The Indian Ocean Climate Initiative Stage 3 2009 Workshop Report

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GOVERNMENT OF WESTERN AUSTRALIA

Australian Government
Bureau of Meteorology

CSIRO

The Indian Ocean Climate Initiative (IOCI) is a partnership of the State Government of Western Australia, CSIRO and the Australian Bureau of Meteorology, which was formed by the Western Australian Government to support informed decision making on climate variability and change in Western Australia.

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1. Introduction

The Indian Ocean Climate Initiative Stage 3 (IOCI3) research agreement was signed in March 2008. The four-year IOCI3 research program consists of four themes:

1. Baselines, Predictability of WA Climate and Attribution of Climate Change.
2. Current and Future Climate of the North-West, including Extreme Events.
3. Very-High Resolution Climate Change Projections for the South-West.
4. Science Leadership and Support.

An IOCI3 workshop is held annually to update stakeholders on the progress of the research. In 2009, the IOCI3 workshop was held on 26 and 27 October. Key stakeholders, such as representatives from Australian and State Government departments, the scientific community, universities and industry, were invited to attend the workshop.

IOCI3 scientists gave updates on the progress on each research project on Day 1 of the workshop. The Day 2 program involved presentations from representatives of government departments on their climate science needs and discussion sessions to determine the gaps in climate science knowledge in WA. Information gathered from this workshop will contribute to the development of a climate change research program post-IOCI3 that meets the needs of government stakeholders.

2. Progress of research in IOCI3

Overview of IOCI3
Speaker: Dr Bryson Bates (CSIRO)

Dr Bryson Bates provided an overview of the objectives and role of IOCI3. The major objectives of IOCI3 are:

- To deliver climate research outcomes that will underpin sustainable development in the North-West and South-West regions of Western Australia.
- To enable the State to achieve economic, social and environmental benefits by drawing upon the strategic knowledge and technologies derived from the national climate science programs of BoM and CSIRO.
- To enhance the State's accessibility to the current state of climate knowledge so that informed policy decisions can be reached.
- To build a climate research capacity in Western Australia that is focused on priority issues for the State.
- To facilitate partnerships that will enable State agencies (and sectoral stakeholders) to integrate IOCI's climate research findings with their

assessments of climate impacts, vulnerability and potential adaptation strategies.

The IOCI research program has a justifiably proud record in leading regionally-specific and practically relevant climate research in Australia. Dr Bates stressed that effective policy development and adaptive capacity in WA require knowledge of the latest development in climate science. Outputs of IOCI3 will enable assessments of the impacts of climate variability and climate change on each sector and assessments of sectoral vulnerability, which will enable the development of effective adaptation strategies for WA.

Dr Bates also stated that IOCI has played a significant role in placing climate change scientists and retaining regionally specific knowledge in WA.

Detection and Attribution

Speaker: Dr Carsten Frederiksen (BoM)

IOCI Stage 2 found that the decline in south-west WA rainfall was accompanied by and apparently associated with changes in the large scale atmospheric circulation. These changes in circulation are most likely due to a combination of natural variability and the enhanced greenhouse effect. Dr Carsten Frederiksen's research in *Project 1.1: Detection and Attribution of Changes to Weather Systems and Large Scale Circulation Drivers* aims to answer the question of attribution, i.e. which climate forcing (natural or anthropogenic) caused the changes in the large scale southern hemisphere circulation and climate, and consequently affected the weather systems and local climate of south-west WA (SWWA). This information is important for government agencies to know whether to prepare for further rainfall decline in SWWA due to increasing anthropogenic greenhouse gas emissions.

Dr Frederiksen showed that July (winter) zonal winds and the Phillips instability criterion have decreased upstream of and over SWWA. The Phillips instability criterion measures shear in the atmosphere. If the criterion is greater or equal to zero the atmosphere is unstable and likely to generate storm (i.e. rainfall) activity. Research also found a reduction in the growth rate of leading storm modes crossing SWWA. He concludes that this reduction along with a southward deflection of storm tracks is the primary cause of the reduction in winter rainfall over SWWA.

In autumn (May), zonal winds show a similar southward deflection of the jet stream. However, this effect is not localised over SWWA but is a hemispheric effect. Since the mid 1970s, there has been about a 10% reduction in the average growth rate of storm track modes. An analysis of the maximum streamfunction amplitudes of the storms for May shows that the strength of the

subtropical storm track, which affects SWWA, has decreased while the polar storm track has increased. Dr Frederiksen concludes that changes in autumn are related mainly to fewer storms growing on the sub-tropical jet and more storms growing on the polar jet.

Dr Frederiksen showed projected changes in the Philips instability criterion at the end of the 21st century relative to pre-industrial conditions, using the IPCC Special Report on Emission Scenarios of B1 (550ppm by 2100), A1B (700ppm by 2100) and A2 (820ppm by 2100). Although not all models can simulate the observed changes in the Phillips criterion, more than a third can quite well. Model outputs from these "good" models show that the impact of further increases in greenhouse gas concentrations can lead to further large reductions in the Phillips instability criterion in regions important for the development of storms over SWWA. These reductions can be more that twice those simulated by models at the end of the 20th century. This suggests further dramatic reductions in storm growth and further decreases in SWWA rainfall, possibly as large as those already witnessed.

Regional Climate and Weather Systems – SWWA
Speaker: Miss Catherine Ganter (BoM)

This project investigates the changes in the frequency and types of synoptic weather systems that affect SWWA. Self-organising maps were created for winter systems. Analysis of these maps show that the reduction in "wet" system types account for 50% of the rainfall decline. The step decline in rainfall in the 1960s-70s was linked to the decrease in the strength of the subtropical jet and in the synoptic wet types. However, the recent decrease in rainfall (post 2000) is related to an increase in high pressure systems rather than a decrease in low pressure systems.

Rainfall intensities have also changed. Stations to the east experienced an increase in extreme rainfall while stations to the west experienced a decrease in extreme rainfall in the summer half year. Over the winter half year, trends are mixed but become clearer if data were divided into early and late winter. In early winter (May to July), there was a clear decreasing trend in extreme rainfall while there was no clear trend for late winter (August to October).

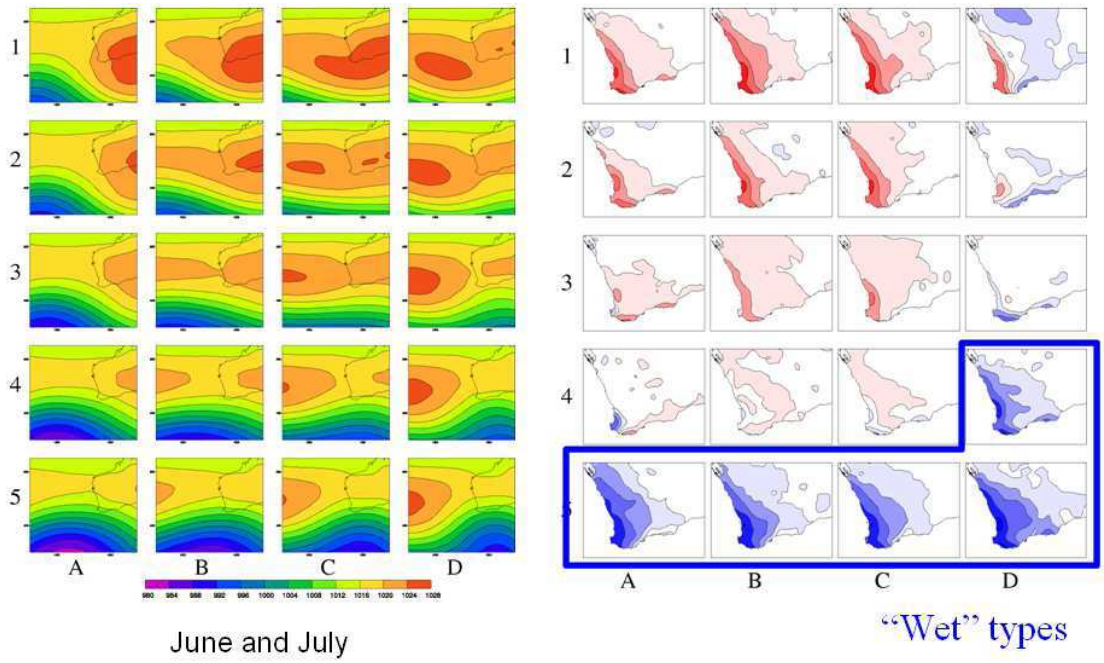


Figure 1: Winter synoptic types (mean sea-level pressure patterns) categorised using a self-organising map on the left, and their corresponding rainfall anomalies on the right. Blue means wetter conditions, red means drier.

A self-organising map was also created for the summer period. The summer synoptic patterns show less variability than winter patterns. Summer patterns were organised into 12 synoptic types as opposed to 20 for winter. Due to the impact of tropical cyclones, the different synoptic types show no clear association with rainfall (wet or dry) patterns. However, there were clear correlations for temperature anomalies, and these will be pursued further.

Maximum summer temperatures have been decreasing in SWWA but there has only been a slight increase in summer rainfall. However, projections from *Climate Change in Australia* show an increase in summer temperatures. Research will be conducted into the reasons for the decreasing trend in maximum summer temperatures and whether this trend will continue.

Limits of Seasonal Predictability

Speaker: Dr Carsten Frederiksen (BoM)

Dr Frederiksen and co-workers have developed new methodologies for estimating the potential predictability of surface temperature and rainfall. These methodologies are based on the assumption that the seasonal mean climate anomaly consists of an "intraseasonal" weather noise component and a "slow" component. The weather noise component is due to processes with time scales ranging from two weeks to one season, for example the Madden-Julian

Oscillation. At the long timeframes, this component is essentially unpredictable. The slow component is related to external forcings and slowly varying internal dynamics, for example sea surface temperatures, greenhouse gas forcing and the slow Southern Annular Mode. At the long timeframes, this component is potentially predictable because the underlying processes are slowly evolving and therefore potentially predictable. With these methodologies, it is possible to estimate how much of the total inter-annual variance in a climate variable is due to the intraseasonal and slow component.

An index known as "potential predictability" for a climate variable, for example rainfall, is then defined as the fraction of the interannual variance due to the slow, or predictable, component. Charts showing regional distributions of this index for various seasons will give an idea of where seasonal forecasting can theoretically be done with reasonable level of accuracy.

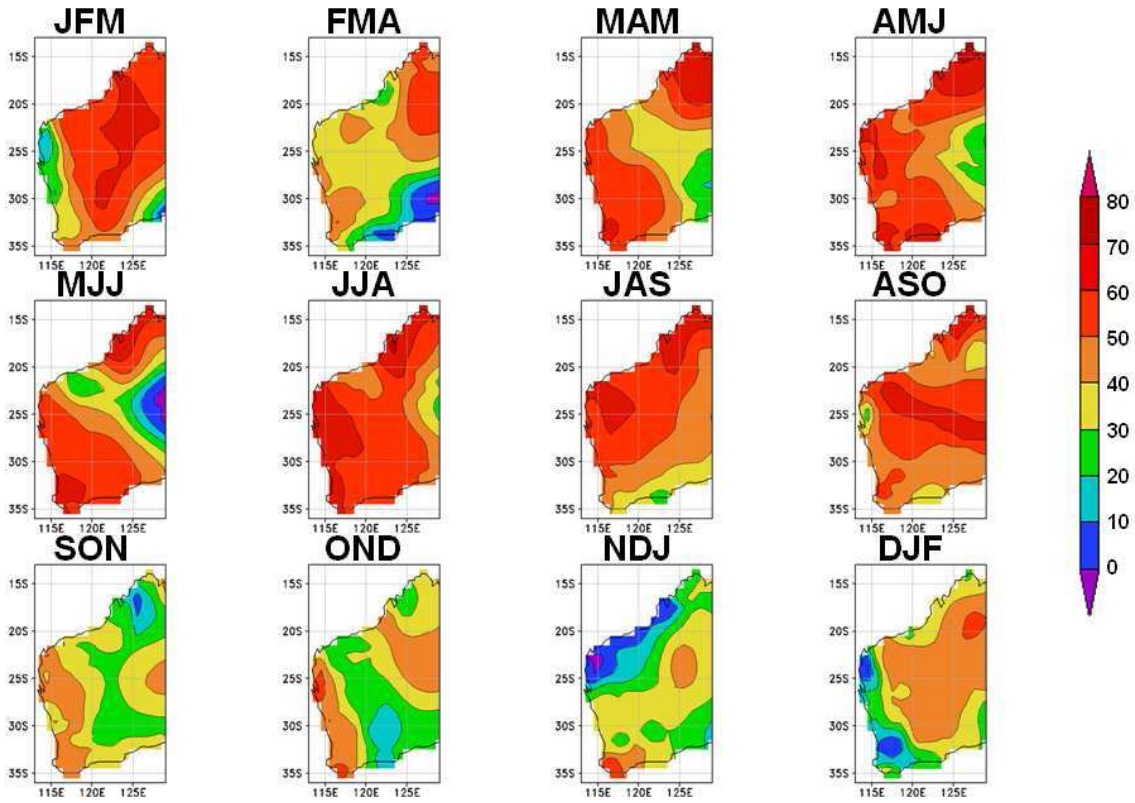


Figure 2: Potential predictability (%) for maximum surface temperatures

Dr Frederiksen's research project has so far yielded the following conclusions:

- WA maximum and minimum surface temperatures generally have fairly high potential predictability in all seasons. This suggests that slow processes dominate the interannual variance of surface temperature.
- The patterns of potential predictability can be quite different for maximum and minimum temperatures – suggesting different processes dominate the predictability.

- For maximum temperature, the potential predictability is generally lower during the seasons September-October-November to December-January-February. There are also large spatial variations between seasons.
- For minimum temperature, the potential predictability is relatively lower over southern WA during the period January-February-March to February-March-April and May-June-July. Again there are large spatial variations between seasons.
- Rainfall variability is dominated by the intraseasonal component resulting in much lower potential predictability. Over SWWA, the potential predictability ranges between 10 – 30% during May-June-July and June-July-August.
- The highest rainfall potential predictability over northwest WA occurs during the summer seasons December-January-February and January-February-March.

Regionally Specific Climate Data and Monitoring for WA
Speaker: Marco Marinelli (BoM)

WA has diverse climates and often sparse observation networks, especially in north-west WA (NWWA). In addition, changes in networks, such as movement of individual stations, over the past century are not well accounted for. Project 1.4: *Regionally Specific Climate Data and Monitoring for the North-West and South-West to Support the Understanding of Past, Present and Future Climate* will develop datasets suitable for monitoring climate change, validation of climate models and downscaling applications. In particular this project aims to:

- To apply rigorous scientific methods to the development and extension of climate change datasets for WA.
- To enhance the range of datasets used within IOCI 3.
- To increase the accessibility and usability of the datasets.

Through ongoing work in this project, a number of new station records have been flagged as potential additions to the high quality meteorological datasets throughout WA. For rainfall data, more than 100 stations have been added to the high quality dataset, especially in NWWA. Progress in this addition is 90% complete. For temperature data, preliminary work has identified several new additions to the high quality dataset, especially in SWWA. Further work will be carried out to determine if other stations are suitable.

The development of a new IOCI web portal for graphing, analysis and delivery of station climate data is also currently underway. Other work in this project includes the development of an enhanced homogenised tropical cyclone database for WA, a very high-resolution (e.g. 0.025º) regional historical analysis of rainfall, temperature and vapour pressure for SWWA, covering the key runoff and agricultural regions and sector-relevant climatologies, baseline data and trend analyses for WA.

The CSIRO Mk3.6 GCM: Simulation of Rainfall in Australia's North-West

Speaker: Leon Rotstayn

Observed rainfall over NWWA has increased even though global circulation models (GCMs) have projected decreasing rainfall for the region. Low-resolution climate modelling (Rotstayn et al., 2007) suggested that pollution aerosols from Asia (not greenhouse gas emissions) might be driving the observed rainfall increase over the North-West, by changing the temperature gradient between Asia and Australia. However this low-resolution model output has several limitations which include its inability to properly simulate modes of rainfall affecting WA, such as the El Nino Southern Oscillation (ENSO).

The CSIRO Mk 3.6 model has shown itself to be a good model to investigate the link between aerosol air pollution in South East Asia and the observed increased rainfall over north-west WA. The model simulates the leading "ENSO-like" mode of rainfall variability well, with maximum variability over central-eastern Australia, in good agreement with observations. The second mode of rainfall variability is also well-captured by this model, with maximum variability over NWWA. This mode may be the rainfall mode that is excited by the aerosols. The date of monsoon onset is well-captured by the Mk3.6 model but the intensity of the rainfall is too high.

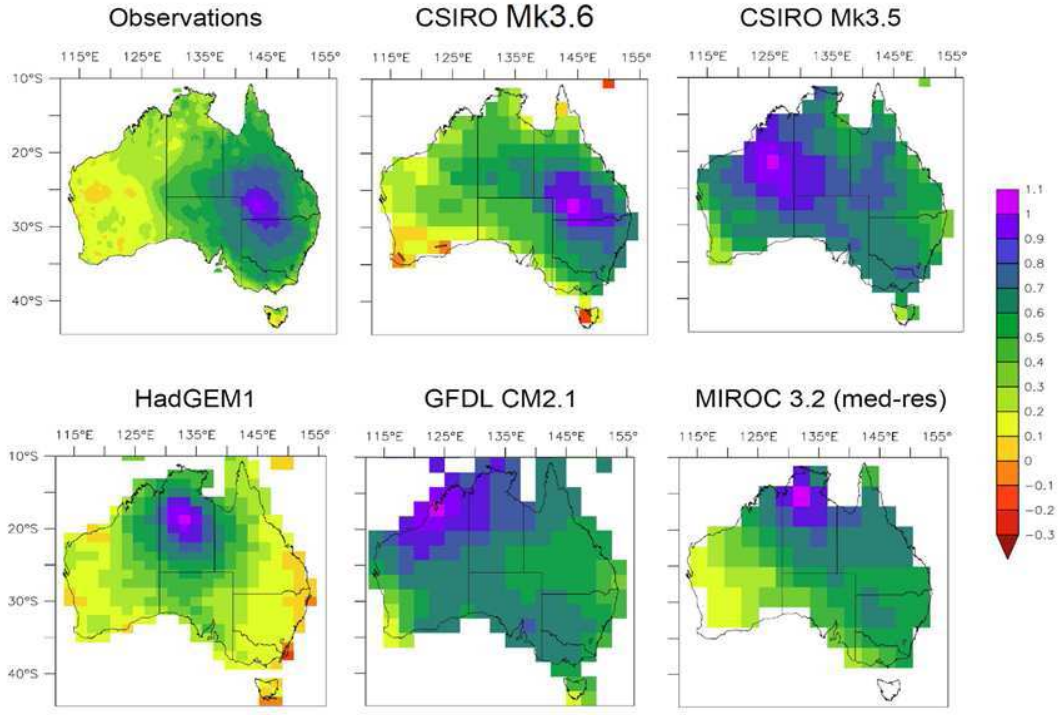


Figure 3: Leading (ENSO-like) mode well captured by CSIRO Mk3.6 model compared to others

The next step in this project will include "piggy-backing" on a project funded by the Queensland Government. This will allow the results of this part of the IOCI3 project to be linked to modelling in the Intergovernmental Panel for Climate Change's Assessment Report 5.

Understanding the likely cause of the increased rainfall in NWWA is important as the policy response for different causes will differ. A rainfall increase driven by anthropogenic aerosols is likely to be more short-term than one driven by greenhouse gases because Asian countries are broadly expected to reduce their air pollution levels over the next few decades. Increased rain might also mean more frequent or more intense tropical cyclones

Tropical Cyclones in the North-West

Speaker: John McBride (BoM)

Project 2.2: The topic: '*Tropical Cyclones in the North-West'* was formulated around the question of "*What do we know about tropical cyclones in the NW and how will they be modified under climate change?*" The study into the climatology of tropical cyclones that affect NWWA has been completed.

A forecast model with a 1-, 2- and 3-week lead time for tropical cyclone occurrence and genesis is currently under development. The logistics regression model will use the following predictors:

- Daily climatology;
- Index of the Madden-Jullian Oscillation (RMM1 and RMM2);
- Index of ENSO (Nino-3.5); and
- Indices of Modoki ENSO and the Indian Ocean Dipole (TNI and DNI).

This work is useful to industries in NWWA. One of the milestones of this project that will begin in 2010 is to develop a series of expert statements on the vulnerability of WA to changes in tropical cyclone activity under climate change. Information on the likely impacts of tropical cyclones will need to be sought from IOCI3 stakeholders.

Statistical Downscaling for the North-West

Statistically Downscaled Climate Change Projections for the South-West

Speaker: Steve Charles (CSIRO)

Statistical downscaling aims to bridge the gap between the coarse scales simulated by global and regional climate models and finer scales required by process models. It links weather states and atmospheric predictors to multi-site

daily rainfall. Future projections of rainfall can be generated for selected rainfall stations based on projected atmospheric predictors and their resultant weather state sequences.

Statistically downscaled information is derived from the Nonhomogeneous Hidden Markov Model (NHMM). The first step in the process is calibration, which involves the selection of rainfall stations, candidate atmospheric predictors and the number of weather states and the optimum combination of predictors. The next step is to validate the outputs. This involves assessing reproduction of rainfall statistics such as wet-day occurrence frequencies, wet- and dry-spell length distributions, rainfall amount distributions and interannual variability and spatial correlation for occurrences and amounts.

Project 2.3: *Statistical Downscaling for the North West* is applying the NHMM in the Kimberley and Pilbara regions, where nine and five stations have been selected respectively at this preliminary stage. When compared to observed data, it was found that downscaled information usually under-predicts for very extreme rainfall. The next step is to assess the global circulation models for their potential to reproduce the NWWA atmospheric predictors required to provide statistically downscaled projections.

Previous work in IOCI Stage 2 has yielded downscaled rainfall information for SWWA using the previous generation of GCMs. Downscaling results revealed a decreasing probability of occurrence of the "SWA Winter State 2" which brings rainfall to SWWA and an increasing probability of occurrence of the "SWA Winter State 5" which brings dry conditions. All GCMs investigated show the same trend but with different magnitudes of change (Figure 4). This information has been used in studies into climate change impacts on water yields and crop yields.

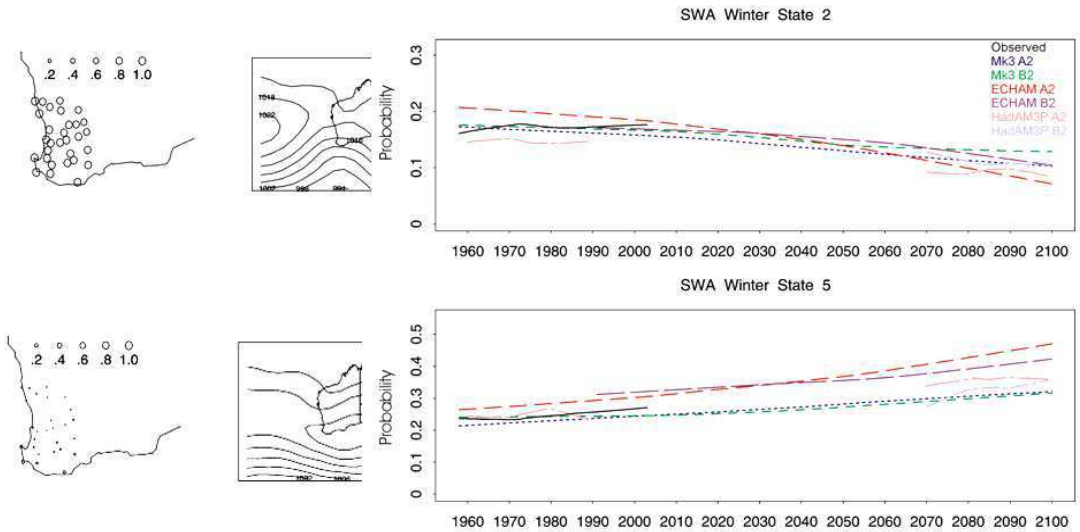


Figure 4: Projected decrease in probability of the SWA Winter State 2 and increase in probability of the SWA Winter State 5 from statistically downscaling three GCMs (CSIRO Mk3.0, Max Planck Institute for Meteorology ECHAM4 and Hadley Centre HadAM3P) for SRES A2 and B2.

Project 3.1: *Statistically Downscaled Climate Change Projections for the South-West* is assessing how well IPCC AR4 GCMs simulate WA climate with the aim of refining projections for SWWA. Preliminary results show that there are no clear winners but there are a few models that consistently perform better. Methods for adjusting GCM predictors to reduce bias are thus being investigated.

The next steps in this project will be to produce daily rainfall projections using the "better" performing, bias corrected or weighted GCMs based on performance. This will produce more confident climate change scenarios for SWWA. The project will also produce downscaled scenarios for rainfall and temperature for a larger number of stations in SWWA. The A2, A1B and B1 scenarios will be used for mid (2046-2065) and late (2081-2100) century.

Dynamical downscaling of tropical cyclones for the North-West

Speaker: Deborah Abbs (CSIRO)

The key questions that this project seeks to answer are:

- How well do models represent tropical cyclones?
- What is the impact of climate change on the characteristics of tropical cyclones in this region?

Tropical cyclones, with scales of tens of kilometers, are not properly represented by most global circulation models (GCMs) at their normal resolution of approximately 200km. Downscaling of GCMs to obtain higher resolutions is done using the Conformal Cubic Atmospheric Model.

The projected changes of the downscaled behaviour of tropical cyclones averaged across seven different models are:

- A decrease in the number of tropical cyclones by 48%.
- A decrease in the number of tropical cyclone days by 53%.
- A decrease in average duration of 0.6 days.
- A poleward shift in genesis latitude by 0.6^0.
- A poleward shift in decay latitude by 0.8^0.

Further dynamical downscaling of tropical cyclones to resolutions of 15km show that there is a distinct decrease in central pressures of tropical cyclones in 2070. The decrease in central pressures is less clear for tropical cyclones in 2030. The projected impact of climate change on wind speeds is less clear.

In summary, there are fewer tropical cyclones projected for 2070 but modelling outputs suggest an increased percentage will be severe tropical cyclones. Tropical cyclones are also projected to form and decay further to the south.

Rainfall Extremes: Potential Forecast Skill and Climate Change Scenarios for the South-West

Speaker: Mark Palmer (CSIRO)

Changes in extreme weather are another important dimension of our future climate. A 10% change in extreme rainfall, for example, may have more impact than a 10% change in the mean rainfall. Increased confidence in how extreme weather will change in the future is important for risk and vulnerability studies.

In this project, a Generalised Extreme Value (GEV) analysis has been applied to a synoptic classification. Research from Mike Pook and James Risbey showed that frontal systems are the dominant wet weather synoptic systems over our region. These synoptic systems are classified into 3 types of frontal systems – cold fronts, complex fronts and frontal waves – and cut-off lows. Their research also showed a decrease in rainfall resulting from cut-off lows and no trend for rainfall resulting from frontal systems. Frontal systems are associated with more extreme rainfall than cut-off lows.

The Pook and Risbey classification is used to split the daily rainfall data into rainfall caused by frontal systems and by cut-off lows, though currently it has only been done for a restricted range of years. GEV analysis has been done for each of these synoptic systems separately, showing that the characteristics of extreme rainfall differ for the different systems. Intensity-frequency-duration curves can be generated for each of these systems.

Work is also continuing on selecting atmospheric predictors for extreme rainfall. Projections based on the behaviour of these predictors will allow for projection of extreme rainfall in the future.

3. Proceedings from Day 2

Session 1 - Introduction

The second day of the IOCI 3 Workshop was opened by Mr Steve Waller, Director of the Office of Climate Change in the Department of Environment and Conservation.

The aim of the second day of the workshop was to discuss the extent to which the IOCI 3 research program meets the needs of government agencies with a view to informing future IOCI activities. The format for the day involved a mix of presentations, discussion, break-out groups and audience participation and was facilitated by an independent facilitator, Joel Levin of Aha! Consulting. A full report on the facilitated aspects of the day is included in the facilitator's report at Appendix 1.

Learning from yesterday
Joel Levin - Facilitator

The main activities of the day began with a review of learning from the first day of the workshop. A polling questionnaire (Appendix 2) completed by participants at the close of day one posed four questions concerning the match between the IOCI 3 research and the needs of government agencies, specifically:

- participants' level of understanding of the research presented;
- relevance of the IOCI 3 objectives to agency needs;
- usefulness of the results of IOCI 3 to agencies; and
- confidence that the results of IOCI 3 will help agencies to progress effective policies.

Polling results

The polling results were somewhat predictable with public sector research organisation and university representatives expressing moderate to high levels of confidence in regard to all four questions. State government agency representatives indicated a more varied and wider spread of levels of understanding and perceptions of relevance of the research to agency needs. However, agency representatives indicated more positive, moderate to high perceptions of the usefulness of the research and confidence that the results will help agencies to develop effective policies. The results of the polling are presented in full in the facilitator's report at Appendix 1.

Discussion

It was recognised that the results in relation to understanding reflect the complexity of the science. Though it was noted that the presentations varied considerably in the level of detail provided and that in some cases it is not possible to assess the usefulness of the research from a short presentation, rather more analysis is needed. There was however, acknowledgement that state agencies don't necessarily need to know all the fundamentals of the science process but are most interested in the results.

Whilst it was generally agreed that the outputs of IOCI will be valuable there was broad consensus that these alone will not be sufficient for the identification of actions required for adaptation and additional work will be necessary to enable effective adaptation.

Furthermore, it was agreed that whilst assessing the context of policy relevance is very important, more critical is the need for a dialogue and building relationships between researchers and research users over the longer term.

Concerns

A number of concerns were raised in particular with regard to a disconnect between the science and users' levels of awareness. The research community felt there was an unrealistically high expectation among the user community as to what can be delivered, emphasising that the IOCI program is very small, relatively speaking, with limited funding.

Specific concerns in respect of the science identified a lack of high quality data underpinning the modelling and also the need for a wider view incorporating both land and ocean information; there was agreement on the need to consider both spheres together and to engage with the Western Australian Marine Science Institution (WAMSI). It was also suggested that IOCI research concentrates on scenarios and timeframes that may not be relevant to industry, and a need for more extreme scenarios and shorter timeframes was expressed. There were also concerns about how the outputs and information arising from IOCI will be aggregated and broad consensus on the need for a one-stop-shop.

Motivations

There were many positive feelings about the value of the IOCI workshops in particular the networking aspects of the meeting and opportunities for building relationships.

There was recognition of the commitment and capabilities of the scientists and of real progress being made in improved understanding for WA. From a user's perspective it was recognised that many of the problems different agencies are

working to address are common and that there is room to improve connections to enable these to be addressed more efficiently. Finally, there was a more radical suggestion that consideration be given to going beyond the IOCI program format towards the establishment of a more formalised institution bringing physical scientists together with those doing adaptation work to identify synergies.

The information and understanding gained from this exercise will be valuable in informing the continued activities of the program and the design of any future programs following IOCI 3.

Getting focused for today
Joel Levin - Facilitator

For the next two sessions, workshop participants were asked to consider the following two questions whilst listening to the presentations:

1. What outcomes is my agency seeking to achieve in our efforts to progress effective climate change policies?

2. What types of information does my agency need to know more of to better inform adaptation policies and actions?

Participants were encouraged to note responses to each of these questions on post-it notes during sessions two and three. Responses were posted on the walls, grouped by subject areas and were used by the facilitator to determine and inform the topics for discussion in the break-out sessions during the second part of session three.

Session 2 - Using IOCI results: previous experience

Session two comprised of two presentations, one each from a research institution and a government department perspective, discussing their experiences in working with the IOCI program in the past.

An IOCI scientist's perspective
Speaker - Dr Steve Charles (CSIRO)

Dr Charles reported having had a positive experience engaging with IOCI, in particular he noted the value of having a high level of participation in the research panel and that the research plan was adaptive. He noted the useful role of the website in particular for sharing and accessing publications and emphasized the value of relationships at different levels including: good relationships with the

local BOM office; good interactions within and between CSIRO, BOM and government agencies; and having valuable small team partnerships such as with the Departments of Water (DOW) and Agriculture and Food (DAFWA). However, he noted that some other institutions, notably the universities, had not been involved in the program.

With regard to the research itself Dr Charles highlighted the value in having identified links between downscaling and agriculture through work involving DAFWA and water resources involving DOW. He also identified additional benefits leveraged beyond the core IOCI program through work funded outside of IOCI that has also contributed to knowledge, and through participation and promotion at the Greenhouse 2009 conference which brought international recognition and collaborations.

In closing Dr Charles highlighted the important role that the 2005 IOCI workshop had through the sector group activities that led directly into the research requirements for the IOCI 3 program and posed a question to the user audience as to how agencies will use the IOCI projections?

Perspective from government departments

Speaker - Ed Hauck (Department of Water)

Mr Hauck also presented a very positive experience of the Department of Water (DOW) in engaging with IOCI; in particular, he highlighted the history of partnerships within the program. He noted that the program has facilitated project planning across agencies as well as enabling more planning for research and has brought together government agencies to work together on projects.

In respect of information provision, the program has been particularly valuable in helping DOW to develop an understanding of the language of climate change, in providing knowledge to back up opinions, proposals and discussion, in raising awareness and stimulating debate, providing new contacts and in facilitating alignment of perceptions of the importance of climate change issues.

DOW has made substantial use and direct application of IOCI research outputs, for example in reference to the identification of groundwater issues the program was valuable in highlighting the need to communicate with government and achieve alignment and support from the wider community in order to enable decision-making. As part of the Stirling catchment study DOW made their first use of downscaled modelling coming out of IOCI; IOCI work was also critical to the report that led to the securing of investment in WA's first desalination plant. Furthermore, IOCI research provided DOW and the Water Corporation with a platform to open dialogue with the Minister for Water and with the Premier and to facilitate decision making on new water source developments. The Department's

vision in 2004/5 was based on IOCI capacity to provide scenario information. In all DOW was able to advance projections of climate change impacts on WA's water resources with the support of IOCI research.

Session 3 – WA Government's climate science needs

Session three comprised six presentations from government agencies who presented their agency's climate science needs.

Agriculture
Speaker - Dr David Bowran (DAFWA)

Dr Bowran began by outlining the importance of timescales:

- Short-term, daily information is necessary for tactical decisions;
- Medium-term, seasonal information is more challenging but necessary for strategic decisions involving costs and inputs; and
- Long-term information is required to inform major changes to practices and management systems.

DAFWA are using downscaled modelling to look at yield changes and longer-term data to inform gene discovery work on drought and heat tolerant species.

Dr Bowran identified climate science needs of DAFWA in relation to:

- Regional scale, seasonality and extreme events data and probability of change;
- Totality of the Indian Ocean complex and weather implications;
- Data sets, in particular access to historical data;
- Climate variability risks, enduring change, identification of resilient and robust systems; and
- Incremental versus fundamental change and specifically identified breakpoints.

Dr Bowran also highlighted the need for a process to strengthen partnership relationships, in particular noting the need to build relationships between climate research interests in social, political, economic, ecological and technological processes, in recognition that IOCI is delivering only one component.

Fire and Emergency Services
Speaker - Ralph Smith (FESA)

Mr Smith's presentation focused primarily on fire. Currently, bushfire threat analysis is carried out using tools such as fuel loading maps and other practices

to mitigate the threat of bushfires. An important question is whether current practices will be sufficient to address future bushfire threats in a changing climate. Mr Smith also highlighted the dual problem associated with reduced rainfall, that is, reduced rainfall is likely to lead to a reduction in community populations in regional areas and therefore less firefighting volunteers, however, reduced rainfall is also likely to lead to larger fires.

Important questions for FESA include the need to identify:

- Under what condition the current vegetation structure and composition will commence significant collapse, particularly in forest and woodland areas? Vegetation composition and potential changes will likely alter fuel loading and will impact on fire behaviour; therefore there is a need to improve understanding of the relationship between climate change and changes to fuel structure.
- What are the conditions or phenomenon associated with climate change that will encourage and stimulate fires?

Mr Smith highlighted the following information requirements:

- Improved modelling and greater certainty of projected extreme rainfall and tropical cyclone patterns and behaviour.
- Research into variation in rainfall regime and structure for the whole of WA and not just for SWWA and NWWA.
- Research into timing of wind changes, period of frontal systems and variation in movement of fronts. This information is important to identify the opportunity for controlled burning.
- Greater understanding of the relationship between fire behaviour, intensity and fuel load, and also of changes to fuel structure due to climate change.
- More specific models with greater certainty.
- Quantification of the potential increase in bushfire threats. A changing climate, e.g. increased minimum and maximum temperatures, decreased relative humidity and decreased rainfall may not automatically lead to an increase in bushfire threat.

Finally, there is an important need to improve the ability to separate climate change from technological and community enhancement events. Changes to bushfire events caused by climate change could be masked by technological or community enhancement activities.

Terrestrial biodiversity

Speaker – Dr Colin Yates (DEC)

Dr Yates provided an overview of the drivers and links between climate projections, drivers of biodiversity changes, climate change impacts on biodiversity and management responses. Climate projections (both mean

projections and climate variability information), global change drivers (i.e. threats from other sectors e.g. water extraction and invasive species) and knowledge on species ecology and adaptive capacity are all required to project the response of species and therefore ecosystems to the impacts of climate change. Understanding the response of ecosystems will allow anticipatory management advice to be provided and effective management responses to be put in place. These management responses include new biodiversity reserves where ecosystems can survive amid climate change, increasing connectivity between reserves and increasing resilience of ecosystems.

Statistical and dynamical downscaled data will reduce uncertainty in biodiversity models. However, a larger regional set than that produced by IOCI 3 is needed. Climate variability and extreme events are also more important than means for projecting impacts of climate change on species population. Impacts of climate change on phytophora (dieback) are also important. The spread of phytophora is likely to increase with increasing summer rainfall extremes. In addition, changes in fire regimes are also a priority in climate change biodiversity research. In particular, whether there are particular synoptic patterns associated with fires in various regions and if there will be any increase in these synoptic patterns.

In summary, Dr Yates identified the following information required for climate change biodiversity research:

- Downscaled climate data, both average and extreme, covering areas outside that of IOCI 3;
- Investigation into the impacts of climate change on fire weather;
- Projection of behaviour of synoptics that are associated with fires; and
- The establishment of an internet-based portal for easy transfer and delivery of climate data.

Local Government

Speaker - Dr Neil Carroll (City of Mandurah)

Dr Caroll highlighted the wide-ranging responsibilities of local government from health issues, such as increased presence of mosquitoes, through biodiversity and water supply to infrastructure and construction matters. From the perspective of the City of Mandurah, site specific information is needed on:

- Geomorphology, wave setup (important during extreme events), and topography;
- Sediment transport modelling;
- Planning guidelines applying modelling and probability to different locations;
- Engineering solutions and alternatives for adaptation to climate change impacts;
- Emergency management plans;
- Risk management and liability scenarios; and

- Adaptive strategies.

The following actions need to be taken:

- Community education including translation of climate change science and impacts tailored to specific community needs and levels of understanding;
- Community consultation;
- Prioritisation of risks;
- Improved short-term monitoring;
- Identification of funding alternatives such as user pays;
- Development of local climate change expertise within local government;
- Audit of current infrastructure; and
- Centralisation of knowledge base.

Dr Caroll stressed that threats and losses to infrastructure are happening today, there is a need for acceptance that there will be loses in the face of climate change and that there is a need for answers in the short-term for long-term solutions. He also identified the need to investigate the link between our drying climate and the impacts on infrastructure integrity.

Water
Speaker – Ed Hauck (DOW)

Mr Hauck stressed the need for good observational data sets and associated outputs from climate models. There is also a need for climate predictions at the seasonal to five year timeframes for immediate decision-making and five to 20 year timeframes for strategic decision-making. He also indicated that there is currently a move towards statutory management plans for the water sector. In addition, with the move towards water trading, the quantification of available water and water entitlements is very important. Increased confidence in climate projections and better climate science is needed to support hydrological models for this purpose. An improved understanding of the changes in climate variability that accompany climate change will assist in characterizing how extremes and critical climate sequences are likely to affect system performance.

Health
Speaker - Dianne Katscherian (Department of Health)

Ms Katscherian began by highlighting that the role of the health sector in its broadest sense is to protect public health, prevent adverse health outcomes and promote better health, in addition to providing treatment and care services. She discussed the potential impacts of climate change on health noting that impacts could be both positive and negative, direct and indirect, and that these would vary according to different locations. She highlighted the importance of including health impacts of climate change into policy decisions.

Ms Katscherian presented a detailed look at impacts on health caused by temperature through temperature increases and extreme events. The most important issue she identified is that when ambient temperatures exceed 32 degrees C the human body must activate mechanisms to remove heat to maintain body temperature. If the body is unable to adequately cool, heat related illnesses may arise ranging from heat cramps, to exhaustion and heat stroke, which can be life threatening if not addressed effectively. It was noted that a number of different groups within the population are particularly vulnerable to heat related illness and therefore each of these groups will need to be targeted through policies and measures to raise awareness and reduce risk.

In addition Ms Katscherian gave an overview of a number of other ways in which increased temperature can lead to a range of health risks including through increased water, food and vector borne diseases and impacts on water and air quality and on food production. In addition to these direct health impacts there was discussion of how increased temperatures can also affect human behaviour and lifestyles, with knock-on economic and social impacts, as well as further health effects.

In terms of health sector needs, Ms Katscherian stated that whilst there is an important role for the health sector to provide input to actions and measures to mitigate against the effects of climate change, it is most important that other agencies and sectors, such as planning, incorporate health risks and considerations into their activities.

Health sector science requirements include:

- Improved understanding of projected environmental changes associated with populations, including changes in structure and locations of populations and activities such as work and recreation.
- Increased local scale data on projections and risks/vulnerability.
- Specific information on duration of temperature events, water availability and frequency and intensity of extreme events.
- Increased reliability and certainty in models.
- More refined information parameters such as reliability and certainty in models, limits of projections and different timeframes of applicability.

Ms Katscherian emphasised that in addition to direct science needs the health sector also has specific requirements regarding the communication of science to address specific planning and response decisions. Furthermore the science outcomes need to be in a form accessible for both policy development and also for translation to the wider public.

Session 3 - WA Government's climate change science needs discussion

The second part of session three involved group discussion to explore climate change science needs in more detail. Throughout the morning sessions participants had noted a number of comments in response to two key questions:

1. What outcomes is my agency seeking to achieve in our efforts to progress effective climate change policies?

2. What types of information does my agency need to know more of to better inform adaptation policies and actions?

Responses to these questions fell largely into four common key themes that became the topics for discussion of four break-out groups. Participants joined one of the four discussion groups on:

1. Communicating and translating data to raise awareness.
2. Specific research needs.
3. Coordination of climate change science.
4. Linking up agencies.

A summary of the outputs of the small group discussion is presented below. Detailed information is included in the facilitator's report at Appendix 1.

Discussion Group 1: Communicating and translating data to raise awareness

A number of issues and concerns about current communication and translation activity were identified along with some requirements for improvement. These can be roughly grouped as below.

Governance and responsibilities

- Roles and responsibilities are not clearly defined, responsibilities should be shared. Need to establish a governance structure for climate change adaptation.
- There is a clear need for managing and influencing expectations.
- There is a considerable level of trust and assumptions about what is accounted for that may not match up with reality, there is a need for more clarity.
- Starting points are not always clear and often retrospective decisions are made.
- There is a mis-match between those asking the research questions and those seeking answers; there is a need for feedback from research to governance structure.

- Some key players are not present at many climate change discussions such as today e.g. the Department of Planning who have a significant role to play in implementing mitigation and adaptation measures. Need to ensure all stakeholders are engaged and aware.
- More social scientists should be involved in programs like IOCI.

Presentation

- Different groups need different messages; information needs to be tailored to different groups.
- Climate change science presented often addresses issues at the global or national levels where as community concern is local. Information on the impacts of climate change needs to be presented at a local level i.e. what direct impact does climate change have on the community.
- Need to draw on other experiences such as in agriculture, economics was a clear driver. Economics and safety are two key factors that directly affect communities and to which they will respond. Need to address these issues in communication of climate change information.
- Translation is a specialist role.

Research

- Research is needed into methods and tools for communication and identification of priorities and expectations of community.
- Need to build capacity to visualize/make threats real.
- Issues around the availability and acceptability of information need to be addressed.
- Need for community research to identify what is important.
- Need for a review process - are we collecting the right data?

Other

- Communication and translation needs to result in behavioural change.

Discussion Group 2: Specific research needs

Many varied and specific research needs were identified and are listed in full in the facilitators report at (Appendix 1), the discussion group identified the following science needs common to several agencies:

- to develop consistent time and spatial scales to enable better comparison of data;
- more downscaling;
- presentation of data in formats such as maps with clear lines and numbers indicating observations and projections;
- phenomena based projects and for two-way feedback of phenomena;
- improved dialogue between users and suppliers of the data to ensure a stronger match between needs and provision of research and to improve usability of research outputs;

- improved climate variability profiles associated with climate change scenarios;
- more localised data as opposed to broad scale downscaled data; and
- greater interaction between research groups such as between IOCI and WAMSI.

The existence of useful research within other programs was noted but that there is a lack of linkages between programs and it was questioned whether it is the role of IOCI to improve these linkages. In addition the importance of the interface between basic research, adaptive research and users of research, was noted.

Discussion Group 3: Coordination of climate change science

It was agreed that there is a need for improved co-ordination of climate change science within WA. In particular:

- As a starting point there is a need to scope out who is doing what research, in particular fundamental climatology and climatology impacts.
- Greater networking among researchers and between researchers and research users is required to improve the focus of research and to ensure the right questions are being addressed.
- There was general agreement on the need for development of a single information portal for climate change research information providing access to data and outputs from models and translation of science to service a wide range of stakeholders. Such a portal could also provide a one-stop reference point for climate scenarios and projections which is important for consistency and inter-comparability. Any such portal would best be led by a state government agency or coordinating body and would need to be well-resourced.

It was also suggested there is a need to feed research work into IPCC AR5 modelling and other CSIRO models.

Discussion Group 4: Linking up agencies

It was agreed that there is a need for greater collaboration and interaction across agencies within WA to generate a critical mass through linked agencies. The following key issues, requirements and characteristics for linking up agencies were highlighted:

- A clear focus through identification of common issues and clearly identified science priorities; where are there most linkages between areas of research/agencies?
- Need to address the different time horizon needs of different agencies.
- Prioritisation of issues (for research).

- Develop a key research model across agencies that builds on synergies and cuts wastage.
- Need to ensure when framing new adaptive responses that adverse impacts elsewhere are minimised.
- Need to take discussion to people who implement activities on the ground.
- A cross-departmental working practice or team, or consider bringing people together in cross-agency groups in a neutral location for some of the time.
- Apply an adaptive management cycle.
- Look at existing collaborations and follow governance structures that work well, for example the Gnangarra Sustainability Strategy working group works well.

Session 4 – The post-IOCI 3 world for WA climate science

The final session of day two comprised of a panel discussion followed by an open discussion on the future for climate change science in WA, in particular whether there is a need for an IOCI 4 program and what this or any alternatives might look like. The panel comprised of representatives from the three IOCI partner organisations who each gave a brief presentation of their thoughts for the future.

Panel Member - Dr Bryson Bates (CSIRO)

Dr Bates began by stating that if the need for an IOCI 4 program was agreed that planning would need to start immediately and that above all it would require a significant amount of enthusiasm and momentum.

Dr Bates outlined some of the characteristics of the current program that should be taken into account when considering a new program:

- the current model involves large numbers of people but a small amount of time;
- when the current program was negotiated, writing of the contract was the last step but it took the longest so should be considered earlier in the process;
- intellectual property, liabilities and commercialization issues were the three key sticking points; and
- work was fragmented and piecemeal, an integrated effort is needed to create a more natural flow.

Dr Bates suggested that an IOCI 4 program is needed and that it should:

- bring together oceans, coastal zone, atmospheric and land based research components;
- link with local universities and state agency researchers;
- link with paleoclimatologists, specifically concerning the very recent past (<500 years);

- link with WAMSI, oceanography, storm surges and erosion work in particular is relevant;
- have a more strategic relationship between research providers and users;
- include properly planned and resourced communications activities;
- better address data issues in particular good access to data; and
- make the most of the potential benefits of international and national collaborations, including allocation of a budget.

Panel Member - Mr Bruce Stewart (BOM)

Mr Stewart suggested that the World Meteorological Organisation model provides a good example of key areas that a partnership program of this type should include, these are:

- Observations - (in situ) integration of data (networks) and access to data.
- Research - sound science, modelling, capability to develop "seamless predictions".
- Climate Services – historical record, monitoring, outlook/predictive information feeding to the user community, for use in community tools and robust services are required (note BOM has a lot of information on monitoring, the historical record and seasonal outlook).
- User interface – importance of two-way feedback.
- Capacity building – with community, how to use information, community services (note access to key capabilities will be harder within Australia).

In respect of an IOCI 4 program Mr Stewart made the following recommendations for areas that could be improved on:

- governance, a better management structure;
- quality control;
- links, improve links with external individuals and in particular social scientists;
- ensure networks and links are managed; and
- funding, access to money will get harder.

Mr Stewart also identified the need to get a better handle on natural climate variability within predictions and a measure of the uncertainty of predictions.

Panel Member – Mr Steve Waller (OCC)

Mr Waller recommended considering a different question - what will be the need for a sub-national program in the future? He suggested that a future program would be unlikely to take the same form as the previous IOCI programs but that it would need to leverage off national funds to create a series of small, targeted programs, as there will not be funds available for single large programs in the near future.

Mr Waller said be believes there is a need for a sub-national program because there are significant WA specific needs that won't be addressed at the Commonwealth level, such as the existence of the SW biodiversity hotspot and the lack of information at Commonwealth level relating to a Mediterranean climate, as exists in WA. Furthermore he suggested that science will demonstrate that south west WA will be one of the regions most impacted by climate change and that national benefits would be derived from the WA experience.

With regard to the nature of a future program:

- The key question for a future research program is how to decide on research needs and priorities and how to integrate these.
- There is a need for centralized coordination of climate change science in WA.
- The nature of a future program would be both top down from the agencies and bottom up from the research community.
- A new program should involve more applied consequential research, which is more appropriately carried out at the sub-national level.
- There is a significant demand for projections and data, but can a program deliver on all these?
- A research program should integrate other work such as national climatological work and ocean based research.
- There is a need to reconsider observed trends, such as rainfall, over the last 30 years or so with GCM projections. How can we trust projections before we do this?
- Research should be prioritized towards the base scale, targeting finer scale activity e.g. downscaling.
- There should be improved links and networks and a new partnership involving more organisations including the Commonwealth, regional agencies, universities and the social science community.
- At the extreme end consideration could be given to establishing a climate adaptation institution.

Mr Waller noted that to realize the above, or any new program, would require considerable effort and that in order to drive it to success an enthusiastic leader is essential and possibly an appropriate statutory body something like a West Australian Adaptation Committee. He also suggested that there may be a need for legislation, such as a climate change bill, to strengthen the effectiveness of any major new initiatives. Finally, he remarked that building climate change capacity within WA is something that hasn't been very successful to date but that this should be a focus for the next WA climate change research program.

4. Summary

Professor Lyn Beazley, Chief Scientist of WA, in her closing speech on Day 1 of the Workshop noted the excellent progress made by IOCI3 scientists in understanding the climate of WA. Highlights of progress made include:

- Increased understanding of the underlying causes of our changing climate, which will provide a good foundation to confirm climate change projections produced by climate models.
- Increased number of high quality stations in the north-west, which is important for research into extreme weather events and downscaling work.
- Mk 3.6 model has proven itself to be a good model to investigate the link between aerosol air pollution in South East Asia and the observed increased rainfall over north-west WA. Other global circulation models have projected a decrease in rainfall contrary to the observed increased rainfall over the area.
- Progress of work to develop a 2-week forecast model for tropical cyclones and to investigate the behaviour of tropical cyclones under climate change is useful to industries in north-west WA, especially the oil and gas sector.
- Improvement in confidence of climate change projections for south-west WA, which will lead to more effective adaptation policies.
- Progress in work to investigate rainfall extremes in south-west WA, which is an important input into vulnerability assessments.

Professor Beazley also stressed the importance of IOCI3 research to WA in terms of climate change adaptation and called for a more coordinated approach to address the climate change research needs of WA. The issue of a more coordinated approach for climate change research in WA is echoed by the participants in the workshop. Meeting the needs of stakeholders, in particular the WA State and Local Governments should be a priority in climate change research in WA. Speakers in Session 2 of Day 2 presented varied needs across the different sectors. Discussions in Session 3 highlighted the need for better communication and knowledge transfer between stakeholders and researchers, increased coordination of climate change research in WA and improved linkages between agencies.

To end Day 2 of the workshop, participants were asked to each sum up their feelings about the two-day workshop in one word. Responses were varied but there were many positive comments about the value of the networking opportunities provided by the workshop and the opportunity to meet the different researchers. There were also many positive responses to the information reported and progress being made by the different research groups. There was some concern, following the last session, about the future of the IOCI program but there appeared to be general consensus that people want to see a continuation of the program in some form and that work should commence as soon as possible to look at future arrangements beyond IOCI3.

Indian Ocean Climate Initiative

Indian Ocean Climate Initiative Stage 3
2009 Workshop Report

Appendix 1
Aha! Consulting Report on Day 2 of Workshop

October 2009

Workshop Report

Australian Government
Bureau of Meteorology

Indian Ocean Climate Initiative

1. Introduction

On the 26th and 27th of October 2009, the Office of Climate Change (OCC), Commonwealth Scientific and Industrial Research Organisation (CSIRO) and The Bureau of Meteorology (BoM) hosted a two day forum on the finding and next steps for stage three of the Indian Ocean Climate Initiative (IOCI). Day two (27th) was facilitated by Aha! Consulting with the view to

- Better understand what is needed for the translation of the science into agency policy
- Discuss what/if any the next stage/phase of IOCI activities would look like.

During the morning a range of speakers sharing both the scientific and agency perspectives on the following two questions

1. What outcomes is my agency seeking to achieve in our efforts to progress effective climate change policies?
2. What types of information does my agency need to know more of to better inform adaptation policies and actions?

During the presentations participants made notes on these two questions, which formed the basis for discussion in Session 3 after lunch. This report provides a collation of notes/outputs in the following format

- **Suggested strategies**
- **Setting the scene for day two**
- **Final Session - Beyond IOCI3**
- **Notes from group work**
- **Collation of specific participant responses.**

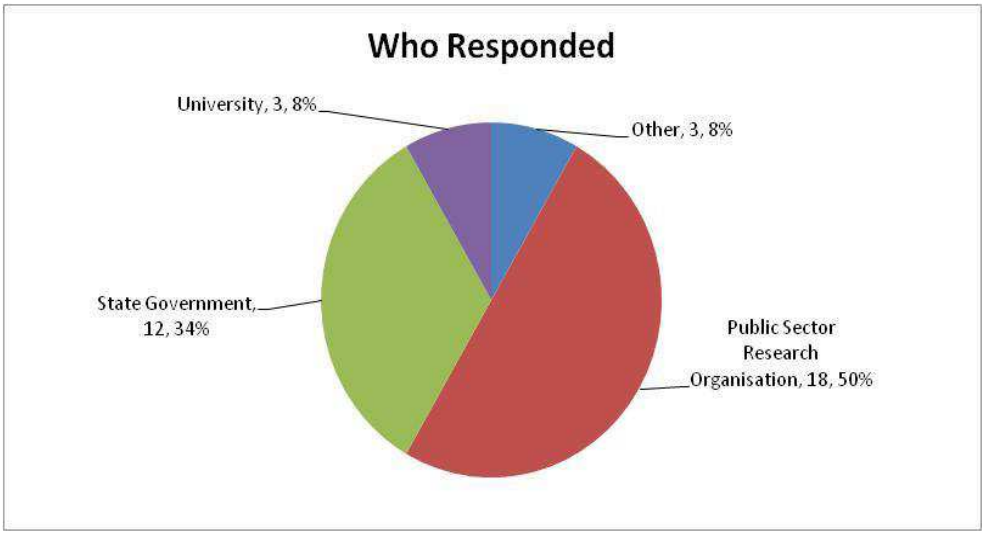
Suggested strategies

The following strategies were developed by the group in Session 3. There was not enough time on the day to prioritise these strategies.

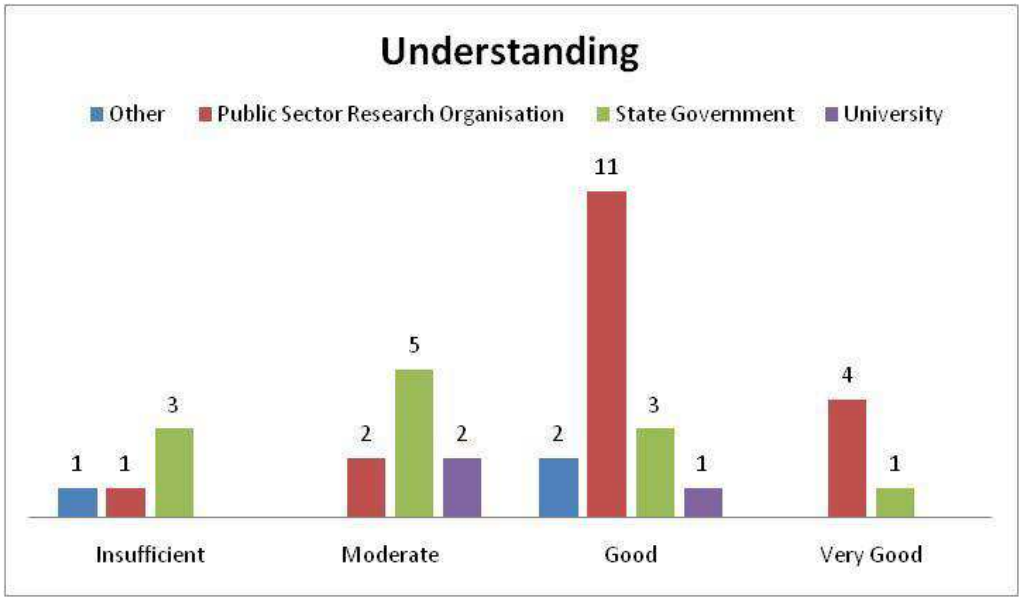
1. Spend time and money on development of a Community Engagement strategy
    a. Steps: Base Research -> Data Interpretation -> Community Agency Information
    b. IOCI would compile the available data
    c. IOCI/Agencies/Scientist convert the data into community friendly information for the different target groups
    d. Agencies communicate to their constituencies
2. Develop agreement on the timeframes and spatial scales to enable more consistent modelling and exploration into specific phenomena
3. Create a 1 stop reference point for available data, linking the range of research groups
4. Create greater linkages between people involved in the various topic/issues
    a. Have this work supported by coordinating body
    b. Ensure there are linkages at the 'coal face' as well as the policy levels
    c. This can help ensure there is a clear research model for all to follow
    d. Sharing staff across agencies, could improve these linkages
    e. We can start by exploring what is working/not working in fostering these linkages

2. Setting the scene for day two

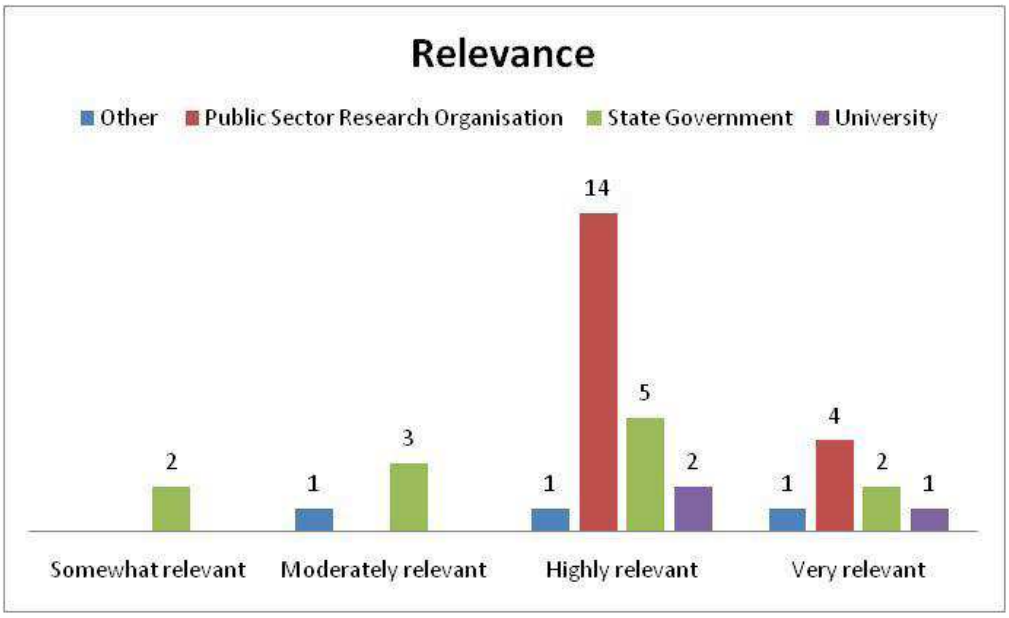
On the completion of day one participants were asked a series of question as a prelude to day two the results to these questions provided a start to the discussions on day two.



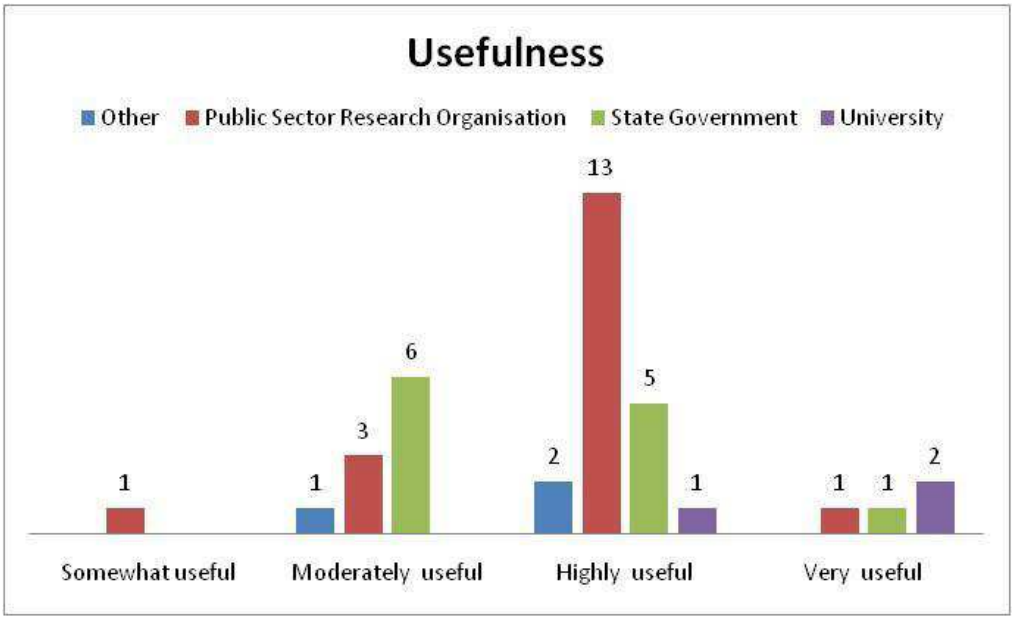
1. How would you rate your understanding of the research presented today?



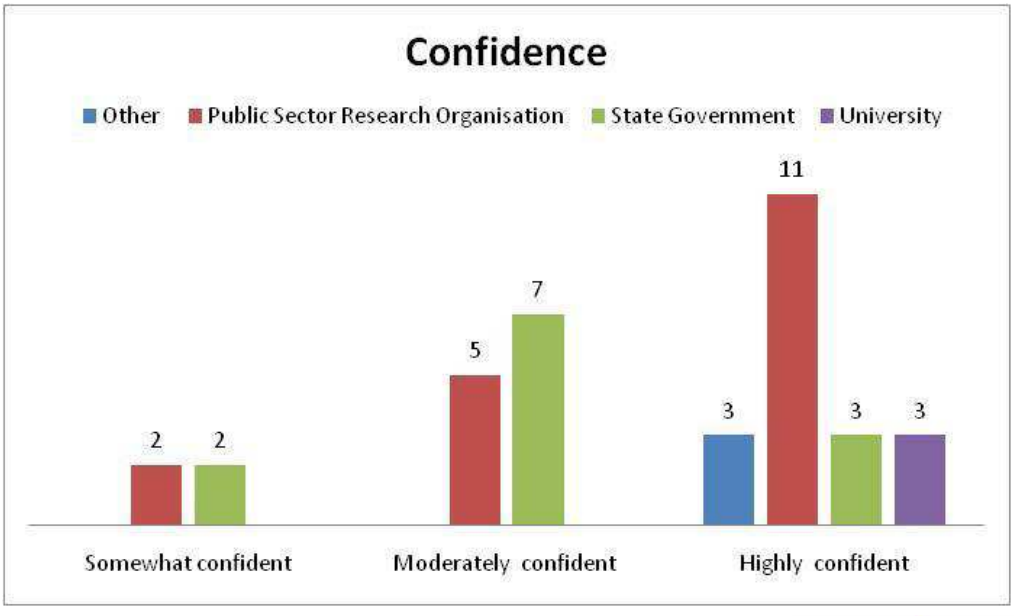
2. How relevant are the research objectives of IOCI3 to the issues your agency/sector is seeking to address?



3. How useful will the results of the IOCI3 research be to your agency/sector?



4. How confident are you that the results of the IOCI3 will help your organisation develop effective policies?



Comments from the end of day one questionnaire

- *Worth considering a meeting in northwest with stakeholders. Would be very interested to see what the data may be used for - issues, risks etc*
- *I would like to have heard more about the actual results, less about the inner workings of the models. Policy makers and interdisciplinary researchers need information that they can incorporate into their own work. Also, nearly inaudible volume at the back. But thanks it was still worth coming.*
- *Would be good to have a northwest focus meeting. Also greater emphasis on impact and relevance would be good*
- *Note: The BoM will use the outcomes of the IOCI3 research to inform the services (climate and weather) we provide to WA*
- *Could involve the universities a bit more*
- *Primarily interested in outputs/new data. Obtained some insights into methodology today*

Other comments from the floor on the commencement of day two

At the start of day two participants were asked two questions;

1. What where the things that motivated me from day one?
2. What where the things that concerned me from day one?

1. <u>The things that motivated me from day one</u>

- Building a network of relationships
- Commitment and capability of scientists doing this work
- Seeing other individuals working on a range of issues (reducing the isolation of this effort)
- Seeing the progress being made in our level of understanding

2. <u>The things that concerned me from day one</u>

- Seeing a disconnect between scientists -> agencies and community
- Feeling like there are unreal expectation on what the research can deliver (time required/time expected)
- Not seeing the various efforts being aggregated (need a 1 stop shop)
- Lack of high quality data
- A need to build greater relevance to specific industry (ie: Resources etc)
- Uncertainty if the name IOCI is still relevant moving forward

3. Beyond IOCI3 (Session 4)

At the final session of the day, the group was asked to consider three questions (below). A panel of spoke briefly to the topic of "what post IOCI3 might look like" which lead to some small group work.

The group reconvened to share their responses to these questions;

- Do we need an IOCI4? (ie: once the IOCI3 agreement ends)
- What ends would this IOCI4 be seeking to achieve?
- What form should an 'IOCI4' type initiate take?

Do we need an IOCI4?

- Based on what we have heard over the past two days there is still significant unmet climate science needs. Indicating a need for a 'form' of collaborative/coordinated approach to continue.
- SW Australia is the only recognised bio-diversity hotspot and most at risk Mediterranean climate. Affirming the importance of continued research specifically focused on this region.

What ends would this IOCI4 be seeking to achieve?

- While there is a need to continue the climate science research, there is a need to focus on applied consequential research. This shift will speed up the move towards policy actions
- To ensure the Federal Government continues to focus on the broader climate science, making sure there is no duplication of effort and wasted resource.
- To enable the reconciliation of the observed trends with rainfall projection to bolster future trending accuracy/capability (the question was asked if these trends are national or WA centric? Ie: can this work be completed at the federal level)
- To convert data into a business cases that improve the ability for agencies to fund climate adaptation initiatives/programs.
- To build collaborative adaptive strategies. Recognising that adaptive strategies may sit across a number of departments/agencies.
- To ensure continuity of knowledge and background of people current involved to avoid reinventing learning.

What form should an 'IOCI4' type initiate take

- Need to determine the governance structure. Is a collaborative arrangement the best (eg: ICOI type structure or do we need to move to a Statutory body to enable/enforce adaption policy.
- Whatever form it takes there is a greater need to engage with the public
- The release of CCAMS (Climate Change Adaptation and Mitigation Strategy) in 2010 can be a framework that will spark/progress these discussions
- Potential breakup of the structure could be: Oceans, Coastal, Atmospheric, Land
- Potential name: South West Adaptive Network (SWAN)

Other issues/questions that would need to be resolved as part of any future collaboration

- Who holds the IP rights to research/knowledge and how is this shared?
- What is required at the international level of collaboration?
- How do we build the capacity of communities to use the data?
- Need to better understand climate variability.
- Need to link to Commonwealth initiatives to proven duplication and keep them responsible for their role in research.
- Defining the level and type of community engagement.

4. Small Group Outputs

Four themes were identified and prioritised by the group during the morning presentations. Participants were broken up into small groups for discussion on the following topics:

- Communicating and translating data to build awareness
- Specific research needs
- Coordination of climate change science
- Linking up agencies

Outputs from the discussions are presented below.

4.1. Communicating and translating data to build awareness

<u>What does the community want to know in regards to climate change?</u>

- Need clear assignment of roles and responsibilities
    - Shared responsibility (governance structure for CC adaptation)
    - Setting priorities (what will you work at)
- Are we using the information to inform decisions today?
- Managing and influencing expectations of agencies and the community
- Determining the starting point (retrospective decisions)
- Insurance companies
- Different groups will have different messages to deliver and need to hear different messages
- We need to construct clear messages to decision makers
- There is a mismatch between people asking the questions and those seeking the answers (feedback from research to governance structure)
- Trust – assumptions of what is accounted for
- There are many other players that are not present today that need to be (eg: Department of Planning)
- We need to better understand how to talk climate change to 'Joe public'
- Climate Change science is still at the global level community ; community concern is local level
    - Experience of Agriculture: Economics – cost of moving now rather than later
    - Economics and safety direct affect to communities
    - Need to build the capacity to visualise (make it real)
    - Availability and acceptability of information

1. Community research – what is important to the community?
2. Identification of priorities
3. Review process – are we collecting the right data?
4. Specialist translation role – translation into action

- Not enough social scientists involved in IOCI
- Not just about communicating, also requires behavioural change

4.2. Specific research needs

See the Section 5 for a full list of specific needs.

- Need to develop consistent timescales / spatial scales to enable better comparison of data
- Need downscaling -> characteristics of the phenomena
- Need to establish dialogue between users and suppliers of the data to ensure there is a stronger match
- Need for more localised information

4.3. Coordination of climate science

- Feeding research into IPCC AR5 modelling + other CSIRO models
- Need to know who's doing what?
- Greater networking is required
- There is value in the development of a single portal for climate change research
    - Translation of science to service a wide range of stakeholders (Scientists, government dept, community)
    - Needs to be led by state government agencies and be well resourced

- Need for coordination of science
    - Fundamental climatology (done by IOCI)
    - Climatology impacts (through agencies)

- Need for a 1 stop reference point for climate scenarios and projections
    - Important for consistency & inter-comparability
    - Possibly IOCI or other state coordinating body

4.4. Linking up agencies

- Start by looking at what collaborations are working well: Gnangarra working group (Management of a problem with a set of clearly defined issues...lead to benefits of collaboration)
- There is concern that issues are not clearly defined
    - Breakdown climate change issues (eg: climate change and fire)
- Researchers/agencies are using different time horizons to assess risk and set research parameters
    - Fire immediate (near when consequences)
    - Water immediate (medium)
    - There are different priorities
    - Linking of agencies by need for different timescales. Knowledge, action needs.

- Collaboration / interaction across states (scientist perspective)
    - Need for more collaboration
    - Need for national climate science program integrating across sectors
    - One stop shop?
    - Avoiding unnecessary waste (duplication of reports, building common scenarios planning)

- Need to look at where there are the most linkages between areas (agencies)
    - Eg: Water (biodiversity), Water (Fire)

- What are the barriers to agencies conducting appropriate risk assessment?
    - Risk assessment knowledge
    - Appropriate downscale prediction
    - What is a model that will be able to support each agency?
- When framing adaptive responses – want to make sure not to adversely impact else where.
    - Alignment issues
    - Look at scenarios – how we adapt, what would be the consequences
- Climate change issues are quite dispersed and not always focused
- State may be able to help CSIRO division to come together
- What are the key research issues that will bring everyone together?
- Critical mass is needed
- Define objectives (each sector)
    - offer a suite of options
- Directors General Group on Climate Change and Energy (DGGCCE) / Climate Change Policy Interdepartmental Steering Group (CCPISG) (end of chain)
    - Need lower level
- Need to prioritise issues
    - Research needs/ policy needs (climate and adaptive)
    - Model engaged interagency
    - Regionally focused and constrained (ICOI National/South West)
    - Pitched to engage all relevant agencies /stakeholders
    - One go-to hub
- 1 st step – scenario planning approach /systems approach
    - What are the scenarios
    - What are the most likely scenarios to base action on

- Adaptive management cycle
    - Common baseline language
- Key research model across agencies
    - Put people together
    - Take discussions to people who implement in the ground
    - 3 days together (2 days with their agencies)
- Model needs to build on synergies and cut wastage

5. Individual participant responses

During the morning a range of speakers sharing both the scientific and agency perspectives on the following two questions

a) What kind of climate change outcome is my agencies looking to achieve?
b) What types of information does my agency need to assist in achieving this?

During the presentations participants made notes on these two questions which have been 'themed' into the following groups.

5.1. Coordination of Climate Science and Agencies

	COMMENT	WHO
1	• Greater alignment and interaction between agencies	OCC
2	• The support required to FESA from the health sector need to be assess. Inextricability linked to planning requirements for FESA	DOH
	• We need to link across disciplines, sectors and interest but don't have institutionalised means	Curtin
	• Link between mental/physical health and environmental health implications for funding	
	• New interdepartmental platform to encourage X agencies delivery of adaptation strategies and research. With an independent industry chair (or professor) based at WA university	
1	• Cross sectoral collaboration communication and support on climate change impacts and predictions	Local government
	• Coastal local government needs will be different to inland local government. Establish collectives of each 'type' of local government to indentify the priorities as collectives and then partnership with research institutions.	
2	• Coordinated and formal cross-agency/sector working groups (including all stakeholders)	Local government
2	• From a scientist perspective, it would be useful to know how policy is formulate and the role that our science plays in formulating it	CSIRO
	• Should a water strategy focus on more renewable sources – ie: more desalination	
2	• To know what work other agencies are undertaking	
	• Who is not in the room today and who needs to be?	
1	• Coordination of climate science across agencies	
	• How do we manage transformational change, who do you best pull everything together	DEC
1	• Climate science outputs available to all state and local government agencies	DEC
2	• Knowledge of climate change related research across WA	DEC
2	• Better climate observational networks across WA (Spatial coverage, Maintaining HQ observations)	Agriculture

5.2. Communicating and translating data to build awareness

	COMMENT	WHO
	• Clear communication of risk to community	Local Government
	• Need tools to develop local expertise	Local Government
1	• Web portal for climate projection data (make data more accessible) – central knowledge base	OCC
2	• Easy way of sharing climate data (internet)	
2	• High quality rainfall data, other climate data – the information is available but need human resource to accomplish	BOM
	• Concern: the size of data generated by models and capacity to handle this within reasonable timeframes, so that they can be translated into meaningful data sets or scenarios for users to have date which is up to date. How do you overcome time lags?	DAFWA
	• Seasonal forecasts of extreme temperature (heat/frost)	Agriculture
	• Climate projections for extreme temperature frequency for specific months of the year	Agriculture
1	• Widespread uptake and use of high quality dataset that we will produce to underpin climate change research fir ICOI	
2	• CSIRO mathematical and informational science (can CLAM) has developed a statistical model to forecast Soil dryness index (Li et akl 2003), which may be used to guide spring/autumn burring to control bushfires.	Ralph Smith
2	• High quality datasets and maintenance of them	BOM
	• Local relevant rainfall and temperature projections for 2030, including extreme GHG emission scenarios	Agriculture Research WA
2	• Lidar Mapping accessible to local government planner	Local Gov
2	• What are the best ways to access and use datasets that Bom will produce?	BOM
2	• Are the current plans going to meet you agencies needs?	BOM
2	• A timeline for decision points and capability to changer	Agriculture
2	• How to communicate the unimaginable...millions of $ worth of housing useless, Perth to become arid, sea levels rise	

5.3. Different Agency outcomes/needs

	COMMENT	WHO
2	• Information /research on how to inform/change behaviour/decisions for climate adaptation	
	• How do you prioritise what you protect?, how do you get community acceptance of loss	Local Government
1	• Improved management of natural resources, considering climate variability trends	Agriculture
1	• IOCI to assist with social change process	Agriculture
	• Strategic/regulation to support local government to require adaptable buildings for climate change	Building commission
1	• Resilient farming/regional communities	Agriculture
1	• Providing targeted local services to meet local needs	BoM
1	• Robust/Resilient agricultural systems that are adaptable to climate variability as well as change	Agriculture
1	• Is incremental change the safest or step change?	Agriculture
	• Better understanding of climate change on buildings particularly events (temperature rise, reduce water, extreme events) in WA (Metro and Regional)	Building Commission Dept of Commerce
2	• Coordination with DoP to ensure that CC impacts are taken into account and managed by the state and local government planners	Local Government
1	• Appropriate planning processes to address climate change impacts (and take these into account when development approvals are issued)	Local Government
2	• What areas are going to be too dangerous for housing to be built? (bushfire, extreme events)	Building commission
1	• Better strategies to assist communities to adapt to build in areas at risk from bush Fire	Building commission
	• How do we influence the social component of behavioural change	DEC
1	• Need assurances that we will have – safe, affordable, nutritious, accessible food sources	DOH
2	• Well defined user requirements	BoM
	•	

5.4. Specific Research needs

	COMMENT	WHO
1	• Pilbara Kimberly climatology – assess changes cause of rainfall increase. – assess relationship between tropical weather systems and rainfall	BOM
	• Are they concerns about which forcing agents are responsible for recent rainfall changes? (eg: long-term Vs short term)	Agriculture
2	• Mapping of sites by climate change risk (drying, bushfire, increased storm surge/sea level rise)	Building commission
	• Sort medium long term seasonal rainfall forecast for managing climate variability	Agriculture Research WA
	• Do native species have genetics memory of past climate change and can this be identified?	
1	• Sea level rise predictions at a scale which can support local planning policy	Local Government
1	• Short term predictions for day-to-day management. Long term predictions for planning processes	Local Government
1	• Downscale projections under AiFi scenario	
1	• Regional site specific analysis required	Local Government
	• Understanding risks lined to treatment Vs prevention	Health
2	• Adequate 'risk' mapping (bush fire , flood, cyclone, storm surge, seal level risk, coastal erosion prone areas?	Local Government
2	• Cost/Risk projections based on local scale IOCI data/science	Local Government
2	• Information on risks of transforming changes ot WA climate	Agriculture
2	• Best estimated of future rainfall, stream flow and GW recharge characteristics in 5-10 years increments- so that water management can be progressively changed as drying occurs	DoW
	• Need for local maintaining and observations – place event in context, local ownership, motivate response	
	• Science motivated by vulnerability and impact	
1	• Inputs into risk and adaptation planning processes for local government (risk mapping- fire/flood/infrastructure/asset management)	Local Government
1	• Understanding the cost and liabilities (legal, legislative planning, infrastructure) than are exacerbated by climate change	Local Government
2	• Specific information about temperature, water scarcity and extreme events n building and building materials in different climate zones	Building commission
	• How does uncertainty of climate change projections change with different downscaling methods	Agriculture Research WA
2	• Reliable downscaled climate projections, testing and selection of GCM's	Agriculture
2	• What is the potential for tropical cyclones to travel further south and impact on southern communities in a changing climate?	FESA
1	• Number fo days of server weather downscaled analysis to allow regional prediction of future fire scenarios	FESA
2	• Importance of impacts on water quality	
1	• Improved quantification of drying trends so that adaptive management oof water resources can be progressively implemented overtime	DoW
	• How we characterise climate variability with CC	DEC
2	• Improved seasonal climate forecasting as part of improved agriculture decision making	
	• Climate change scenarios on rainfall intensity change (rainfall/hr, rainfall and wind intensity) for 2030 to estimate change in erosion potential	Agriculture Research WA
2	• Changes in synoptic patterns in future climate	
1	• Guidelines on changed to future fire management under CC, Characterise changing fire risk,	FESA
2	• need quantification of element affecting fire risk	FESA

1	• Better knowledge of changes to rainfall patterns	BoM
	• What is the likelihood of specific events linked to vulnerability of identified ecosystems	DEC
	• Climate change projections on dry-season sequences in the future (2030)	Agriculture Research WA
	• Guidance appropriate GCM for use in different applications	
	• Climate change scenarios for synoptics changes (fire and bio diversity)	Agriculture Research WA
	• Farmers have been adapting to the incremental changes (by enlarge). What will be critical to adaptation strategies for them is will there be transformational change (step) changing in rainfall and when?	
2	• Improved certainty on likely changes to tropical rainfall. Proportion of rainfall coming from tropical cyclones	
	• Longer term is 15-20 years but this timescale decadal variability is likely important (i think of long term as 100 years)	Ed Huck
	• Fire risk – what is the probability of synoptic weather patterns with high fire risk?	DEC
1	• CC science is and will remain the basis for adaptation science, policy and adaptation decisions---best available science	DoW
2	• Better projections/prediction of rainfall trends across the state	DoW
	• Given that we will never get rid of the uncertainty do we need more verification/details in the science or do we need to put our resources into developing solutions?	
1	• Tropical cyclones: what extend will the increased intensity of tropical cyclones impact on NW and inland communities	FESA
2	• Need consentient baselines and planning horizons across the board	DoW
2	• Downscaling climate data to regional scale	Dow
1	• Improved modelling with greater clairty	
	• Improved modelling for all of WA	
	• Need to diversify away from Ag and water....sea level, surges, human health, thresholds,	
2	• There appears to be an increase in lighting during summer and starting fires across wide areas. What is the potential for this to increase?	FESA

6. Appendix One- Day Two Program

Time	Presentation	Speaker (Affiliation)
	***Session 1* – Introduction**	
8.30 – 9.00	**Registration – CELS Reception Foyer -**	*****Coffee / tea will provided in the foyer***
9:00 – 9:40	**Opening and welcome**	**Joel Levin**
	Learning from yesterday	Facilitator
	Getting focused for today What kind of climate change outcome is my agencies looking to achieve? What types of information does my agency need to assist in achieving this?	
	***Session 2* – Using IOCI results: previous experience**	
9:40 – 9:55	**An IOCI scientist's perspective**	**Dr Steve Charles (CSIRO)**
9:55 – 10:10	**Perspective from government departments**	**Ed Hauck (Dept of Water)**
10:10 – 10:30	**Morning Tea – Mezzanine Level**	
	***Session 3* – WA Government's climate science needs**	
10:30 – 10:40	**Agriculture**	**Dr David Bowran (Dept of Agric & Food)**
10:40 – 10:50	**Fire and emergency services**	**Ralph Smith (FESA)**
10:50 – 11:00	Questions, reflections and collection of ideas	Facilitator
11:00 – 11:10	**Terrestrial biodiversity**	**Dr Colin Yates (Dept of Env & Cons)**
11:10 – 11:20	**Local Government**	**Dr Neil Carroll (City of Mandurah)**
10:20 – 11:30	Questions, reflections and collection of ideas	Facilitator
11:30 – 11:40	**Water**	**Ed Hauck (Dept of Water)**
11:40 – 11:50	**Health**	**Dianne Katscherian (Dept of Health)**
11:50 – 12:00	Questions, reflections and collection of ideas	Facilitator

12:00 – 13:00	Lunch – Mezzanine Level	

Session 3 – WA Government's climate science needs discussion

13:00 – 14:30	**Discussion Groups**	Large group for Prioritisation (10min) Small Group Discussion (35min) Returning to Plenary (45min)

14:30 – 15:00	Afternoon Tea – Mezzanine Level	

Session 4 – The post-IOCI3 world for WA climate science

15:00 – 16:00	**Panel Session**	**Panel**
	What does post IOCI3 need to look like to ensure the best quality outcomes?	**Dr Bryson Bates (CSIRO)**
	- Governance/Structure	**Dr Bruce Stewart (BoM)**
	- Funding/Subject Matter	**Steve Waller (DEC)**
	5 min per panel member then open forum	**Anthony Swirepik (Dept of Climate Change)**
16:45 – 17:00	**Where to from here, wrapping-up**	Facilitator
17:00	**Close**	**Robert Atkins (Deputy Director General – Environment, Dept of Env & Cons)**

- End of Report-

Appendix 2
Polling Questionnaire

Day 1 Polling Questions

This questionnaire is aimed at the users and potential users of the Indian Ocean Climate Initiative Stage 3 (IOCI 3) research.

1. How well would you rate your understanding of the research presented today?

Poor	Low	Moderate	Good	Very Good
0-25%	25 – 50%	50-75%	75 – 85%	85 – 100%
1	2	3	4	5
☐	☐	☐	☐	☐

2. How relevant are the research objectives of IOCI 3 to the issues your agency/sector is seeking to address?

Not relevant at all	Somewhat relevant	Moderately relevant	Highly relevant	Very relevant
1	2	3	4	5
☐	☐	☐	☐	☐

3. How useful will the results of the IOCI 3 research be to your agency/sector?

Not useful at all	Somewhat useful	Moderately useful	Highly useful	Very useful
1	2	3	4	5
☐	☐	☐	☐	☐

4. How confident are you that the results of the IOCI 3 will help your organisation to progress effective policies?

Not confident at all	Somewhat confident	Moderately confident	Highly confident	Very confident
1	2	3	4	5
☐	☐	☐	☐	☐

5. Which type of organisation do you represent today?

☐ State Government agency ☐ Local Government agency

☐ Public sector research organisation ☐ Private sector research organisation

☐ Other (please specify) ……..

6. Any other comments on the potential usability of the IOCI 3 Research

_____
_____
_____
_____
_____
_____