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Long-term meteorological forecasting in Australia

Definition of long-term meteorological forecasting

2.1 For the purposes of this inquiry, long-term meteorological forecasting is interpreted as the forecasting of weather and climate from one to several months in advance. The simpler term 'seasonal forecasting' is sometimes used. The inquiry did not focus on short-term weather forecasting (hours to several days) or on long-term climate-scale projections (years to centuries) other than as necessary to provide particular context to discussions on seasonal forecasting.

Forecasting in Australia

2.2 The Australian Government Bureau of Meteorology (BoM or the Bureau) stated that meteorological forecasting and climate modelling are important to Australia's economic, environmental and social well-being and prosperity.[1]

2.3 BoM added:

> Predictions of weather and climate at time scales from hours to days and across seasons can influence decisions that range from

1 BoM, *submission 4*, p. 3.

> emergency management procedures and systems through to when or whether to plant particular crops.[2]

2.4 BoM explained that Australia is also particularly vulnerable to:

> … the impacts of climate change which is projected to result in decreased rainfall and increased frequency of drier and warmer droughts for the southern part of the continent, with more intense and frequent extreme events such as heavy rainfall and tropical cyclones in the north.[3]

2.5 BoM added that Australia's location and size expose it to a range of weather extremes such as heatwaves, bushfires, cyclones, floods and storms.[4]

2.6 BoM explained that its current policy is to:

> … maintain a seasonal climate outlook service that draws on meteorological and related observations, a climate modelling capability, a suite of forecasting tools, and information available from similar services and research elsewhere.[5]

Australia's unique climate and weather

2.7 Several submissions reiterated the need for region-specific application of forecasting models. For example, the Australian Academy of Science (AAS) stated:

> Australia's position in the Southern Hemisphere Indo-Pacific Region demands specific national weather and climate research capability to ensure forecasting systems are tuned to provide maximum national benefit.[6]

2.8 The Department of Agriculture, Fisheries and Forestry (DAFF) added:

> The Southern Hemisphere is somewhat unique and a lot of efforts in the Northern Hemisphere are not going to address the sorts of

2 BoM, *submission 4*, p. 3.
3 BoM, *submission 4*, p. 3.
4 BoM, *submission 4*, p. 3.
5 BoM, *submission 4*, p. 3.
6 AAS, *submission 25*, p. 1.

> questions we want addressed and certainly not at the scale that farmers need this sort of very localised up-to-date information.[7]

2.9 CSIRO explained that Australia relies on international observation systems such as satellite data, and benefits considerably from weather and climate forecasting technology developments in other countries, adding that:

> National capacity to further develop forecasting technologies is essential, because of Australia's specific vulnerability to Southern Hemisphere phenomena that are not the focus of most developed nations' forecasting activities.[8]

2.10 A discussion of the unique weather and climate variables affecting Australia can be found in Chapter 3.

Who does our forecasting?

2.11 Under the *Meteorology Act 1955* the Bureau of Meteorology has responsibility for the collection of meteorological and related data and the forecasting of weather and the state of the atmosphere, including the issuing of warnings for severe events likely to endanger life and property. The Act also requires BoM to produce records of weather observations and maintain the national climate record.[9]

2.12 Seasonal forecasting for Australia is provided predominantly by BoM's Climate Services Program:

> The Bureau of Meteorology has interests in forecasting meteorological and related conditions on all timescales. The Bureau currently has a strong and reliable weather forecasting capability out to around seven days and some capability at seasonal timescales to produce outlooks for general rainfall and temperature conditions likely over a coming three-month period.[10]

7 DAFF, *transcript of evidence 3 June 2009*, p. 2.
8 CSIRO, *submission 16*, p. 15.
9 BoM, *submission 4*, p. 5.
10 BoM, *submission 4*, p. 3.

How seasonal forecasts are made

2.13 BoM stated that, for the past two decades, it has been issuing forecasts on expected anomalies in rainfall and temperature across Australia over the coming three months, i.e. seasonal forecasts.[11]

2.14 BoM and CSIRO discussed methods of forecasting:

> Most operational forecast products are based on statistical forecast methods that have been used for more than two decades. Some new, experimental dynamic forecasts are showing improved forecast skill and are expected to replace statistical forecasts in the future. They are currently used to provide additional guidance for the operational service.[12]

2.15 BoM's submission discussed at length the fundamentals of meteorological forecasting, including the difference between statistical and dynamic modelling:

> Meteorological forecasting in general involves gathering observations about past or present conditions that define and influence weather, and using those observations in some way to predict what the meteorological conditions will be at some future time. Forecasts can be based on statistics of the past ('statistical forecasts') but for weather are now almost exclusively based on complex models of the atmosphere, earth surface and ocean that take as input the observations of existing and past conditions.
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> …
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> A key assumption of statistical forecasting is that past weather and climate patterns are sound indicators of what can be expected in the future. Climate change challenges this assumption because it suggests that in the future the conditions that affect weather and climate increasingly will exceed the bounds of past experience. Consequently, a climatic state, i.e. the average conditions over a period such as a month or season, which is outside the bounds of the climatic record used to construct a statistically based forecast system, will likely be less well forecast than any climatic state that is within the bounds of that record.
>
> …

11 BoM, *submission 4*, p. 5.

12 BoM, *submission 4*, p. 3; CSIRO, *submission 16*, p. 4.

> Dynamic forecasting, however, is based on fundamental physical and dynamical relationships; relationships that are largely invariant to climate and climate change, and are conditioned by assimilating (dynamically) observations of the past and present state.[13]

2.16 BoM further explained that dynamic seasonal forecasting has distinct advantages over statistical forecasting in a changing climate regime:

> Dynamical forecasting models use extensive mathematical calculations based on the laws of physics, but do not start from perfect representations of the weather system (either in terms of equations or observations) and so do not produce exact forecasts of the future. Indeed, even the smallest of errors in an otherwise perfect model will grow over time, limiting predictability of weather to around 10-14 days. Hence, every forecast has a degree of uncertainty attached to it.[14]

2.17 BoM explained that the closeness of forecasts to actual events when reviewed with hindsight is referred to as 'forecast skill', and that this skill for a given time interval (e.g., daily forecasts) declines as predictions are made further into the future. BoM added:

> Hence, forecasts of tomorrow's weather are generally more skilful than forecasts of the weather five days from now … seasonal forecasts tend to involve statements about average conditions over future weeks to months rather than forecasts of specific conditions on particular days in a future season.[15]

2.18 BoM also explained levels of uncertainty and ensemble forecasting:

> Uncertainty, which grows with the length of a meteorological forecast, is being quantified by generating a series of forecasts under slightly different starting conditions in the model, which reflect the level of uncertainty in not being able to exactly prescribe the current state of weather everywhere, and then analysing the spread in the series of forecasts. This approach, termed ensemble forecasting, allows more appropriate probability statements, i.e. estimates of uncertainty, to be made about a forecast. Ensemble predictions generally provide more robust and reliable assessments of forecast conditions.[16]

13 BoM, *submission 4*, p. 6.
14 BoM, *submission 4*, p. 6.
15 BoM, *submission 4*, pp. 6-7.
16 BoM, *submission 4*, p. 7.

2.19 Professor Roger Stone, a climatology and water resources researcher, explained that outputs from climate forecasts (eg three or six month outlooks) are most appropriately described in probabilistic terms:

> … very much akin to the same way medical outlooks and 'odds' are described (eg – 'there is a 30% probability of survival after 5 years in a medical diagnosis' and 'there is a 30% chance of receiving the long-term median rainfall for this time of the year for your region over the next three months').[17]

How seasonal forecasts are used

2.20 BoM stated that reliable seasonal forecasting has considerable potential to deliver tangible benefits for forward planning and business operations in agriculture and other industry and government sectors.[18]

2.21 BoM further explained:

> Sound meteorological forecasts, including seasonal forecasts, are central to good risk management in agriculture and other weather sensitive industries as they enable informed planning and decision making well in advance of undertaking key activities. Skilful seasonal forecasts can be used to maximise benefit in good years as well as avoid losses in bad years. For example, 70-80% of profits are made in 30% of years in southern wheat growing regions. Improved information about which years are likely to be better (or poorer) has considerable potential benefit. A seasonal climate forecast can be used to determine the optimum time to sow, the area sown and the amount of fertilizer that might be required.[19]

2.22 BoM discussed the benefits of seasonal forecasts to some sectors:

- Seasonal forecasts can be used to obtain natural resource and risk management benefits in addition to economic benefits. Some work has focused on the use of seasonal forecasts to alter plant rotation strategies to reduce groundwater build-up and associated salinity increases …;
- … substantial increases in farm income can be achieved by adjusting stocking rates to match forecasts of plant growth and thus avoiding increases in natural resource degradation in

17 Prof Roger Stone, *submission 10*, p. 4.

18 BoM, *submission 4*, p. 7.

19 BoM, *submission 4*, pp. 9-10.

seasons expected to have lower plant growth. This is a clear benefit of seasonal forecasting but is difficult to quantify economically;

- There is considerable potential for whole-of-industry gains from climate forecasts. For example, sugar millers in Queensland use climate forecasts to plan mill maintenance and operating schedules. Transport and storage enterprises likewise could benefit from advance planning of capital expenditure, maintenance and operations based on robust seasonal forecasts;
- Reliable seasonal predictions of water availability are highly valuable for water resources management and irrigated agriculture, and could provide useful information on water allocation forecasts, water markets, and irrigation water availability;
- Long term air quality forecasting also depends on sound seasonal weather prediction. Early warning of likely air quality issues provides information for policy makers in formulating effective and targeted long term air pollution policies. Long-term air quality forecasting depends on accurate long-term meteorological forecasting because the meteorology affects air quality both directly and indirectly. Potential benefits from seasonal air quality forecasting include:
  - ⇒ more effective and better targeted air pollution control strategies;
  - ⇒ improved seasonal forecasts of hospital admissions because of air-quality-related patterns in asthma and other respiratory ailments; and
  - ⇒ quantifying the links between air quality and climate to ensure optimum mitigation and adaptation strategies.[20]

2.23 BoM stated that the key challenges to enhance the utility of seasonal forecasts for users include not only improving the skill, timeliness and delivery of the forecasts but also improving communication and understanding for users about the appropriate interpretation and use of the valuable but uncertain information contained in seasonal forecasts.[21]

2.24 The Weather Channel discussed the way in which seasonal forecasts are used, and the difficulties associated with media interpretation:

> At the Weather Channel we use a particular product, the Seasonal Outlook service, and we tend to avoid fifty-fifty-type situations because they are so difficult to explain, particularly in a 30-second grab. Also, they are particularly difficult to explain in newspapers.

20 BoM, *submission 4*, pp. 10-11.

21 BoM, *submission 4*, p. 11.

> I think the way the bureau explain them on their web site is the best way of doing it because they really go into all the nuances and the detail. It is a very difficult situation to explain.
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> …
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> What the bureau is trying to get across to the public is perfectly legitimate, in that if you use these forecasts, say, for a 10-year period, you are going to come out in front. If you are just going to use a forecast once then it is like backing a favourite at the racecourse; favourites do not always win. If you use these forecasts on a regular basis then you will come out in front and that is a difficult thing to get across, particularly in newspapers that are after a snappy headline. That can change the whole meaning of the product underlying it. It is a challenge … it is a difficult product to use and I think many farmers actually use it through agricultural consultants, and they talk about it in detail. It is a product that is very difficult to use for the mainstream media.[22]

2.25 Professor Roger Stone raised some of the challenges associated with any increase in the use of seasonal forecasts:

> Climate forecasting or 'long-range meteorological forecasting' … has been demonstrated to have considerable capabilities and modest but useful 'skill' for many regions of Australia. However, inter-agency jealousies, poorly trained (in climate systems) rural extension personnel, and poor representation in the media have all led to confusion and poor uptake in many sectors. It is believed a reason for this is that [seasonal forecasting] should more appropriately be represented as a 'risk management system' rather than a 'weather forecast' system.[23]

2.26 Professor Stone also explained that a considerable amount of work had been done in Queensland to integrate seasonal forecasts into management systems:

> Much advanced work in this field has been completed in Australia, especially in regards to agricultural applications at the APSRU group in Queensland (Agricultural Production Systems Research Unit – a joint CSIRO, Queensland Government, University of Queensland agency) to show the value of integrating *tested and scientifically published* climate forecast systems with

22 Weather Channel, *transcript of evidence 30 June 2009*, p. 12.

23 Prof Roger Stone, *submission 10*, p. 3.

> agricultural systems models. Work at APSRU has been world leading in that it was one of the first in the world to demonstrate the full value of climate forecasting through its potential to usefully change and help on-farm management decisions and also in being able to provide formulae for testing climate forecast skill associated with a given forecast system.[24]

2.27 BoM stated that the benefits of seasonal forecasting would be enhanced through clarification and education on the appropriate interpretation and application of forecasts and, accordingly, increased user-confidence about what season forecasts do (and don't) offer.[25]

2.28 BoM discussed the use of forecasts in decision making, and the need for interaction with forecast users:

> The limits to skill and the inherent uncertainty of seasonal forecasts are not yet well understood by end users, and user expectations of potential improvements in forecasts may be higher or lower than can be achieved. Seasonal forecasts will be most valuable and informative if their uncertainty is well-understood, well-communicated and well-used. Education of end-users in the best use of forecast probabilities is essential, and end-user participation in the development of the information products derived from the forecasting model, whether statistical or dynamical, provides considerable benefit.[26]

2.29 BoM added that seasonal forecasts should be one element in decision making processes:

> There are, of course, other considerations in determining the best management decisions; using seasonal forecasts is just one part of an overall forward planning and risk management strategy, which helps determine the way to lean, and not necessarily the way to jump. This distinction is important because of the uncertainty inherent in seasonal forecasts.[27]

2.30 The Queensland Department of Environment and Resource Management (DERM) discussed the need to easily incorporate forecasts into management systems:

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24 Prof Roger Stone, *submission 10*, p. 4.

25 BoM, *submission 4*, p. 7.

26 BoM, *submission 4*, p. 10.

27 BoM, *submission 4*, p. 10.

> Seasonal climate forecasts need to be translated into terms that can be readily incorporated into management and decision making. The Queensland Government has learnt that a 'transparent' approach leads to a better understanding of the underlying processes, a better appreciation of the probabilistic nature of seasonal climate forecasts, and therefore encourages long-term adoption.[28]

2.31 DERM suggested that a lack of available specialist interpretation for some BoM products limits their effectiveness and uptake in some cases, and emphasised the importance of translating seasonal climate forecasts into more meaningful terms for decision-makers.[29]

2.32 DERM commented extensively on increasing the rate of adoption of seasonal forecasts by the community. The submission suggested that:

> Innovations with respect to increasing the rate of adoption by the community should concentrate on the need for continuous training of both advisory staff and the community. To assist better decision making, the contextual information that supports climate forecasting must be able to be understood by the business managers.[30]

2.33 DERM explained that it has provided "Managing for Climate Workshops" to help users better understand climate processes, the nature of seasonal climate forecasts and how to incorporate these into business and risk management frameworks, and that such workshops could be extended beyond the agricultural sector.[31]

2.34 DERM suggested that broader communication mechanisms should also be in place to:

> … disseminate targeted, useful, easy to understand, but risk cognisant climate forecasts that are applicable for a range of business purposes, through a range of mediums and communication processes (via the internet, message alert systems, workshops, preparation of case studies, extension programs).[32]

28 DERM, *submission 33*, p. 6.
29 DERM, *submission 33*, p. 6.
30 DERM, *submission 33*, p. 22.
31 DERM, *submission 33*, p. 22.
32 DERM, *submission 33*, p. 22.

2.35 DERM added:

> Such networks (including government departments, councils, community and catchment groups) provide the necessary link between climate forecasting and the development of policy responses, in order to support management systems and decision making. It also provides an essential feedback loop to ensure those on the ground responsible for implementing such solutions can influence their future development.[33]

2.36 DERM discussed the emerging need for the education of the next generation of research and advisory staff:

> In this respect, educational institutions have a role in incorporating climate information into practical courses, and in turn, current practitioners have a role in providing source of reference material and texts.[34]

2.37 DERM hopes that, given a more effective main-stream, broad-based promotion of seasonal climate forecasting, there will be less reliance in the future on high-profile 'gurus' and climate champions facilitating the adoption of seasonal climate forecast information by the community.[35]

2.38 DERM suggested the need for national agencies to further develop partnerships with state agencies, particularly as it may be difficult for national agencies to deal closely with a large Australia-wide user-base:

> These partnerships need to progress from a provider-user relationship to one which recognises the vital contribution that state agencies can play in both developing, value adding and extending climate information. Whilst each state may be at a different level in this regard, increased rates of adoption can only be expected by empowering state agencies … [36]

2.39 DERM believes there will be a continuing need and role for local interpretation of seasonal forecasts, both by the BoM regional office and the Queensland Government through the Queensland Climate Change Centre of Excellence (QCCCE):

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33 DERM, *submission 33*, p. 22.
34 DERM, *submission 33*, p. 22.
35 DERM, *submission 33*, p. 22.
36 DERM, *submission 33*, pp. 22-23.

> As a practical measure to improve relevance of information to decision makers, the QCCCE recognises the importance of strengthening communication with the BoM regional office and collaboration with other state agencies. For example, through the exceptional drought periods in South-East Queensland this decade, the QCCCE has collaborated with water authorities, in particular SunWater, Department of Natural Resources and Water and the Water Commission to develop customised inflow and dam-level 'forecasts' bringing together the knowledge, data and skills of all agencies concerned.[37]

2.40 DERM added:

> With respect to rural industries, enhanced seasonal forecasting and decision support tools to assist producers in incorporating this information in their production decisions are an essential component in assisting producers become better prepared for drought.[38]

Improvements in forecasting

2.41 CSIRO stated that, as a direct result of the successful use of internationally available satellite data and contributions from Australian research and development, the predictive skill for southern hemisphere meteorology is now similar to that for the northern hemisphere.[39]

2.42 CSIRO explained that weather forecasts have improved significantly over the last few decades, as they have evolved from empirically based forecasts to today's forecasts which are based on computer models of the atmosphere.[40]

2.43 CSIRO further explained that, for the Southern Hemisphere, the forecast skill of the five day forecast today is as good as the three day forecast was in 1989.[41]

2.44 CSIRO added:

37 DERM, *submission 33*, p. 23.
38 DERM, *submission 33*, p. 23.
39 CSIRO, *submission 16*, p. 15.
40 CSIRO, *submission 16*, p. 10.
41 CSIRO, *submission 16*, p. 10.

> The improvements in forecast skill give scientists confidence that significant improvements in seasonal forecasts can also be achieved. Much of the improved skill … arises not only from better model representation of the atmosphere and oceans, but also the assimilation of increasing amounts of satellite data.[42]

2.45 CSIRO also stated that:

> Smarter systems and better use of existing and expected data streams, however, are needed to realise the full potential of weather forecasting systems and to provide forecasts at smaller spatial scales with reliability over longer lead times.[43]

2.46 BoM stated that existing seasonal forecasts for Australia appear to have reached their peak level of performance, and may even be declining in skill as the climate changes. BoM further explained that recent initiatives are focused on developing next-generation dynamic seasonal prediction models that can take changing climate conditions into account.[44]

Ways to improve Australian seasonal forecasting

2.47 Professor Neville Nicholls, a distinguished climate and weather researcher, stated that the limitations in the skill of seasonal forecasts need to be recognised, and that improvement of forecasts is feasible, however they will remain short of "perfect".[45]

2.48 Professor Nicholls reiterated that the statistical relationships between indices of the El Niño – Southern Oscillation and subsequent rainfall and temperature remain the core of the operational seasonal climate forecast system, despite any problems noted and the age of the statistical forecast system.[46]

2.49 Professor Nicholls noted that:

> Ultimately, the statistical forecast system will be replaced by improved coupled ocean-atmosphere models, capable of direct prediction of rainfall and temperature over Australia, so work is required to continue the development and improvement of these

42 CSIRO, *submission 16*, p. 10.
43 CSIRO, *submission 16*, p. 15.
44 BoM, *submission 4*, p. 3.
45 Prof Neville Nicholls, *submission 12*, p. 5.
46 Prof Neville Nicholls, *submission 12*, p. 5.

models, in parallel with the re-engineering of the statistical forecast system.[47]

2.50 Professor Nicholls made the following detailed suggestions and steps to be taken for the improvement of the seasonal forecast system:

- Re-engineer the operational forecast system run by the Bureau of Meteorology, to include new data that have become available since its initial introduction in the mid-1990s, and utilizing more modern statistical approaches.
- Re-engineer the system to include recent research on climate factors, other than the El Niño – Southern Oscillation and the Indian Ocean sea surface temperature patterns, affecting Australian rainfall.
- Develop a system that takes into account the long-term changes in Australian temperature and rainfall, and changes in the behaviour of the El Niño – Southern Oscillation, to avoid bias due to our changing climate.
- Develop a system that allows useful prediction across the "autumn predictability barrier". This will require more research on the causes of the barrier and methods to circumvent it.
- Provide sustained funding for the development of dynamical and empirical seasonal-to-interannual forecast systems, and their application.[48]

The next step

2.51 CSIRO discussed the role of the recently established Centre for Australian Weather and Climate Research (CAWCR):

> CAWCR comes under a joint research agreement between CSIRO and the Bureau of Meteorology. It is not a new institution. It is an unincorporated joint venture or partnership between CSIRO and the bureau. It is put together to essentially bring together research and development expertise from those organisations focussed on weather and climate research in the broadest of senses. It grew out of a recognition that Australia is a relatively small country which could not really afford to maintain separate R&D activities in different organisations, and it made sound sense for the bureau and CSIRO to get together and collaborate with the university sector to develop, in particular, Australia's future weather and climate forecasting capability. That is a key focus of the centre. The centre does not provide services directly to the community. Our

47 Prof Neville Nicholls, *submission 12*, p. 5.

48 Prof Neville Nicholls, *submission 12*, p. 5.

> research outputs are provided into the bureau for finessing into services as appropriate or as research outputs through CSIRO flagships and research themes. We do research across a very broad range of areas ranging from aviation, weather forecasting, research to support aviation forecasting, right through to climate and climate change simulation.[49]

2.52 BoM stated that, through its collaboration with CSIRO in the CAWCR, it now has world-class capability in the key area of climate and atmospheric research.[50]

2.53 CAWCR's activities are further discussed in Chapter 3.

Different forecasts and services

2.54 The Committee heard from a number of other forecasting agencies. Weather Risk Management Services Pty Ltd (WRMS), explained that they are able to value add to the basic information provided by the BoM and CSIRO:

> Weather Risk Management Services provides consulting services to weather and climate sensitive industries here in Australia and overseas as well. We generate the products that the Bureau of Meteorology and CSIRO are producing and far beyond. It is not just season outlooks but very detailed risk assessments. That is basically how we have built over the years our reputation here and abroad as well.[51]

2.55 WRMS told the Committee that this allows them to expand their services to weather sensitive industries beyond the usual users of long range weather information. The company:

> … specializes in tailored forecasting and weather and climate risk assessments for the Australian and overseas weather sensitive energy, soft commodities, construction and agricultural markets. Considerable expertise has been gained in R&D in numerical weather prediction modelling and climate modelling and directly applied in a commercially demanding environment to weather sensitive industries. WRMS has to prove every day, that weather

49 CSIRO, *transcript of evidence 18 May 2009*, pp. 31-32.

50 BoM, *submission 4*, p. 5.

51 WRMS, *transcript of evidence 30 June 2009*, p. 23.

> and climate forecasts can add value to weather sensitive industries.[52]

2.56 The Committee heard that WRMS could have provided useful information regarding the potential bushfire threat in Victoria in early 2009 but that they were constrained by both their business demands and legislative requirements regarding the dissemination of information:

> … Again, we already have these building blocks but we have to sit back and think: how do we actually do business in Australia? We have to do it in a smarter way. So how do we exchange this information? I do not receive any state or federal government funding. For example, I have customers who pay a fee to obtain certain information about heatwaves. Heatwaves in the southern states would indicate an increased airconditioning load coming up in the summer. This is basically what happened in the previous two summers. The interest was in that, and a by-product of it would obviously be bushfires. Bushfires also impact on the hydro catchments of AGL and Snowy Hydro. If you have a bushfire going through those catchments, it changes the catchment's characteristics and that can have an impact on the availability of electricity during critical periods.
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> So, again, the building blocks are already there. The way that we exchange information has to change in this country, because it is basically one of the road blocks. I would be unfair to my customers, my clients, who are paying a lot [of] fees to obtain such sensitive information, if I exchanged it when we do not have any formalism to do so. It is not my bad intention to withhold information. It is basically a business case as such. So how do we do business in Australia? Are we actually allowed to exchange information? How do we cooperate with the Bureau of Meteorology, for example? The Bureau of Meteorology is allowed through various acts to issue the warnings, whereas we as a privately owned business and, as I understand it, other providers in Australia are not in a position legally to issue warnings. We may burn somebody. So there has to be a better formalism as to how we exchange this information.[53]

52 WRMS, *submission 21*, p. 1.

53 WRMS, *transcript of evidence 30 June 2009,* p. 27.

2.57 The Committee sought clarification of these claims from BoM. It considers that there is a need for private sector agencies who are able, to provide forecasts for targeted clients:

> In terms of the private sector, the bureau has a process whereby we put as much of the information we collect and produce through modelling and other capabilities out into the community and we provide a range of services in the public good for the Australian community. Because that information is out there, there is a private sector capability that builds up and it is not only on the seasonal forecasting it is on weather forecasting more targeted at specific users of the information. They are giving them more detailed services that we could not provide to specific groups, and they do it on a commercial basis. … We have a communication mechanism with them. We meet with them regularly and discuss where we are headed, what we are doing and what products we are actually bringing back into the public good side of things so that they are aware of what more information will be available and can look at their services and adjust to that accordingly. So it is very much a partnership from that point of view.[54]

2.58 However, BoM stated that warnings need to be tightly controlled to avoid misinformation:

> One area where we try to tow a fairly hard line is in the area of warnings. We believe, and it is fairly common practice around, that it is not good to have warnings coming from different sources giving conflicting information. That is one area where we expect the private sector not to encroach on, but that is not to say that there are not private individuals out there who do that as well.[55]

2.59 Concerning warnings regarding the potential high risk of bushfires in Victoria in 2009, BoM told the Committee that it had extensive consultations with fire agencies prior to the fire season:

> In terms of long lead forecasts, our standard forecast is a three-monthly forecast issued the month before, but there has been for some time now a collaboration between researchers and fire agencies. Workshops are held around September or October for the coming fire season. The one held in October last year provided an outlook for the coming fire season and so highlighted areas which had a higher risk of fire danger and so forth. In the outlook

54 BoM, *transcript of evidence 12 August 2009,* p. 11.

55 BoM, *transcript of evidence 12 August 2009,* p. 11.

> that was provided to fire agencies, southern Victoria was highlighted as an area of potential higher fire risk. It is not just public information that we make widely available on the website. We engage with agriculture and with fire agencies to provide more detailed forecasts, and that was done in the lead-up to the last fire season.[56]

2.60 The Community and Public Sector Union (CPSU) stated that its members were concerned about the potentially corrosive role of other organisations trying to compete with BoM's services, particularly in the long-term forecasting area:

> The Bureau is seen as the pre-eminent organisation for providing weather information in the short term, but NOT in the long term. We are being sidelined by inferior direct model output products from overseas organisations (often NOT a national Meteorological and Hydrological organisation), which provide misleading, contradictory and not well verified information.[57]

2.61 CPSU added that of particular concern is the:

> … "proliferation of private weather companies providing misleading material to the public". According to a Senior Meteorologist, the best specific day computer models have accuracy rates of only 60% or less when forecasting events such as rain seven days ahead. However "some companies" are exceeding what is possible with current computer modelling and "providing specific day forecasts for weeks even months ahead at specific locations … I believe many farmers are being misled by some of the long range products provided by the private sector".[58]

2.62 Another private forecasting agency whose work was brought to the attention of the Committee is Weather Action, a UK firm that uses solar activity to provide long term forecasts. The agency has recently extended its forecasts to Australia and appears to be having a fairly high success rate.[59]

56 BoM, *transcript of evidence 12 August 2009*, p. 12.

57 CPSU, *submission 3.1*, pp. 5-6.

58 CPSU, *submission 3.1*, p. 6.

59 John McLean, *supplementary submission 32.1*, pp. 4-5.

Using overseas forecasters

2.63 An article published in the *Weekly Times* on 17 June 2009 discussed the use by Victorian farmers of a Japanese forecast warning of unfavourable conditions for the winter growing season. The article states:

> Swan Hill grain grower Geoff Nalder said farmers would pay a lot of attention to Prof Yamagata's forecast.
>
> "He's been right on the money for the past three years," Mr Nalder said. "It's going to make us more cautious. We'll put our purchases on hold and trim back in other areas."[60]

2.64 When asked about the use of overseas forecasts, and why Australian farmers are relying on international forecasts instead of those projected by our own Bureau of Meteorology, Professor Neville Nicholls stated:

> I am not surprised and certainly not disappointed that Australian farmers are actually aware of that sort of information as well as the information that comes from the Bureau of Meteorology … it is not really an either/or situation at the moment; it is not just that our Japanese colleagues have worked all of this out and we haven't. It is a bit more interesting than that.[61]

2.65 Professor Nicholls explained further that differing forecasts arise due to disagreements over the degree of influence of climatic features:

> I am a close friend of Professor Yamagata. He knows my family well and visits us whenever he is in Melbourne. He and his colleagues have done interesting work following work that I did 20 years ago on the role of the Indian Ocean in governing Australian climate and rainfall variability. It has led to some really interesting scientific disputes. We have interesting and civilised disagreements over dinner. He would suggest that there is a stronger influence of the equatorial Indian Ocean on rainfall over southern Australia than I believe is appropriate. I think there is still a much stronger influence coming from the equatorial Pacific, but Toshio Yamagata thinks otherwise.[62]

2.66 Professor Nicholls explained the difficulties faced in developing useful seasonal forecasts:

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60 www.weeklytimesnow.com.au/article/2009/06/17/87111_latest-news.html, accessed 4 November 2009.

61 Prof Neville Nicholls, *transcript of evidence 29 June 2009*, p. 15.

62 Prof Neville Nicholls, *transcript of evidence 29 June 2009*, p. 15.

> If we get back to the problem of how does a farmer make his mind up, this is again something that I try to address in my submission but this is a really challenging problem because the climate is changing and our old data do not include all the ramifications of that changing climate. It makes it really hard for the scientists and so devilishly difficult for a potential user to sort out these problems: which bits are climate change, which bits are the natural climate variability that we have been able to predict in the past and how do they interact? I admit I have no simple answer to this because I do not have a simple answer even to myself and it is something I have been thinking about for a long time.[63]

Value-adding forecasters

2.67 The Weather Channel explained its role in bringing forecast information to Australians:

> … we have an agreement with the Bureau of Meteorology under which they give us their products and their data free of charge in exchange for us distributing the information. In this information we cannot differ from the Bureau; our agreement specifies that our forecasts must be the same as the Bureau's, so we give the same information as the Bureau but we attempt to value add to the information. As an example, if the forecast is for a shower or two then we will say things like, 'mostly in the afternoon and we think we might get one to five millimetres'. We try to add a little more detail to the basic forecast.[64]

2.68 The Weather Channel explained that the additional forecast detail that it provides is derived from the vast amount of forecast and warning information from BoM, and that BoM often does not have the time or resources to provide that finer level of detail to the public.[65]

Committee comment

2.69 The Committee was astounded to learn that private enterprises are apparently able to forecast particular seasonal conditions and events, which may not necessarily have been forecast by our leading national agencies. The question that came to the mind of Committee members when this issue came to light was "how did you forecast these events and

63 Prof Neville Nicholls, *transcript of evidence 29 June 2009*, p. 15.

64 Weather Channel, *transcript of evidence 30 June 2009*, p. 9.

65 Weather Channel, *transcript of evidence 30 June 2009*, p. 11.

why didn't anyone else?" When considering the skills, knowledge and expertise in our national agencies, the question that came to mind was "what do they know that CSIRO and the Bureau don't?"

Impact of seasonal forecasts on agriculture and other industries

2.70 CSIRO and BoM explained that there is a wide range of industries that can and do benefit from seasonal forecasts, and a wide range of management decisions that can be altered in response to seasonal forecasts:

> Examples of potential or realized relevance of seasonal forecasts include:
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> - dryland cropping, influencing sowing date, area, variety, fertilizer application, and mixed farming choices;
> - irrigated cropping, affecting use of irrigation water;
> - grazing, modifying stocking rates;
> - horticulture, influencing variety selection of annual crops, expected harvesting schedule and market supply;
> - viticulture, affecting planning for irrigation and harvests;
> - large infrastructure projects, allowing planning for rain delays;
> - emergency services, assisting planning and preparedness for likely extreme events;
> - water resources, influencing water rationing and irrigation allocations; and
> - tourism, through planning capacity and services for warmer/cooler seasons.[66]

2.71 The Western Australia Department of Agriculture and Food (DAF) discussed the key need for seasonal forecasting to better match the decision-making of agricultural enterprises:

> … there are critical times of the year for making major management decisions. Forecasts at these times of the year can have a major influence on the production, economic, environmental and social outcomes over much of WA. Primary interest is in prediction of the extremes of seasonal climate … Current seasonal forecasts are commonly expressed as probabilities of exceeding median rainfall (a two category outlook). This has little uptake unless the probability is either very

66 CSIRO, *submission 16*, p. 11; BoM, *submission 4*, p. 10.

> low or very high. Producers are seeking forecasts of the likelihood of seasonal climate (especially rainfall) extremes for specific times of the year, such as May to July, and August to September. After seasonal rainfall, grain producers also seek forecasts of the likelihood of frost events during August to September.[67]

2.72 DAF outlined the important periods in the calendar of operations and business decisions of cropping and animal enterprises in the agricultural area of WA:

- Summer/autumn for weed control and accumulation of stored soil moisture - if any;
- May to July for crop and pasture establishment. This is when the bulk of the variable costs are committed;
- August to October is when vegetative growth of crops and pastures, flowering of crops, grain fill and the beginning of harvest in the northern region occurs; and
- November to December for harvest.[68]

2.73 The Western Australia Farmers Federation (WAFF) discussed farmer confidence in seasonal forecasts:

> Because farmers are fairly conservative and because the way they operate their farms is reasonably conservative, until they convince themselves that what they are being told is true then they are not going to change. Even if there was a step change in the predictability there would still only be a very gradual change in farmer behaviour. What we are seeing now in farmer behaviour is that their confidence level in the prediction determines how far they go out. So you have some farmers that are quite confident and look at what is happening further out. The vast majority are back and are probably only using forecasts out to a month or six weeks.[69]

2.74 The South Australian Farmers Federation (SAFF) believes that adaptation to climate change is one of the biggest issues that will affect its membership, South Australia and Australian farming industries in the future:

> With climate change potentially causing an increase in the incidence of storms, flood, dust storms and heat waves, which may result in an increased risk of bushfires, it is vital that farmers

67 DAF, *submission 30*, pp. 4-5.

68 DAF, *submission 30*, p. 2.

69 WAFF, *transcript of evidence 13 July 2009*, p. 11.

> have access to the best weather forecasting data possible. Having access to accurate, reliable and regular weather information, farmers are able to plan their farming activities on a weekly, monthly, seasonal and yearly basis. With this information, they are able to adjust the types of crops that they sow or plant and when they harvest, and plan for the amount of water resources available to them if the drought is seen to continue.[70]

2.75 Seasonal forecasts have the potential to contribute significantly to other industries. Land and Water Australia (LWA) discussed two recent examples where accurate seasonal forecasts would have been beneficial to industry:

> Our experience suggests that many of the other sectors of the Australian economy are yet to appreciate the opportunities that forecasts with skill provide. Two examples:
>
> - Urban water authorities and energy authorities — all of our discussions with these sectors have shown that while there are opportunities for substantial savings [e.g. early implementation of demand management strategies; water supply from least cost sources like dams when the seasonal rainfall is expected to be substantial; base energy load manipulation in heat waves], their participation in R&D is minimal and their application of existing forecasts very limited.
> - Construction industry - this last wet season in North Queensland was predicted to be wet, yet was not factored into work schedules. An excellent example is the Port of Airlie marina development, where other than relocating equipment out of flood levels and pumping flood waters, no work was undertaken for the 4 months November 2008 to February 2009 inclusive. The result has been increased construction costs, delays and the expense of an idle workforce and equipment.[71]

2.76 DERM discussed the SILO system it has developed (based on observations provided to the Queensland Government courtesy of BoM), suggesting that the system has possibilities for the improvement of climate risk assessment.[72]

2.77 DERM explained further:

> In addition to agriculture, examples of other sectoral applications include:

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70 SAFF, *transcript of evidence 14 July 2009*, p. 8.

71 LWA, *submission 7*, p. 12.

72 DERM, *submission 33*, p. 21.

- the tourism industry (e.g. peak holiday periods);
- mining (e.g. flooding of coal mines and coal stock piling);
- the electricity industry (e.g. assessment of anticipated peak load requirements);
- primary industries; (e.g. afforestation and reforestation activities);
- main roads (e.g. optimum construction periods and location);
- rail system (e.g. bridge construction and maintenance periods);
- pest management (e.g. agricultural chemical applications);
- human and animal health (e.g. heat day indices, mosquito breeding cycles and malaria outbreaks);
- building and construction (e.g. penalty contracts and number of wet days); and
- the meat industry (e.g. matching labour to continuity of animal supply).[73]

73 DERM, *submission 33*, p. 21.