in Australia's north are provided with alerts, early warnings and the longest lead times possible for information around drought onset, severity, duration and cessation. This will in turn increase their resilience, profitability and likelihood of long term success in what is a highly variable climate.

Drought information: what do stakeholders want?

Current information provided by the Bureau around such variables as rainfall deficiencies, streamflow and water storages, including forecasts from days to seasons, is already widely used and valued by a wide range of agencies and other stakeholders that need to plan for and manage drought (see Figure 1). Uses of this information range from near term tactical decision-making (e.g. on farm enterprise decisions) to strategic planning around current and future water supply. The applications extend beyond agriculture and water, and include emergency services (e.g., fire season planning), social services, insurance and banking decisions, and natural resource management such as for wetlands.

In response to the National Drought Reform process, the Bureau has recently undertaken an internal review of its capabilities and an extensive external review of stakeholders in a range of industries affected by drought. These explored the extent that current Bureau products service stakeholders' needs and where any future possible investment in research and services should sit. The Bureau conducted stakeholder engagement workshops in most jurisdictions around Australia through the first half of 2014.

Workshop participants were from national, state and regional agencies and organisations representing agricultural and water policy and planning, many agricultural industries, rural support services, natural resource management, and some representation from the finance and insurance sectors. Individual farmers also provided understanding of the practical use of information for on farm planning and decision-making. Participants contributed through

presentations, discussion, and feedback and comments by post-workshop survey. Through these activities, Australian farming stakeholders have clearly communicated a need for an enhanced drought monitoring and drought prediction service to better prepare for and respond to these recurring events.

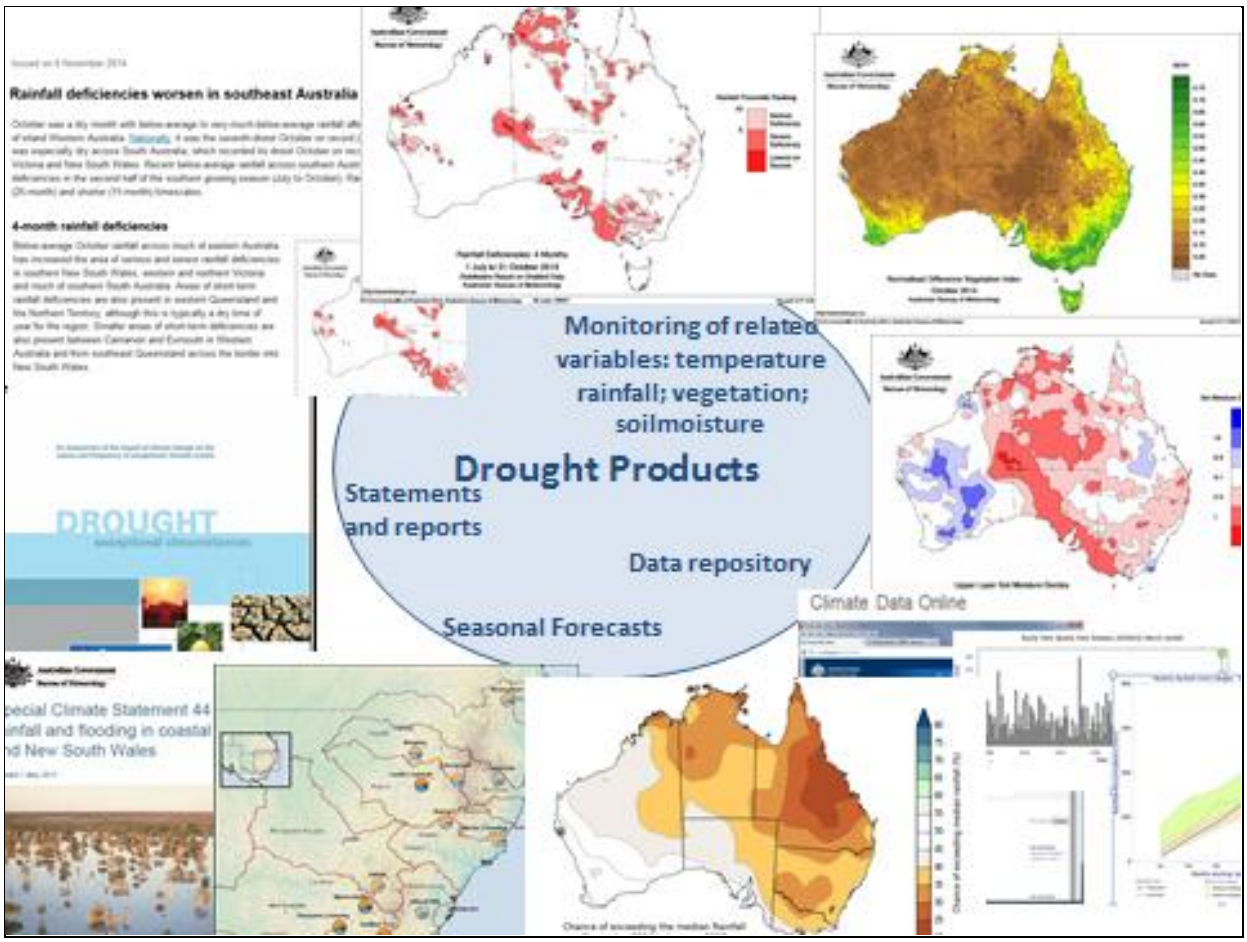

Figure 1. Existing Bureau of Meteorology drought products and services freely available through http://www.bom.gov.au .

The highest drought information priority identified by stakeholders was climate forecasts from a few weeks to a couple of seasons (see Figure 2). From our engagement with stakeholders: *"I want to know where we are going to be over the next season, as we can manage drought if we know where we will be".* Users want seasonal forecast information more closely integrated to current and past conditions and to the extent where changes in drought status can be directly forecast. Users reported that drought related information was most useful for significant decisions when there were indications of their drought status changing. Of greatest interest for agriculture is information on the likelihood of going into and coming out of drought, on a 6-12 month timeframe. Water managers were interested in multi-week, seasonal and multi-year streamflow forecasts, and hydrological modelling across the seasonal timeframe out to 2-10 years (decadal forecasts).

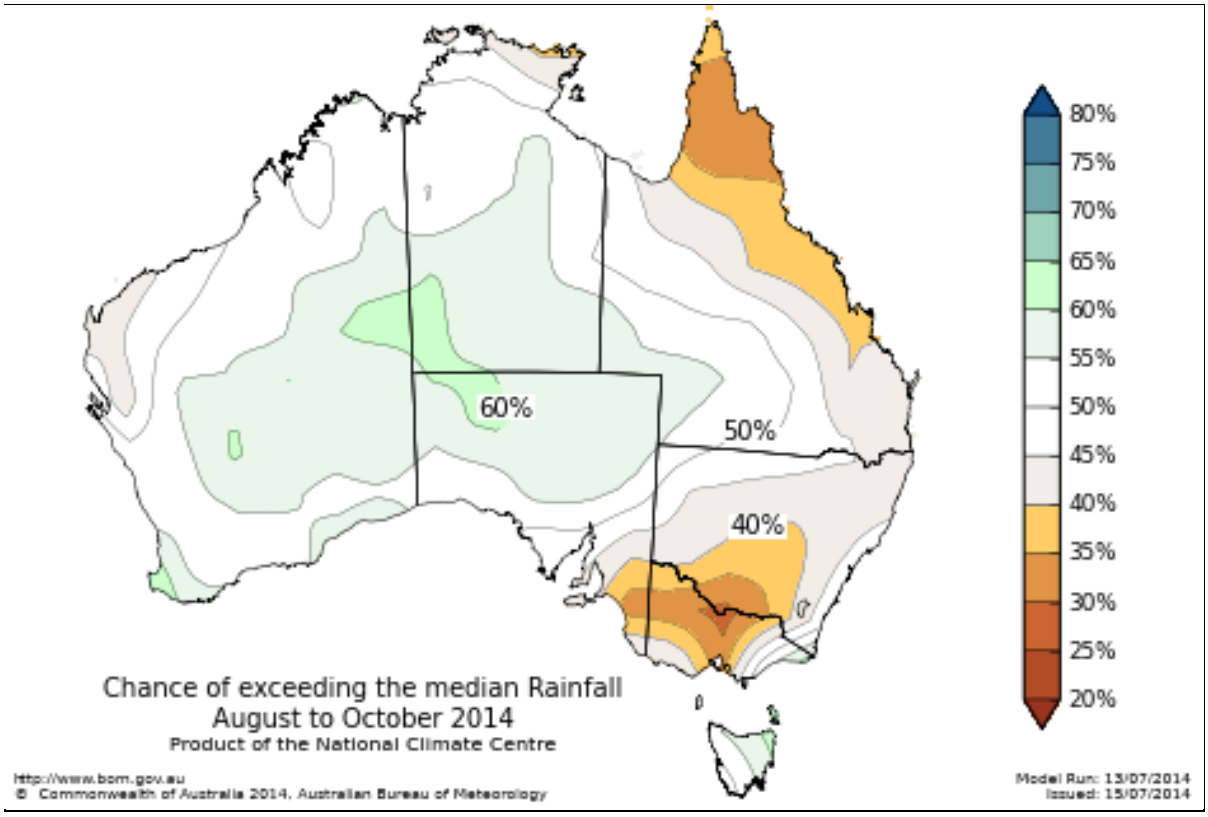

Figure 2. Rainfall outlook for August to October 2014 highlighting increased risk of dry conditions over northeastern and southeastern Australia. While useful, the existing product does not directly inform on future drought risk, but rather provides a perspective on seasonal aggregate rainfall.

The current climate and streamflow outlooks are clearly useful, but more targeted forecasts, such as the likely spatial evolution of drought areas or impacts on water storages, would provide better intelligence for decision makers.

Another common theme was the need to regionalise or localise data. Current national and state-based maps, though useful in many instances, are too broad for regional specific or on-farm applications. The desire from users to drill down to get data for a specific latitude-longitude was often articulated. If monitoring data can be matched up to a locational seasonal forecast, as is currently possible through the current outlook service, then the ability to localise would create greater uptake of any future products.

Feedback from this series of engagements suggests Australia's resilience to future droughts can be improved by using new and innovative remote sensing, drought monitoring, forecasting and communication technologies. Improved resilience stems from increased preparedness, response and recovery to drought conditions across the continent. Australia's ability to better define, characterise and forecast the onset, duration, severity and cessation of drought conditions is key to building a nation that is truly 'drought ready'.

Enhancing drought warnings

The Bureau is using its existing strong relationships with the Department of Agriculture, State and Territory agricultural agencies and Rural Research Development Corporations to improve national monitoring and forecasting for meteorological, hydrological and agricultural drought at farm scale resolution.

As previously stated, the ability to forecast drought to better understand risk, minimise impact and maximise profit was the primary requirement communicated at the stakeholder engagement activities conducted nationally during 2013/14. Developing future capability to forecast drought with greater than three months advance warning would support farmers to better prepare for and adapt to impending drought conditions and assist policy makers with their decisions.

Early warning systems could detect rapidly drying or wetting conditions and alert farmers if these conditions are forecast to deteriorate or improve further, enabling farmers, businesses, water managers and governments to modify their operations quickly. The "opposite" of a flash flood, a 'flash drought' can likewise often catch farmers and governments by surprise (See Southeastern South Australia and Western Victoria 2014 - Case Study). Low rainfall, high temperatures and high evapotranspiration can translate to significant yield losses in crops and rapid reductions in soil moisture and streamflow.

A better integrated national monitoring and forecast system using a refined agricultural drought definition could pick up rapidly evolving, 'flash drought' conditions and assist farmers to minimise losses and optimise resilience in the face of changing environmental and market

conditions. The alert systems could also be tuned to seasonal sensitivities through the productive cycles of specific agricultural sectors such as dry conditions during flowering of crops or during a critical sowing window. If current or forecast conditions look set to exceed critical thresholds for sensitive facets of an agricultural system, the farmer or farm business could receive an alert direct to their smartphone, tablet or computer via a communication channel of their choice. Australian government agencies, of all tiers, could also receive alerts indicating which agricultural communities are experiencing rapidly deteriorating conditions and which may need targeted information campaigns and support to minimise losses and maximise resilience.

Forecasting the cessation of drought conditions is as valuable, if not more valuable in some areas, than forecasting the onset. Minimising damage to soils, livestock and property associated with drought cessation is a critical component of building a more resilient and productive Australian agricultural system. If developed, specific national forecasts of areas expected to undergo drought cessation conditions could be used to target initiatives for recovery from drought and maximise profitability.

Drought monitoring and forecasting services are expected to be enhanced over the next three years as:

- increased supercomputing capability is delivered from mid-2016, enabling more frequent and finer resolution forecasts;
- international climate modelling advances provide the potential to significantly increase the resolution and accuracy of forecasts;
- a new satellite, Himawari-8, becomes operational in 2015, enabling a significant step change in our capabilities to assess the current state of the environment of Australia;
- seasonal forecast modelling capabilities continue to develop;
- an ability to forecast high resolution, greater lead time streamflow and landscape water balance components in every agricultural basin of the nation is introduced; and
- the citizen smartphone “adoption wave” has neared maturity leading to a requirement for tablet and mobile accessibility to georeferenced information across the nation.

Defining and analysing drought

Drought is a prolonged, abnormally dry period when the amount of available water is insufficient to meet normal use. However, as water is used in so many different ways, there is no universal definition of drought. An improved definition of drought would help to improve understanding around the types of drought affecting Australia - meteorological, agricultural and hydrological. A refined definition of agricultural drought could be used to better inform in-drought and recovery support in an objective, targeted, equitable, effective and cost-efficient manner based on current, and possibly, forecast drought conditions. The use of a drought

definition which reflects regional differences in growing seasons and productive cycles would assist through having greater national consistency in making drought support arrangements.

In order to be able to fully forewarn and support farmers, businesses, agricultural communities and governments about the onset, severity, duration and cessation of drought, a drought indicator which lends itself to risk management across the whole sector is required. Australia would benefit from improved awareness and integration across all common measures of drought; agricultural, hydrological and meteorological and how they interact and impact through seasonal cycles. It should be noted that while many State and Territory governments utilise their own drought indicators, which may include pasture growth and soil moisture, there is no consistent definition of agricultural drought employed across the country at present.

Depending on the severity of onset and the nature of water consumption in each catchment, meteorological, hydrological and agricultural drought can affect a region from almost simultaneously to evolving sequentially over many months or years. Traditionally, drought at the national scale has been defined using rainfall data as a sole determinant and, as of 2014, these have informed the basis for decisions on drought concessional loans (see Figure 3).

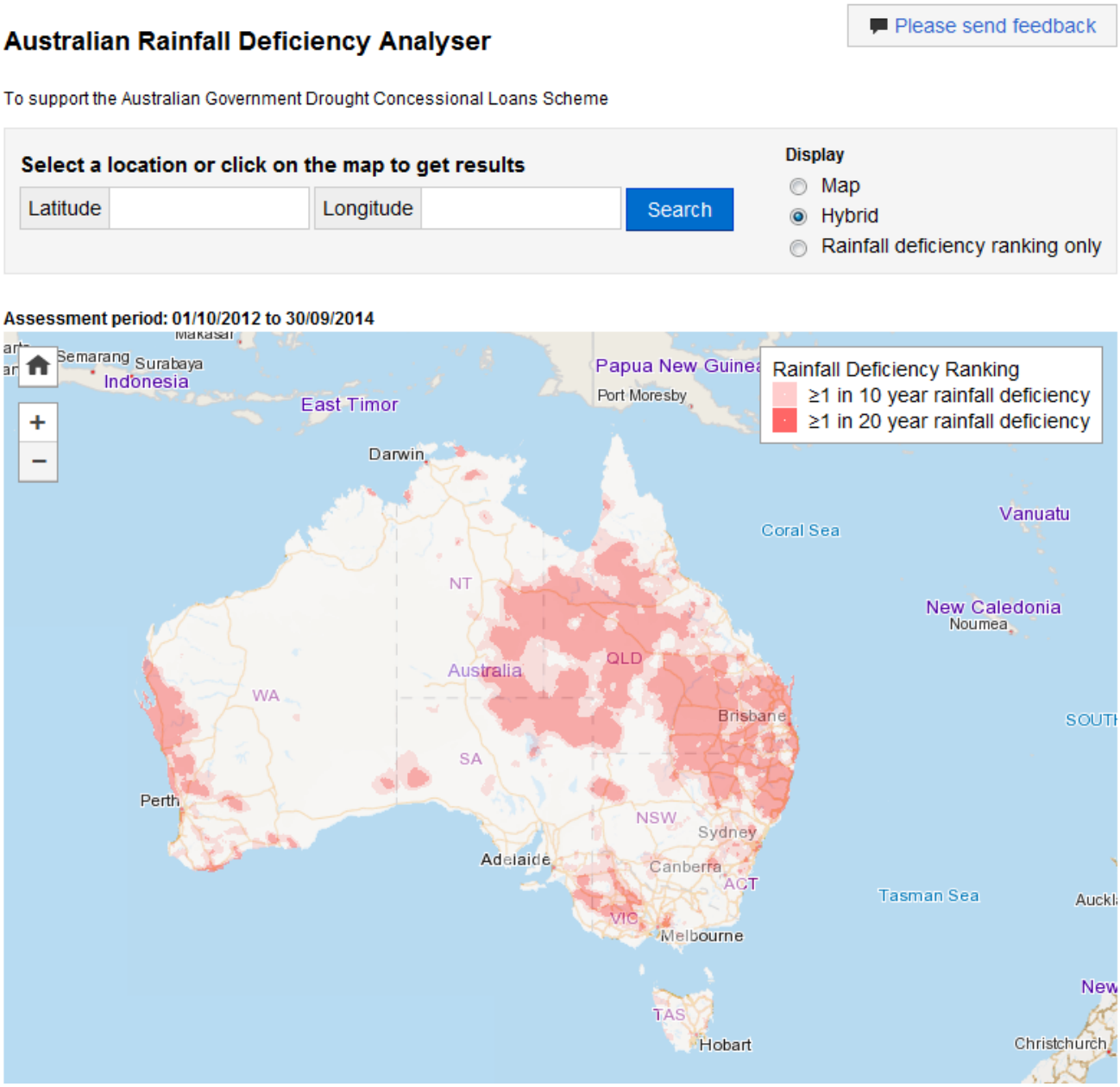

Figure 3. The new drought analyser service to assist decisions on drought concessional loans. Improved integration of this information with forecasts could provide better intelligence for decision makers.

Statistical analyses of rainfall data, when used in isolation with no reference to seasonality, will only identify which areas of the country are experiencing meteorological drought. This can be a first approximation to assessing agricultural drought but a more sophisticated method could produce a better assessment of the on-ground impacts of rainfall deficits. For example, the south-western Australian agricultural grain belt is winter rainfall dependent, a statistical analysis of meteorological drought which includes data from a heavy summer rainfall period will therefore not be representative of the conditions experienced in the critical autumn/winter sowing season. A more refined agricultural drought indicator would improve the community and government understanding of the severity of on-ground impacts to agricultural systems as it could take into account:

- Stored soil moisture
- Seasonality of rainfall compared to the many and varied productivity cycles for each agricultural system in each region of Australia, and
- Available surface and groundwater storages.

Hydrological drought, which refers to the levels of streamflow, groundwater and dam storages, often lags meteorological drought with subsequent impacts on agriculture. It is particularly important in catchments that support irrigated agricultural systems. Meteorological and hydrological drought are two measures that are commonly employed to define drought in Australia yet these measures are not always directly related to the magnitude of drought impacts to agricultural systems in all areas of the nation.

A national Australian agricultural drought indicator would objectively capture the potential for drought conditions to impact the productivity of agricultural systems in each region of Australia, including the tropical north with its distinct climate influences. The measure would assimilate:

- regional variations in climate, including the typical seasonality of rainfall (climatology)
- evapotranspiration (derived from surface temperature, wind and solar irradiance data)
- soil moisture (ground and satellite derived)
- vegetative productivity (satellite derived)
- information for better functioning water markets,
- seasonal productivity cycles of various agricultural sectors (agronomic data), and
- available surface and ground water storages (hydrology data).

There is also a need to better define those multi-year drought events that are particularly difficult for farmers to manage through. These extended periods of drought will not always be long periods of low rainfall which show up using current definitions of meteorological drought. These extended drought periods may be made up of low rainfall years interspersed with average years, however, there will not be the above average rainfall which is needed over an extended period to recover. An indicator of drought that also takes recent conditions such as this into consideration would be desirable.

There are many international examples of how an improved drought monitoring and prediction service might operate. The U.S. National Integrated Drought Information Service (NIDIS) was established in 1998 and has a National Drought Portal (http://droughtmonitor.unl.edu/). The web portal is very comprehensive and has products relevant to drought measures as mentioned above.

The Agricultural Competiveness Green paper also made reference to improving weather data, radars, improving water infrastructure and water markets. For the former, work could be undertaken to assess the optimum weather station networks needed to reduce uncertainties in drought monitoring and forecasting. Reliable and improved water information will help in optimal management of water storages, water-use efficiency, environmental release and proper functioning of water markets.

Tools, skills and advice to help farmers effectively adapt and respond to the risks they face

One of the most significant risks that farmers face is that posed by the high variability of Australia's climate and, particularly, the hazards due to extremes (see Figure 4). To adapt and respond effectively to these risks, farmers need tools that provide information around weather and climate extreme risks, covering all timescales from days to seasons. These tools should be user-focussed and integrated, bringing together the range of weather, climate and water information needed to assist in decision-making and managing risk.

However, even the best information is of limited value unless it is taken up and used appropriately in decision-making. One essential approach for improving drought preparation is to encourage both greater uptake and understanding of relevant weather, climate and water information through farmer education and training around the appropriate use of such information to manage risk and make decisions around drought. Building the capacity of the farming community to effectively interpret weather, climate and water information appropriately for their decision-making, including awareness of any limitations. Inappropriate use of this information can result in poor outcomes. Previously, state-based agricultural

extension services provided advice and training in this area, however a reduction in these services over recent years has created a need to find new channels for providing farmers with the skills to better use weather, climate and water information. This is especially the case with seasonal forecasting information, where the probabilistic nature of the information is sometimes misinterpreted.

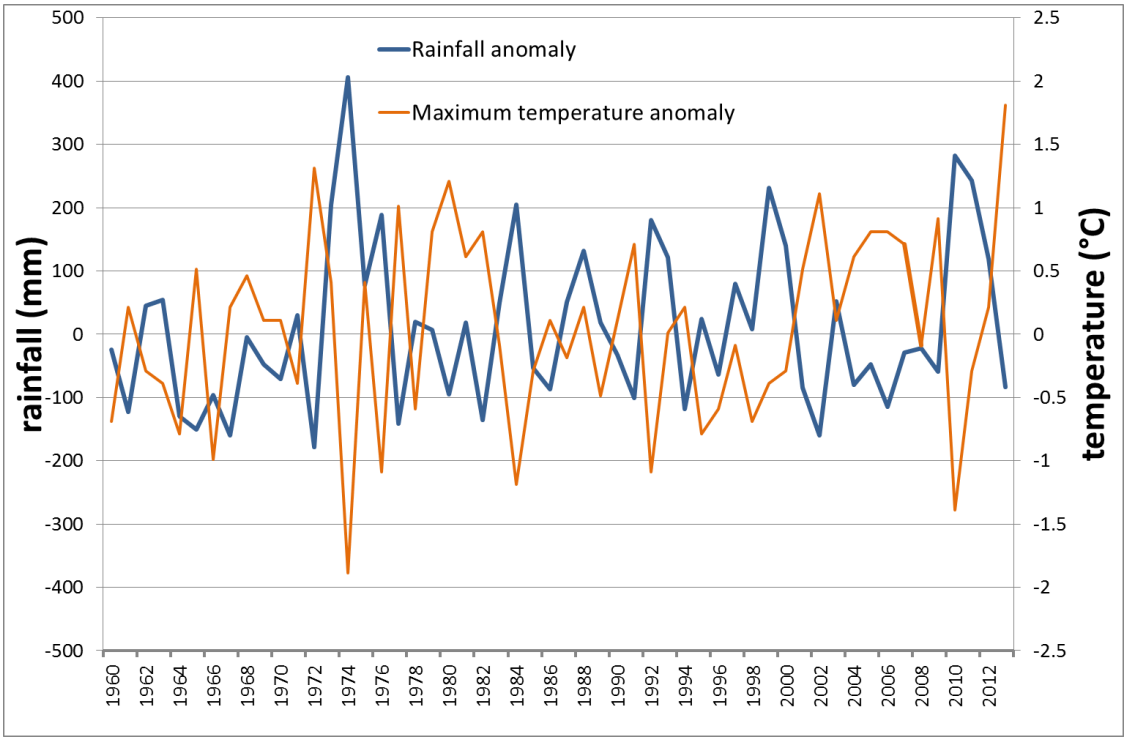

Figure 4. Recent annual rainfall and maximum temperature departures from mean for Wilcannia (31.56° S 143.37° E, NSW) showing high variability and large shifts between extreme wet and dry conditions. Better anticipating the risks from extremes will improve farmers' resilience.

The Bureau is seeking to enhance the impact of the information it provides to farmers and the wider agricultural sector, to ensure that they have tools and advice to adapt and respond effectively to these risks. This entails:

- strengthening engagement with the agricultural sector to ensure information best meets farmer and other decision maker needs.
- focusing on information that enables farmers and other decision makers to manage risks relating to high impact weather and climate events, including extremes such as drought.

- implementing scientific and technical advances, particularly regarding seasonal forecasting.
- promoting adoption and understanding of our information through effective communication and strong networks engaged with rural communities.
- developing a comprehensive training program building on a long history of delivering meteorology and climatology courses.
- promoting the development of extension services (Policy idea 20.d) which are focussed on managing climate, weather and water variability in partnership with Rural Development Corporations and state and territory government agencies.
- advising agricultural education institutions on integrating specialised training on managing climate, weather and water variability into the secondary and tertiary education programmes (Policy idea 14.a and 14.d).

CASE STUDY: Rapid descent into Drought: Southeastern South Australia and Western Victoria – August to October 2014

The end of the 2014 southern growing season was exceptionally dry for much of southern NSW, western Victoria and southern parts of SA (see Figure 5). The severity and timing of these dry conditions resulted in major losses for agriculture in these areas. To what extent were these dry conditions forecast? This is an interesting case study as the dry conditions were actually well forecast. The Bureau was warning of a possible El Niño event (often associated with drought in Australia) in February of 2014, the warning was upgraded to an 'Alert' in April 2014. The seasonal forecast for rainfall (Figure 2) showed higher chances of drier conditions across parts of eastern Australia for August to October, with subsequent forecasts continuing this pattern.

Rainfall at the start of the southern wet season was the best for a number of years; so to what extent should this rapid, flash drought have been prepared for? Given the conditions at the start of the season, you would not necessarily expect people to plan for such a scenario. However, at other critical decision points within the season situational awareness and updated information could help inform further decisions.

We usually think of drought as a creeping long-term phenomenon, but a more encompassing definition of drought will also enable recognition of these short drought episodes which occur within critical seasonal periods. A future forecast of drought onset should be able to capture short episodes as well as multi-year droughts to enable planning strategies around risk management to be put in place as early as possible, from both the farmer and government perspective. Training and user-focussed tools will allow the uptake and integration of this information into planning decisions.

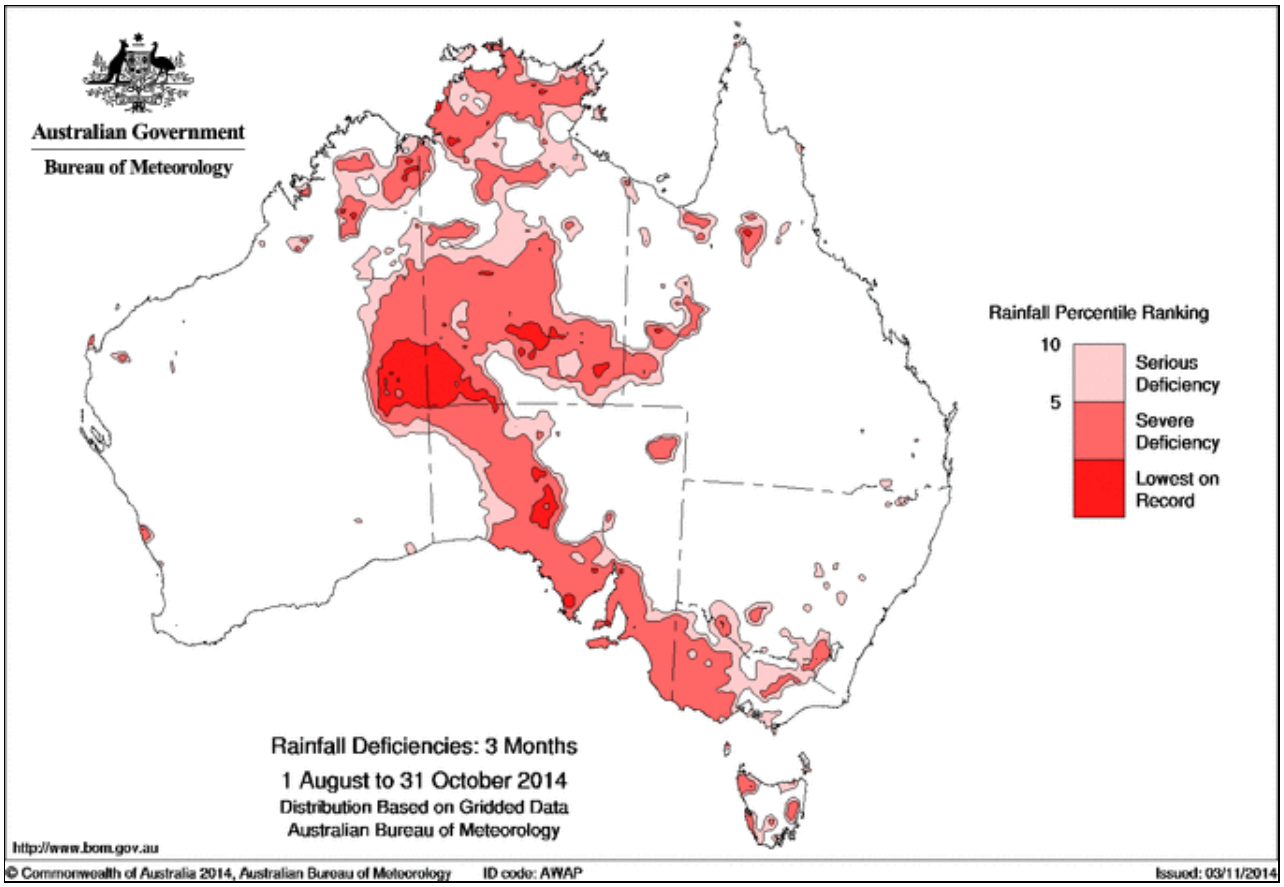

Figure 5. Rainfall deficiency conditions for the three month period August - October 2014. Better definitions and forecasts around drought will improve farmers' resilience and profitability.

Water and Natural Resources Management Services

Comprehensive water information

Water access is a significant challenge in agricultural areas of Australia where water resources are heavily allocated and rainfall is highly variable. Information about the availability of water is important to harness development opportunities for activities such as:

- securing water supplies for irrigated agriculture, whether through impounding surface water and/or development of groundwater resources;
- building water infrastructure at a scale that is cost effective and appropriate for the climate and water demands;
- establishing a water resources planning and management framework that contributes to healthy, productive ecosystems and communities through the sustainable use of water resources; and
- determining the value and requirements for the managed recharge of water to aquifers for subsequent recovery or environmental benefit.

The Bureau has the lead national role in the provision of water information and water availability forecasting services, through the Improving Water Information Program, which is a key pillar of the Australian Government's water reform agenda. The Bureau's water information roles and responsibilities are specified in the *Water Act 2007* which empowers the Bureau to collect and publish water information. The program began in July 2007, funded initially for a ten-year period.

The Bureau has assembled a comprehensive national repository of information on water entitlements, availability and use. It has also developed an extensive set of analytical and forecasting services that can be used to sensitively plan water development in the context of a variable and changing climate. Some examples are:

Rainfall Intensity Frequency Duration information

- used to design water infrastructure such dams, bridges, road drainage and irrigation.

Australian Water Resource Assessments

- a bi-annual assessment of water availability and use for each drainage division across Australia.

National Water Account

- a detailed analysis of water assets, liabilities, entitlements, allocations and use for nine regions that cover 70-80% of total water use in Australia and over 70% of Australia's population.

Short-term streamflow forecasting service

- Forecasts of streamflow for 1-7 days ahead being expanded to cover 61 catchments to support water managers and utilities in making operational decisions.

Seasonal streamflow forecasting service

- Monthly forecasts of the likelihood of particular flow volumes in catchments for the coming three months across 32 river basins. Users are water resource managers and irrigators.

Australian Groundwater Explorer

- National mapping of Australia's groundwater resources, and entitled groundwater use.

Hydrologic Reference Stations

- High quality long-term streamflow records showing variability and trend in annual streamflow for 221 gauging stations across Australia.