Australian Government
Land & Water Australia

MANAGING CLIMATE VARIABILITY
R&D PROGRAM

23 April 2009

Submission No: 7

Committee Secretary
Standing Committee on Industry, Science and Innovation
PO Box 6021
House of Representatives
Parliament House
CANBERRA ACT 2600

Dear Committee Secretary

Submission by the *Managing Climate Variability* Program to Inquiry into long-term meteorological forecasting in Australia

The *Managing Climate Variability* Program welcomes the House of Representatives Standing Committee of Industry, Science and Innovation Inquiry. There is much to be done and the *Managing Climate Variability* Program welcomes the increased Australian Government and end user group interest in forecasting. Improved forecasting skill offers benefits to many – agriculture, construction, mining, emergency services, tourism, urban and irrigation water suppliers, energy authorities, shipping and infrastructure development.

The *Managing Climate Variability* Program and its predecessor the *Climate Variability in Agriculture* Program have been investing in research, development and extension for over 10 years to improve the skill and usefulness of seasonal forecasts for Australian agriculture. These programs have been long term co-investors with the Bureau of Meteorology (BOM) and CSIRO in forecasting. For example, the *Managing Climate Variability* Program was the initial co-investor with the Bureau of Meteorology (BoM) in the Predictive Ocean Atmosphere Model for Australia (POAMA), Australia's dynamical forecasting model, and regrettably remains the only strategic investor with BOM in improving forecasting skill.

The *Managing Climate Variability* Program is a partnership of the Grains, Sugar, and Rural Industries Research and Development Corporations, Land & Water Australia, Meat & Livestock Australia and Dairy Australia and up until last financial year the Australian Government. The partners all recognise the strong potential benefits to agricultural productivity and sustainability of improved forecasting skill. The priorities for investment identified by the *Managing Climate Variability* Program are outlined in our *Research and Development Strategy 2008-2014* which accompanies this Submission.

The *Managing Climate Variability* Program would welcome the opportunity to make a presentation to the Committee. Please contact Ms Anwen Lovett, Executive Manager Land & Water Australia at anwen.lovett@lwa.gov.au and 02 6263 6032.

Yours Sincerely

Michael Robinson
Executive Director

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Managing Climate Variability Program
Draft Submission to the House of Representatives Standing Committee on Industry, Science and Innovation
Inquiry into long-term meteorological forecasting in Australia
April 2009

Introduction

The *Managing Climate Variability* Program welcomes the House of Representatives Standing Committee of Industry, Science and Innovation Inquiry into long–term meteorological forecasting in Australia. *Managing Climate Variability* and its predecessor the *Climate Variability in Agriculture* Program have been investing to improve the skill and usefulness of forecasts for Australian agriculture for over 10 years. The Program was the initial co-investor with the Bureau of Meteorology (BOM) in the Predictive Ocean Atmosphere Model for Australia (POAMA), Australia's dynamical forecasting model, and regrettably is still the only strategic investor with the Bureau of Meteorology in improving forecasting skill.

There is much to be done and *Managing Climate Variability* welcomes the increased Australian Government and user group interest. Improved forecasting skill offers benefits to many – agriculture, construction, mining, emergency services, tourism, urban and irrigation water suppliers, energy authorities, shipping and infrastructure development will all benefit. The imperative to improve forecasting skill is substantial if sectors are to be provided with the climate information and tools they need to assist in adaptation to a changing and increasingly variable climate.

The *Managing Climate Variability Research and Development Strategy 2008-2014* (Attachment 1) sets out many of the key challenges under the following Investment themes:

- Improving climate forecasts
- Soil, climate and water resources - predicting availability
- Agriculture and fisheries applications
- Knowledge, adoption and communication

The Key Messages we ask the Inquiry take into account are:

1. Australian climate modelling methods and techniques and long-term meteorological prediction systems are at most nascent and require increased whole of Government commitment. Our science and predictive skill is in transition from forecasts based on analogue years and "silver bullets" like the Southern Oscillation Index (SOI) to a systems approach that incorporates all of Australia's climate drivers. The skill we do have is due to substantial dedication among a small cohort of scientists, largely within BOM and CSIRO, supported by investment from the end user perspective by those few who are willing to invest in improved forecasts – such as *Managing Climate Variability*. **Opportunities to improve skill and utility are substantial, will yield a high benefit to cost ratio for R&D investment and will require incorporation of all Australia's climate drivers and their manifestation as synoptic features.**

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2. The benefits of more accurate measurement of inter-seasonal climate variability transcend most sectors of the Australian economy and will yield profitability, sustainability and social wellbeing outcomes. For agriculture as just one example, *Managing Climate Variability* research is showing that for broad acre cereals the average profitability dividend of improved forecasting skill, over the last 27 years could well exceed $100/ha/annum, or in enterprise terms, up to about 30% to 40% increased profitability on an average farm size in the southern part of the WA wheatbelt. To achieve such returns, forecasts must be sufficiently accurate, be translated into the most appropriate products and be available at the spatial and temporal scales that users need. **An end-user needs driven approach to providing improved forecasts will yield the greatest benefit for improving the decision-making processes based on the forecasts.**

3. Potential benefits and applications of improved forecast skill are many and varied. As an example, application of forecast systems in 1998 could have helped save BHP Billiton Ltd up to an estimated $33m for just one open-cut mine in that year (Reynoldson, 2005). For northern Australia increased skill in predicting the monsoon duration and break, together with the likelihood of tropical cyclones could be achieved by an investment of less than $1 million in POAMA to incorporate the Madden Julian Oscillation and Tropical Convection. (*Managing Climate Variability* Northern Australia Forecasting Science Plan, 2008). The industries that would benefit include agriculture, tourism, mining, construction and infrastructure development. *Managing Climate Variability* thinks it essential that the Australian Government begins investing in this improvement to POAMA. **Australian Government support for and investment in forecasting, undertaken from the perspective of meeting the needs of multiple end-users is essential.**

4. There are a series of strategies, systems and international examples that will contribute to Australia's innovation and application of forecasts. Concentrating principally on forecasting skill and applications for agriculture:

   - Our science capability to accurately predict changing rainfall due to a changing climate is low to almost nil. Furthermore, with Australia having the most variable climate other than Antarctica, much of the impact of climate change on agriculture, irrigation and urban water supply is likely to be seen in the short to medium term as our climate becomes increasingly variable. However, Australian Government research investment appears skewed to longer term Climate Change prediction rather than also considering short to medium timeframes. **Adaptation timeframes for climate change in many sectors (such as agriculture) are <u>now</u> and also long term. Not only do we need to understand 2070 or 2030, but current (5-10 years) timeframes are also important. More accurate multi-week through to seasonal forecasts will greatly assist in meeting this need.**

   - Many farmers and to a lesser extent, other end-users, already respond and adapt using climate forecasts. As an example, the *Water and the Land* component of the Bureau of Meteorology website that *Managing Climate Variability* co-invests in to ensure the products are farmer relevant, received over 300,000 hits in

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November 2008. Internationally, for example in the USA, the set of forecasting products transcends "weather" and "climate", with information at 4 day, multi-week and seasonal time scales. **For many in Australian agriculture (and presumably other industries) who are seeking to move to a higher level of climate responsiveness, it is essential Australia meets the challenge of improving the skill in our climate forecasts – multi-week through to seasonal.**

- For those in Australian agriculture already active in seeking triple-objective outcomes across profitability, sustainability and climate variability, forecasts need to be translated into predictive assessments, such as soil moisture, likely irrigation water availability, crop fertiliser needs, pasture growth and the risk profile of extreme events – e.g. frost, heat stress, flood and prolonged drought. **Tools that apply forecasts to identify smart strategies within a cropping or pasture (or construction etc) cycle will be of increasing importance as our climate gets more variable.**

- Farmer and agribusiness interest in incorporating climate into production strategies is extremely high. Activities such as *Managing Climate Variability's* "Communicating Climate Change" which worked with leading farmers and then their local communities to increase knowledge and understanding of climate variability and climate change in their region, are in high demand. It is imperative that all users receive precise, regionally relevant, commodity specific, competent and practically orientated information. Diluting extension effort across many small projects without a strong evidence base and rigorous quality control comes with multiple risks. **Consolidated, coordinated and sustained effort in fostering local, regional and commodity expertise in managing climate ie "Climate Champions" and supporting these Champions with knowledge that meets their needs is imperative.**

- *Managing Climate Variability* and its predecessor, *Climate Variability and Agriculture* has been investing in climate risk management for in excess of 10 years, bringing together skilled science teams in partnership with Australian Agriculture. In excess of 55% of this programs very limited budget is contributing to improving forecast skill at multi-week through to seasonal timeframes. The returns have been high and independently evaluated as exceeding a 4:1 benefit cost ratio. **Further investment is warranted.**

- Australia's history in weather forecasting is substantial. Australia's involvement in understanding the drivers of Australia's climate is still strongly skewed to where the information and international investment in remote sensing arrays is the highest – the Pacific Ocean. Certainly ENSO drives a large part of Australia's climate. However, fundamental to improving our overall forecast skill for Australia is better incorporation of all Climate Drivers within our dynamical forecasting models, including variability in the Indian Ocean and Southern Ocean. This implies international cooperation, probably led by Australia with those with an interest in remote sensing arrays in the Indian and Southern Oceans and to our north in the convergence between the Pacific and Indian Oceans. **A Climate Driver based approach to investment is essential and translates into a series of investment needs from modelling through to**

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improved products and underpinning it all increased investment in remote sensing arrays.

The *Managing Climate Variability* Program – role and context

The purpose of the *Managing Climate Variability* Program is to provide more accurate climate forecasts at the time of year and with lead times that are useful for Australian agriculture – farmers, agribusiness consultants and natural resource managers. This purpose translates into research to provide forecasts with more skill and to formulate tools that apply forecasts and other climate information into value-added on-farm management tools. The outcome we seek is Australian agriculture better equipped to make decisions using more reliable climate information. This ensures that Australian agriculture and natural resource management can capitalise on opportunities and reduce exposure to climate risk. [Refer Attach 1, page 2 and pages 8 – 17 of the *Managing Climate Variability Research and Development Strategy 2008-2014*].

With extreme events, natural disasters, climate change and water availability headlining Government and Industry agendas across Australia, responding to climate variability and being able to better forecast climate has become essential if we are to adapt and respond to climate change. All indications are that as our climate changes, variability will increase even further. This makes it even more imperative that research investment is targeted at climate variability, recognises the needs of end users such as Australian agriculture and is well communicated to foster improved climate smart actions, across all sectors. [Refer Attach 1, pages 4 – 7 of the *Managing Climate Variability Research and Development Strategy 2008-2014*]

Managing Climate Variability is a partnership of six investors who are the Grains, Rural Industries, and Sugar Research and Development Corporations, Meat & Livestock Australia, Dairy Australia, Land & Water Australia and up till this financial year, the Australian Government through the Department of Agriculture, Fisheries and Forestry. [Refer Attach 1, page 2 of the *Managing Climate Variability Research and Development Strategy 2008-2014* which gives some of the highlights of our investment to date]. Unfortunately the Australian Government is no longer a direct investor in the program.

Following are summary responses to the Inquiry's Terms of Reference. These responses can be elaborated through presentation to the Inquiry. As with the Committee's Terms of Reference, *Managing Climate Variability* believes that the time is right to investigate and then resource key strategies to support long term forecasting.

Terms of Reference 1 - *The efficacy of current climate modelling methods and techniques and long-term meteorological prediction systems;*

Australian climate modelling methods and techniques and long-term meteorological prediction systems are at most nascent and require increased whole of Government commitment. Key directions are elaborated further in response to ToR4.

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Managing Climate Variability recognises the following phases in development of meteorological prediction systems:

- **Exploratory Phase** – including the substantial excellent work done over generations to record and analyse key attributes of Australia's weather [and which incidentally needs to continue as part of our fundamental understanding]
- **Statistical or Analogue Phase** – where a primary climate driver (or two) is identified with a comparatively poor knowledge of the remaining drivers of Australia's climate, seasons and years. The current state of the primary driver is compared to the record, seeking a period that was seemingly similar upon which to predict climate
- **Single to Multiple Indices Phase** – where patterns in indices like SOI are explored, again based on records and apparent interactions to predict climate
- **Dynamical Modelling Phase** – where Australia's climate is explained through models as a coupled ocean-atmosphere system within and impacted by global climate systems.

Our science and predictive skill is still moving from forecasts based on analogue years and "silver bullets" like SOI to a more systems approach that incorporates all Australia's climate drivers within dynamical modelling.

The dynamical model skill we do have is due to substantial dedication among a small cohort of scientists, largely within BOM and CSIRO supported from the end user perspective by those few who are willing to invest in improved forecasts. Unfortunately the co-investors are few! Note that, by their very nature, dynamical models can accommodate potential influence of climate change as it occurs more easily than can earlier phase systems.

Key Recommendation – There are significant opportunities now to improve forecasting skill and such an investment (based on *Managing Climate Variability's* evaluation of its work) has the potential to yield a high benefit to cost ratio. It is important that any research incorporates of all Australia's climate drivers and their manifestation as synoptic features. While these opportunities can be identified there are currently insufficient funds for this research to be pursued in full.

Terms of Reference 2 -
The impact of accurate measurement of inter-seasonal climate variability on decision-making processes for agricultural production and other sectors such as tourism;

The *Managing Climate Variability* Program and its predecessor, the *Climate Variability in Agriculture Program* have a greater than 10 year track record of investment in climate risk management research and development, delivering to investors an enviable benefit:cost ratio in excess of 4:1.

The themes of our *Managing Climate Variability Research and Development Strategy 2008-2014* summarise what we believe are the key investment opportunities as Australian Agriculture responds to an increasingly variable climate under climate change.

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Theme 1 Improving climate forecasts

The *Managing Climate Variability Research and Development Strategy 2008-2014* is concentrating much of its investment in improved forecasts (about 55% of available budget). This is because the program partners have identified that a lack of forecast skill is a key constraint to increased adaptation to climate change within the agricultural sector. Without more accurate forecasts the risks remain too high for agricultural producers to adopt many of the strategies promoted as essential to farm businesses if they are to rapidly adapt to a changing and more variable climate.

More accurate forecasts in this sense mean both spatial and temporal improvements. Australia needs forecasts that are more precise to a region and therefore to the commodities and on-farm practices of those regions. Likewise, Australian agriculture needs more accurate forecasts in the multi-week to seasonal timeframes and if ever possible, accurate inter-annual forecasts.

Managing Climate Variability in its science planning has identified a series of key investment opportunities to improve forecasting. These and their status in terms of investment are listed in Attachment 5. Clearly more investment would be valuable. At the same time, there is a limited science capability in Australia. Therefore one of Australia's strategies must be to forge closer links and interaction with international research capability. POAMA, Australia's Global Circulation Model, must be improved and it must benefit from international collaboration.

Mainstreaming Global Circulation Model outputs into routine forecasting is a parallel and essential activity. Therefore most of the R&D projects *Managing Climate Variability* invests in have as part of their final phases, the integration of research outputs into routine BOM National Climate Centre products. A good example is our current project on multi-week forecasting, to provide forecasts beyond 4 day "weather" and of shorter timeframe than the current seasonal forecasts. This is because POAMA is exhibiting excellent skill at this timeframe and equally importantly, if we can foster application of multi-week forecasts in on-farm activities then flow-ons to on-farm application of longer term forecasts are likely to be substantial and of course key to improved on-farm adaptation to a changing and more variable climate.

Following is an extract from a recent email received by BOM from a SA grape grower:

> "As mentioned to you over the phone today, since your presentation in the S.E. in August last year, we have been closely watching predictions developed by the POAMA service.
>
> Ultimately, keeping an eye on these forecasts has enabled us to make critical management decisions in a timely manner. For our vineyard operation, factors include:
>
> - Timing of pruning (delayed in some vineyards to avoid exposure of young shoots to frost)
>
> - Leaf plucking and shoot trimming
>
> - Irrigation scheduling, including degree of irrigation deficit applied and maintenance of soil moisture
>
> - Assessment of overall conditions to give an indication of potential fruit quality (in particular, average temperature up to harvest).

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The most striking example of where this information put us in a good position this season, was prior to the recent heatwave. Taking into account a cool first half to January, we were interested to note that the average surface temperature predicted in the POAMA printout, continued to indicate above average temperature for the month. As at the time of assessing this, January was two degrees below average, we began to suspect the potential for a freak, heatwave event. For this reason, it was decided to delay any "leaf plucking" or trimming operations (resulting in exposed fruit which is good in normal to cool and wet seasons, but liable to cause "baking" of fruit in hot conditions). In addition to this, a higher degree of soil moisture was maintained in vineyards where a "regulated deficit" irrigation strategy was being applied. This made it easier to re-establish good\high soil moisture in the profile when the hot conditions arrived.

Going forward, we notice with interest that predictions for our ripening period (one month prior to harvest) are cooler and dryer than average. This gives us a degree of optimism that:

- We will not experience another heat – wave event

- Fruit quality will be good on account of moderate daytime temperatures and potential for diurnal variation (essential for good fruit composition)

- Disease pressure will be low

Knowledge of the current and predicted El Niño and La Niña cycle is obviously also critically important for our annual contingency planning.

Although requiring some degree of interpretation, we've found the POAMA printouts relatively easy to use. An indication of diurnal variation could be handy, although it is possible to get a feel for this as each month\prediction interval progresses.

We will continue to access this service and watch developments with interest."

Clearly, the opportunities are multiple. A second example is the profitability benefits for the southern part of the WA wheatbelt which is a project currently funded by *Managing Climate Variability*. We understand that Dr Peter McIntosh from the Centre for Australian Weather and Climate Research (CAWCR) gave you a brief update on this work during his recent presentation.

As the work is still in progress we would prefer to not present the details at this time. Suffice to say, POAMA is exhibiting excellent skill based on 27 years of record to the level that substantial gains in profitability are likely.

The story is far different in the northern sector of the wheatbelt where POAMA is exhibiting no skill. We explain this as the limited representation at this time of the Indian Ocean Dipole and resulting teleconnections in POAMA . With WA producing about 50% of Australia's wheat crop *Managing Climate Variability* believes improving the skill of POAMA for all of the WA wheatbelt as an imperative and has invested accordingly [see Attachment 5].

Managing Climate Variability would be happy to elaborate on Australia's forecasting needs and how we might best deal with Australia's limited science capability at interview.

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Theme 2 Soil, climate and water resources - predicting availability and
Theme 3 Agriculture and fisheries applications

While many farmers will base their decisions on improved spatial and temporal forecasts, many of our leading farmers and certainly agribusiness consultants and policy makers need forecasts translated into applications. Key applications and opportunities are detailed within the *Managing Climate Variability Research and Development Strategy 2008-2014.*

Ideally, with improved forecasts our predictions for key and fundamental attributes will be improved such as:

- Runoff to water storages – key to setting water allocations and demand management strategies in both urban and rural contexts
- Opportunities for high river flows and floods – key to maximising benefits of flows allocated for the environment
- Soil Moisture – setting the context for crop selection, fertiliser application rate and follow on plantings such as a cereal crop to follow an irrigated cotton crop
- Fish and Prawn / Lobster populations recruiting to the commercial fishery – the basis upon which to set effort controls for the forthcoming season
- Pasture growth and availability – as a basis for stocking rates and movement
- Likelihood of frost or heat stress – setting the parameters for crop or variety type and harvest planning
- Likelihood of a severe wet season in the tropics – underpinning infrastructure works and development scheduling
- and so on.

The list of applications and potential efficiencies and opportunities spans the breadth of our endeavours linked to Australia's natural resources. Much needs to be done. Some successes are already evident such as AussieGrass, Rainman and Yield Prophet – all benefiting from previous *Managing Climate Variability / Climate Variability in Agriculture* investments.

Clearly if there was substantial Australian Government investment in the fundamental need of improved forecast skill (our Theme 1), as applied research and development investor, with an agricultural base, Managing Climate Variability would be able to increase its investment in these Themes. However, as noted earlier, because of the lack of core investment in forecasting, and our fundamental need for forecasting skill it Themes 2 and Themes 3 are to be progressed, *Managing Climate Variability* is principally investing in Theme 1 – forecasting skill. At the same time, because we have an end-user focus, we suggest our limited investment yields exceptionally high returns.

Key Recommendation - An end-user driven approach to providing improved forecasts will yield the greatest benefit.

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Terms of Reference 3 –

Potential benefits and applications for emergency response to natural disasters, such as bushfire, flood, cyclone, hail and tsunami, in Australia and in neighbouring countries;

Potential benefits and applications of improved forecast skill are many and varied. Managing Climate Variability recently undertook a scoping study of needs for improved forecasting in Northern Australia. Some of the examples included:

- **Peanut industry** - through use of forecasts of rainfall for the critical end of wet season period and then application on-farm, it is estimated this industry could have benefited by $1.5M per annum (for peanut and corn management). Aflatoxin management, through more appropriate cultivar planting associated with climate forecast systems, would have provided savings of $4M-$5M per year for the last 10 years (R. Hanson, personal communication). Improving management systems through use of more appropriate seasonal climate forecast systems (especially related to forecasting the northern monsoon strength and duration at intra-seasonal time scales) to better plan for wet harvests in northern Australia would have saved this industry approximately $6M in those types of year (through assisting the saving of crop losses of 7000 tonnes).
- **Open Cut Mining** - application of forecast systems for northern Australia in 1998 could have helped save BHP Billiton Ltd up to an estimated $33M for just one open-cut mine in just that year (Reynoldson, 2005). In a summer such as that occurring in 1998 massive losses occurred through open cut mine flooding, all in a major La Niña year. Judicious use of seasonal forecasting systems would have saved over $30M through the decision to build up stocks before the onset of an expected wetter than normal summer. Once the heavy rains would have eventuated, normal production could be halted and only the stockpile would be mined and all orders could be kept.
- **Prawn Fisheries** – a CSIRO population model that integrates habitat with observed climate to estimate the annual likely recruitment to the Northern Prawn Fishery underpins the regulation of effort annually in this Commonwealth managed trawl fishery – key for both sustainability and profitability. Enhancements by incorporating seasonal forecasts would allow recruitment projections to be made further ahead of the fishery period, essential information for fleet management across the WA, NT and Qld prawn fisheries.
- **Sugar industry** - Antony (2005) notes that for the Herbert, Queensland, region benefits of climate forecasting would equal $19M in just one season if available and in regards to improved planning for an early start to harvest, earlier than normal finish to harvesting, avoiding failed planting, reducing standover cane and better ratooning cane (in the following year), and better ratooning cane in two years hence.

For northern Australia increased skill in predicting the monsoon duration and break together with the likelihood of tropical cyclones could be achieved by an investment of less than $1M in POAMA to incorporate the Madden Julian Oscillation and Tropical Convection. (*Managing Climate Variability* Northern Australia Forecasting Science Plan, 2008). The industries that would benefit include agriculture, tourism, mining,

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construction and infrastructure development. *Managing Climate Variability* has had no success to date in attracting Australian Government investment in this most basic improvement to POAMA.

Key Recommendation - Australian Government support for and investment in forecasting is essential. Engagement with investors such as *Managing Climate Variability* will ensure that new investment is undertaken from the perspective of meeting multiple end-user needs.

Terms of Reference 4 – *Strategies, systems and research overseas that could contribute to Australia's innovation in this area.*

Australia is at the leading edge of strategies and system design. International cooperation is part of the way forward as already recognised through various partnerships such as between the Hadley Centre (UK) and the Bureau, e.g.: super-sized ensembles (recognising overseas supercomputing facilities); expertise in the weekly to ten-day timeframe; a wider spread of products and an IRI-type collaborative institutional framework. Australian dynamical modelling is robust and has been developed at comparatively low cost.

There is much that overseas consortia will never do for Australia: such as autumn barrier, Australian monsoon and tropical cyclones, capturing signal from all relevant Australian drivers combined; blending statistical and dynamical model outputs, direct forecasting of impacts on Australian regions and activities and forecasting for the different timeframes required by Australian users such as agriculture.

There are a series of strategies, systems and international examples that will contribute to Australia's innovation and application of forecasts. Concentrating principally on forecasting skill and applications for agriculture:

4.1 Getting our Science Focus Right

Predictions of temperature change to 2070 through the IPCC are generally seen as robust and have met substantial international peer review. Certainly the projected increase in temperature for Australia is sufficient to promulgate a policy position for greenhouse gas mitigation. In *Managing Climate Variability's* experiences with Australian agriculture, this projected change in temperature is sufficient for groups of farmers to recognise that agriculture, like all other sectors must play a role in emissions reduction – whether that be through an emissions trading scheme or a range of parallel policies is yet to be determined.

However, our science capability, both within Australia and internationally, to accurately predict changing rainfall and increases in climate variability such as extremes that will accompany a changing climate is low to almost nil. No amount of downscaling mechanisms and related modelling will torture inaccurate 2030 and 2070 projections into useful real time information.

With Australia having the most variable climate of any country other than Antarctica, much of the impact of climate change on agriculture, irrigation and urban water supply, and indeed most sectors of the Australian economy, is likely to be seen in very short

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timeframes such as increasingly variable rainfall. Unfortunately much of Australia's current research investment is skewed to longer term climate change prediction when adaptation needs are for forecasting skill now.

Key Recommendation – The adaptation timeframe for climate change is now, and not just 2070 or even 2030. Adaptation in the short term is best facilitated through access to more accurate multi-week through to seasonal climate forecasts.

4.2 Providing an Integrated Suite of Weather to Long-Term Forecasting Products.

Many farmers and to a lesser extent, other end-users already respond and adapt using climate forecasts. As an example of information uptake, the *Water and the Land* component of the Bureau of Meteorology website that *Managing Climate Variability* co-invests in to ensure the products are farmer relevant, received over 300,000 hits in November 2008.

Internationally, for example, USA, the set of forecasting products transcends "weather" and "climate", with information at 4 day, multi-week and seasonal time scales.

POAMA, while not yet central to the National Climate Centre forecasts is showing substantial skill in the period between "weather" [4 days] and "seasonal forecasts" [months ahead]. As an example, refer to the previously cited application in grape growing. The range of applications of multi-week forecasting are probably substantial and right across the Australian economy. To our knowledge no work has been conducted to hypothesise the likely applications and therefore the information products required. As a first step towards multi-week forecasting *Managing Climate Variability* has invested in proving POAMA's skill.

Additional investment will be required to define the precise nature of products needed by all sectors of the Australian economy, including agriculture and to then operationalise a forecasting system through the National Climate Centre that delivers spatially and temporally across weather to long-term forecasts.

Key Recommendation – Surveys of Australian agricultural producers (and presumably other industries) have indicated a willingness to use climate forecasts to lift their capacity to manage their businesses with a higher level of climate responsiveness. However, for this to occur, investment in research which improves the skill of climate forecasts is essential.

4.3 Investing in the Value Add

For those in Australian agriculture already active in seeking triple-objective outcomes across profitability, sustainability and climate variability, forecasts need to be translated into predictive assessments, such as - soil moisture, likely irrigation water availability, crop fertiliser needs, pasture growth and the risk profile of extreme events – e.g. frost, heat stress, flood and prolonged drought.

Managing Climate Variability recognises the importance of providing applications [Refer Attach 1, *Managing Climate Variability Research and Development Strategy 2008-2014*], often through scenario approaches that are then applied as "discussion support" by

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farmers and agribusiness consultants. Nevertheless our investment priority, recognising the importance to improve forecasting skill and our limited resources has meant that only about 15% of our budget can be spent on this important area.

Key Recommendation – Through further investment there is an opportunity for tools to be developed that that apply forecasts in a way that enable end users to identify the opportunities presented by current and forecast climatic conditions. Such tools will enable, for example in agriculture, enable producers to maximise production in good years and minimise losses in bad years.

4.4 Fostering Adoption

Farmer and agribusiness interest in incorporating climate into production strategies is extremely high. 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.

Returning to agriculture, activities such as *Managing Climate Variability's* "Communicating Climate Change" and as part of that, fostering *Masters of Climate* are in high demand. *Managing Climate Variability* recognises as a core role, the need to foster improved Climate Risk Management across the agricultural sector. [Refer particularly to Theme 4 of our R&D Strategy - Knowledge, adoption and communication.]

Managing Climate Variability recently led a $0.75M 1 year project to foster improved understanding of Climate Change and the Opportunities it presented in 3 key agricultural regions – Victorian Wimmera, Eyre Peninsula, SA and North East Agricultural Region, WA. A Checklist of key attributes for any extension and training activities, as extracted from the Executive Summary in our Report to the Department of Agriculture Fisheries and Forestry as the funding agency for this project is as follows:

1. ***Coverage***
   - *Commodities*
   - *Regions*
   - *Farmers, agribusiness consultants and agency extension staff*
   - *Whole of enterprise*

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2. ***Science competence and credibility***
    - *Quality assured science*
    - *Strong links to existing information provision*
    - *Good science communicators*
    - *Linked to local knowledge providers*
3. ***Knowledge support tools***
    - *Web based knowledge resource*
    - *Printed material*
    - *Interactive and mediated discussions*
    - *Formal and informal networks*
4. ***Competent and Australia-wide coordination***
    - *Knowledge of user needs*
    - *Industry credibility*
    - *Flexibility*
5. ***Covering various learning styles and needs***
    - *Masters of Climate fostered and resourced*
    - *Farmer knowledge*
    - *Specifically tailored products*
    - *Ongoing support*

All these components must be met if the extension and training is to be effective. Diluting extension effort across many small projects without a strong evidence base and rigorous quality control comes with multiple risks.

Much remains to be done. Particularly *Managing Climate Variability* would like to explore with the Inquiry the opportunity to ramp up our modest investments in training and then supporting Champions as *Masters of Climate*.

Key Recommendation - Consolidated, coordinated and sustained effort in fostering Climate Champions and supporting these Champions with knowledge that meets their needs is imperative.

4.5 Building and Implementing a Systems Science Approach to Forecasting, Science Investment and Product Delivery

Australia's history in weather forecasting is substantial. Australia's involvement in understanding the drivers of Australia's climate is still strongly skewed to where the information and international investment in remote sensing arrays is the highest – the Pacific Ocean. Certainly ENSO drives a large part of eastern Australia's climate. However, fundamental to improving our overall forecast skill for Australia is better incorporation of all climate drivers within our dynamical forecasting models.

For POAMA to substantially increase in skill the model will need to be able to accurately incorporate all relevant climate drivers – including ENSO, Indian Ocean Dipole, Southern Annual Mode, Madden Julian Oscillation and the Subtropical Ridge.

The inter-connections between these drivers must also be better defined so that

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POAMA adequately depicts synoptic features such as East Coast and Cut Off Lows, Frontal Systems, Blocking Highs, West coast Troughs, Tropical Depressions and Trade Winds.

As detailed in the attached *Managing Climate Variability* Forecasting Science Plan, our limited resources have been applied to the larger, more Australia-wide areas that provide opportunities for improvement. Clearly science investment in just the immediately perceived high opportunities for improving POAMA skill could be 3 times or more the meagre resources that *Managing Climate Variability* can provide.

Some of the other investment opportunities that we perceive include:

- Fully upgrading the operational forecast system run by the Bureau, especially utilising dynamical modelling approaches as well as incorporating key research findings post the mid 1990s
- Ensuring the system takes better account of the long-term changes in Australian temperature and rainfall, which will avoid potential but likely bias due to climate change
- Provide sustained funding for the development of dynamical and empirical multi-week to seasonal to inter-annual forecast systems
- Markedly enhance the services to deliver the resulting forecasting products in close consultation with users

In summary – provide a robust nationally integrated end-to-end service (research, models products, product information, product verification, services, education, applied and tailored products).

Underpinning such an integrated and climate driver based approach is a more adequate system of remote sensing. This implies international cooperation, probably led by Australia with those with an interest in remote sensing arrays in the Indian and Southern Oceans and to our north in the convergence between the Pacific and Indian Oceans.

Key Recommendation - A climate driver based approach to investment is essential and translates into a series of investment needs from modelling through to improved products and underpinning it all increased investment in remote sensing arrays.

Attachments

1. *Managing Climate Variability Research and Development Strategy, 2008 – 2014;*

2. *CLIMAG* – as an example of our routine Newsletter circulated to farmers and researchers

3. Screen dumps off the soon to be launched *ClimateKelpie* website

4. Sample Fact Sheets as prepared during *Communicating Climate Change* project for *Masters of Climate* forums

5. 2008 MCV Forecasting Science Plan and Summary Table – status of MCV Forecasting R&D investment

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