Australian Government
Bureau of Meteorology

Engaging decision-makers in climate predictions for agriculture, water resource management and energy

Andrew Watkins, Liz Boulton, Yahya Abawi, David Jones, Janita Pahalad, Trudy Peatey, Jeff Perkins and Neil Plummer

Australian Government
Bureau of Meteorology

Scope

- Background
- Importance of seasonal forecasting
- Engaging decision-makers and recent lessons learnt from:
  - Seasonal Climate Outlook:
    - Use of market research and user centred design
  - Seasonal streamflow forecasts:
    - Service development in step with the needs of water managers
  - National climate and water briefings:
    - Education and regular access between decision makers and scientists
  - Pacific Island Climate Prediction Project:
    - Communication with farmers, water managers, energy producers and others

Australian Government
Bureau of Meteorology

Background – seasonal forecasting in the Bureau of Meteorology

- 1859 First scientific study of Australian climate (William Jevons) finds irregular rainfall patterns
- Late 1800s Early climatologists identify important teleconnections
- 1985 National Climate Centre and Bureau Meteorology Research Centre (BMRC) established
- 1989 First operational seasonal climate forecast
- 2001 First operational seasonal Tropical Cyclone forecast
- 2010 First operational seasonal streamflow forecast
- 2011-12 Transition to dynamic forecast model (POAMA)

Australian Government
Bureau of Meteorology

Importance of seasonal forecasting to decision-makers

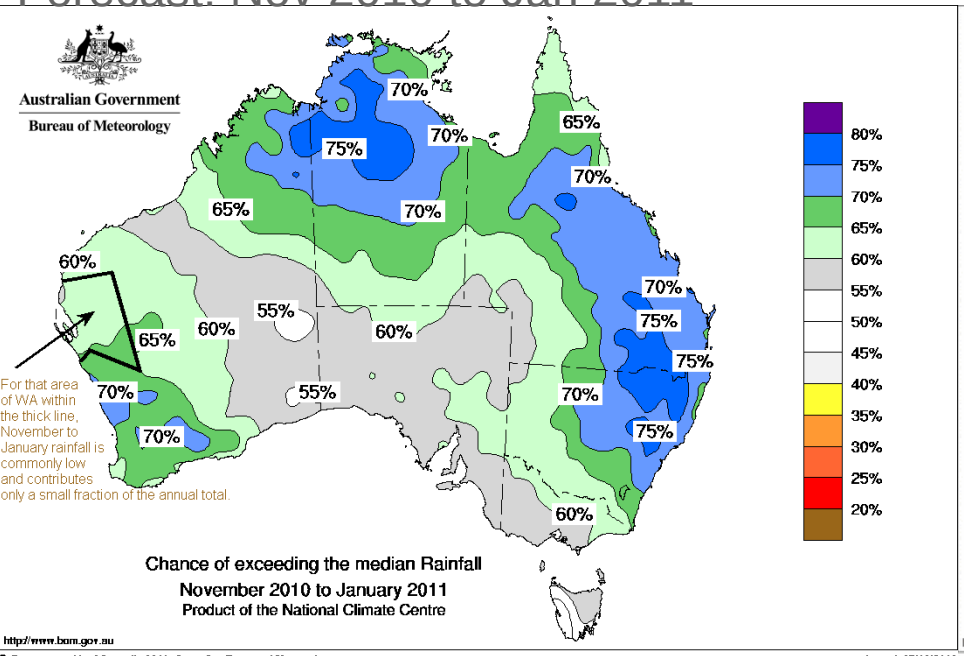
- Vitally important to Australia's economy, society and community
  - 5% GDP variability attributed to annual climate variability ($58 billion)
  - If the Bureau can positive influence Australia's ability to respond effectively to this… it can translate into GDP savings (~ $11.6 Billion p.a.)
- Unprecedented attention on seasonal forecasts in Australia this summer
  - 2010-11 severe and extensive floods
  - Water storage managers instructed to use seasonal forecasts
- Risk and climate change

1. Seasonal Climate Outlook - Review Project

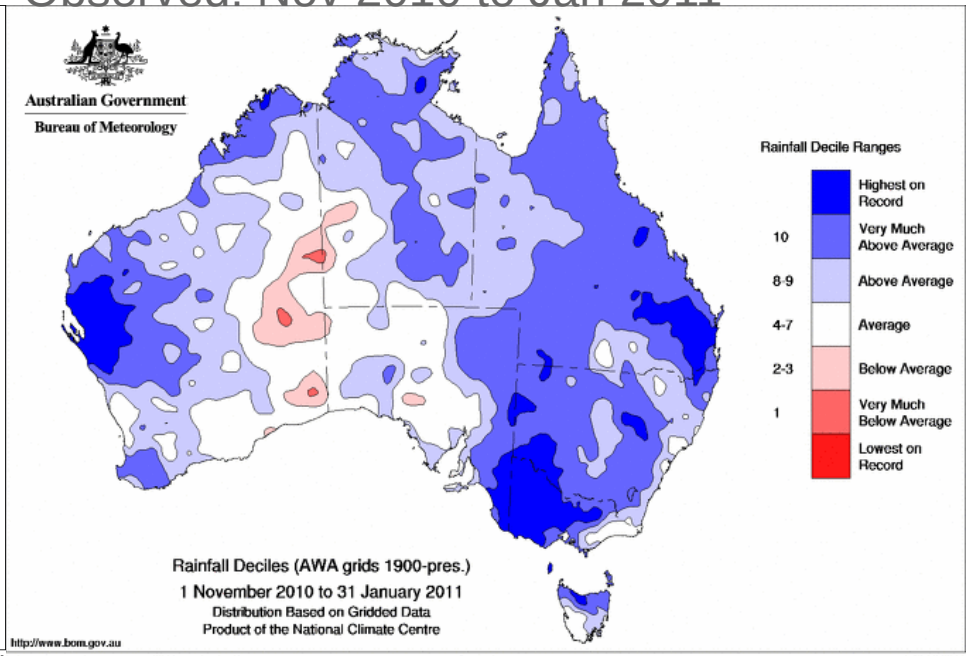
Current product…..

Also reviewed: ENSO Wrap-up product

Forecast: Nov 2010 to Jan 2011



Observed: Nov 2010 to Jan 2011



Australian Government
Bureau of Meteorology

1. Seasonal Climate Outlook - Review Project

Few changes over the last decade

Anecdotal evidence of possible problems

- Language used (expression/terms confidence, median etc.)
- User interface

Launch Seasonal Climate Outlook Review Project

- August 2010 – June 2011
- Multi-disciplinary project team
  - » Internal - communications / marketing experts and scientists
  - » External - Market research and user centred design consultants
- Aim: How can we increase the value of SCO to users?

Australian Government
Bureau of Meteorology

1. Seasonal Climate Outlook - Review Project - ***Overview***

MARKET RESEARCH

Stage 1: Qualitative Research

- *Interview internal Bureau Stakeholders*

Stage 2: Qualitative Research

- *Interview 10 VIP product users*

Stage 3: Quantitative Research

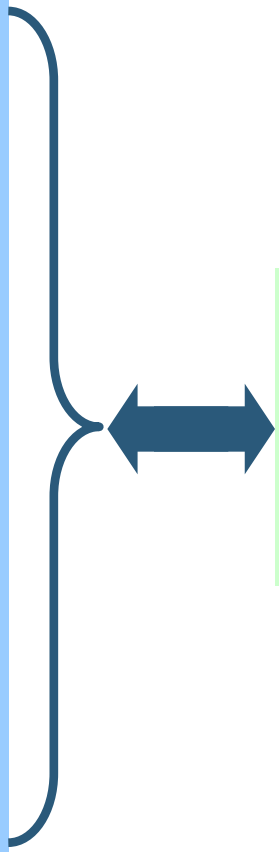
- *Open Public Online Survey (961 resp.)*

Stage 4: Product Testing

- *User Workshop*

Stage 5: Product Testing

- *User Interviews*



User Centred Design (UCD)

- Iterative design improvements

Australian Government
Bureau of Meteorology

What did the market research tell us?

Stakeholder use, value and rely upon SCO highly:

- 43% visited the pages at least weekly
- 71% said it accounted for 60% or more of their information source
- 19% said the site was ***'vitally important – my livelihood or those I advise rely heavily on this information.'***

Comprehension rates are low:

- Users were given 4 comprehension tests which found that they are mis-interpreting the information between 16% and 41% of the time
- Confidence / skill maps - rarely used, low comprehension

Australian Government
Bureau of Meteorology

Problem 1: Plain text solution

- This is not a scientific issue – it's a disciplinary issue (People having been studying language for eons!)
- Get assistance from expert language and communications staff
- Two issues:
  - Troublesome words
  - Poor sentences

Australian Government
Bureau of Meteorology

Problem 1: Plain text solution
Better words

Current	Other or preferred options
Odds	Likelihood or likely Chance
Probability or probabilities	Likelihood Chances (ok to use in some instances)
Anomalies	May need phrase to describe Difference from average or normal
Favoured	Likely
Median	Normal / Usual / Average
Percent consistent	Past accuracy
Chance of exceeding median	Chance above average
A return to neutral conditions	Balanced Stable with no El Nino or La Nina influence

Australian Government
Bureau of Meteorology

Problem 2: A Simple SCO Design

The search for a new idea……

Wide consultation – e.g.

- Australian Mathematical Sciences Institute
- Greenhouse 2011 Conference provided opportunities for many face to face discussions with international experts

Multiple internal brainstorming workshops

Result – 48 Design concepts

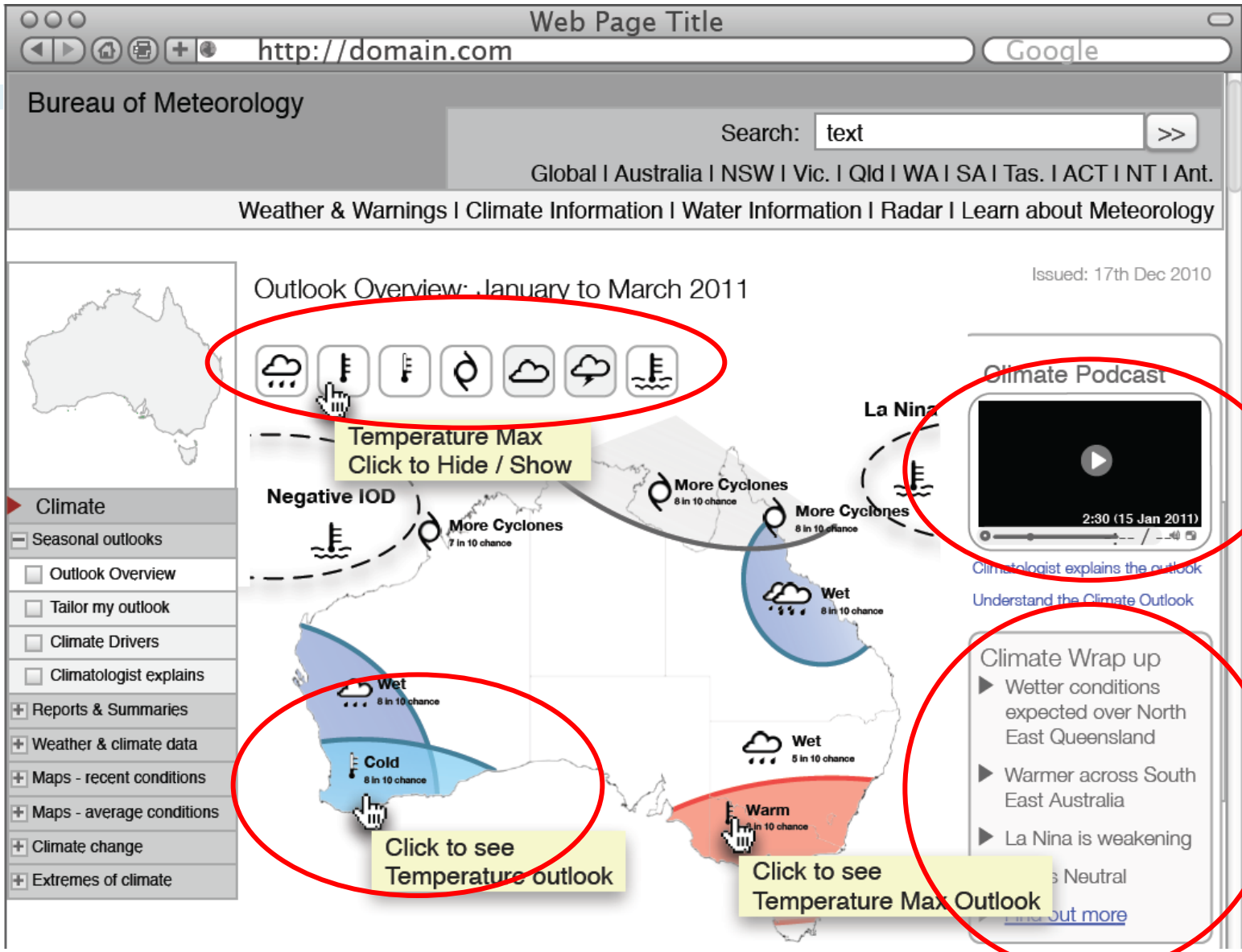
Australian Government
Bureau of Meteorology

Alternate SCO design

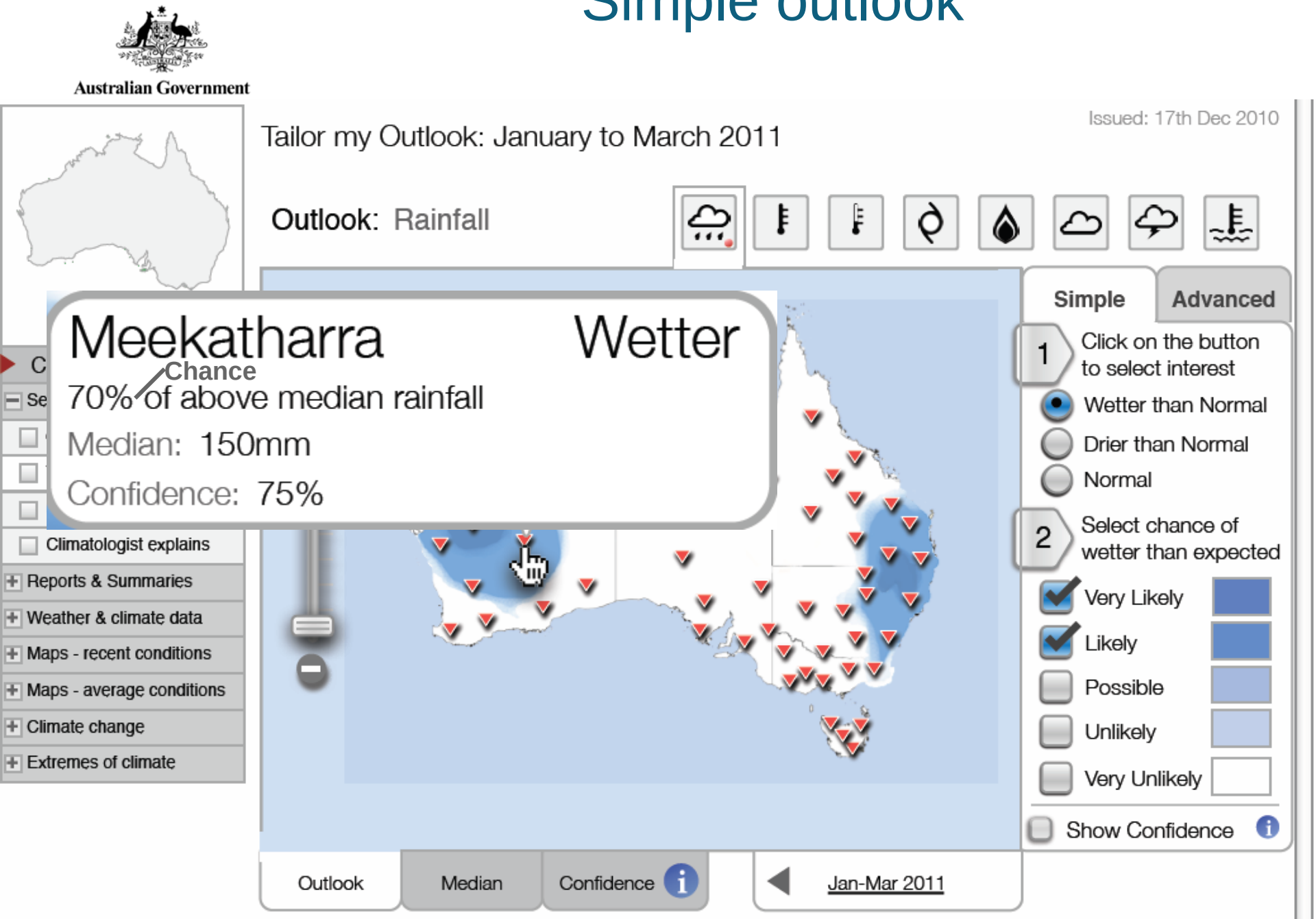
1 – Overview
2 – Confidence
3 – Simple outlook
4 – Advanced outlook

→ Tiered Levels of Complexity

Overview


Web Page Title
http://domain.com
Google
Bureau of Meteorology
Search: text >>
Global | Australia | NSW | Vic. | Qld | WA | SA | Tas. | ACT | NT | Ant.
Weather & Warnings | Climate Information | Water Information | Radar | Learn about Meteorology
Outlook Overview: January to March 2011
Issued: 17th Dec 2010
Temperature Max
Click to Hide / Show
Climate
Seasonal outlooks
Outlook Overview
Tailor my outlook
Climate Drivers
Climatologist explains
Reports & Summaries
Weather & climate data
Maps - recent conditions
Maps - average conditions
Climate change
Extremes of climate
Negative IOD
More Cyclones
8 in 10 chance
More Cyclones
7 in 10 chance
La Nina
More Cyclones
8 in 10 chance
Wet
8 in 10 chance
Wet
8 in 10 chance
Cold
8 in 10 chance
Wet
5 in 10 chance
Warm
8 in 10 chance
Click to see
Temperature outlook
Click to see
Temperature Max Outlook
Climate Podcast
2:30 (15 Jan 2011)
Climatologist explains the outlook
Understand the Climate Outlook
Climate Wrap up
Wetter conditions expected over North East Queensland
Warmer across South East Australia
La Nina is weakening
Neutral
Find out more

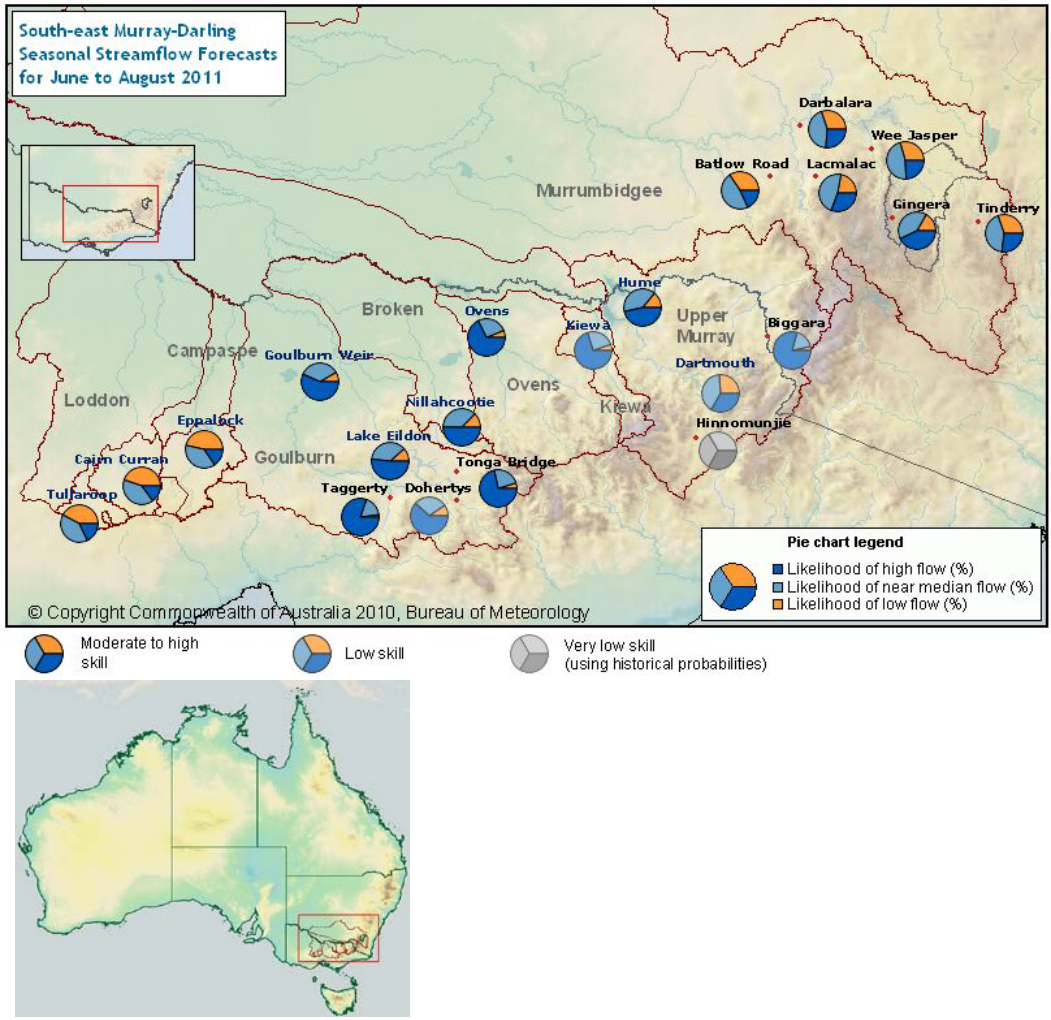
Simple outlook



Australian Government
Bureau of Meteorology

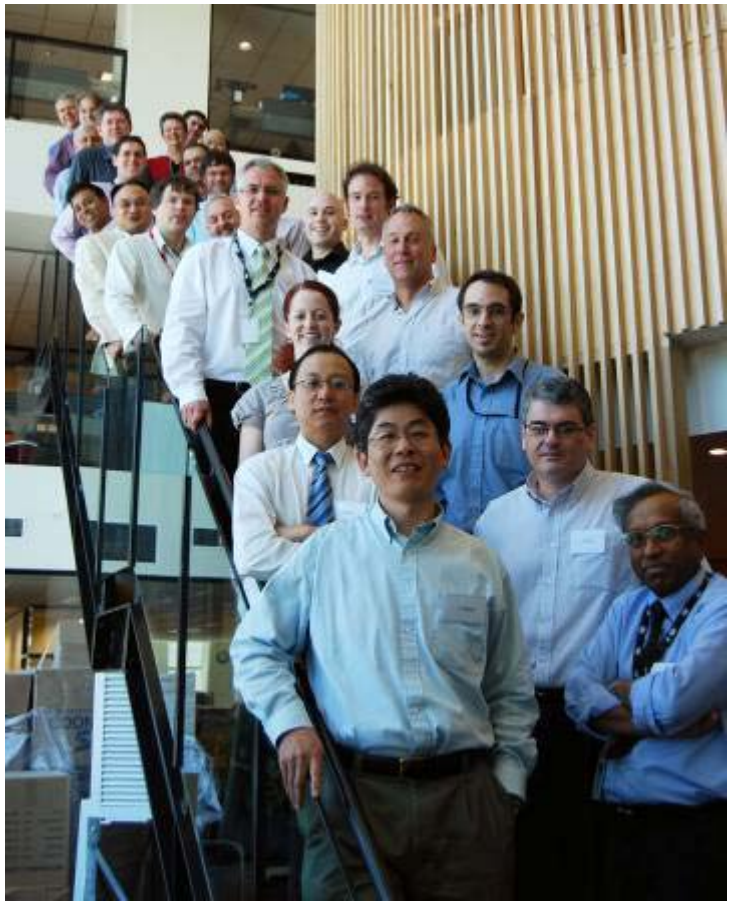
2. Seasonal Streamflow Forecast – collaborate with Water Managers

- Started December 2010
- Initial target catchments in south east Murray-Darling Basin
  - 21 locations (8 storages)
- Using CSIRO Bayesian Joint Probability Model
- Zero lead time 3 month forecasts
- Now planning for statistical/dynamic modelling to extend nationally
- …Will discuss in later presentation



Australian Government
Bureau of Meteorology

It started with stakeholder engagement



- Collaborative planning:
  - Users
  - Researchers
  - Service providers
- Three workshops
  - Planning and requirements – what are users' priority products for decision-making
  - Experimental products
  - Final product design
- Stakeholder meetings with over 20 agencies across Australia
- Experimental website

Australian Government
Bureau of Meteorology

3. National Climate and Water Briefing Series

- What is it?
  - Monthly one hour brief to key national decision makers, held in Canberra Audience: senior officials from most Australian Government departments, and other key agencies, such as the National Farmers Federation
  - Target high priority stakeholders directly

- Format:
  - Review climate activity for past season.
  - Provide forecast for next season: rainfall, temperature, streamflow, tropical cyclones
  - Each month has a theme (e.g. Severe weather briefing prior to cyclone / bushfire / heatwaves risk periods)

Australian Government
Bureau of Meteorology

3. National Climate and Water Briefing Series

Rationale:

- Regular, ongoing conversation with key decision makers
- Build relationships and mutual understanding
- Increase capacity for good decision making through ongoing education
- Increasing scientific literacy – is a key adaptation measure

Lessons learnt:

- Q&A after presentation and social time (lunch) important
- Importance of having special education features

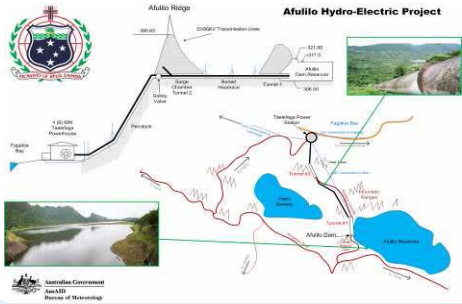
Australian Government
Bureau of Meteorology

4. Pacific Island – Climate Prediction Program (PI-CPP)

- Funded by AusAID for past 8 years
- Pilot Projects:
  - Agriculture in PNG
  - Fisheries Guide
  - Health in Solomon Islands (malaria)
  - Media
  - Renewable Energy in Samoa (hydropower generation)
  - Sugarcane in Fiji
  - Water Management
  - Water Security

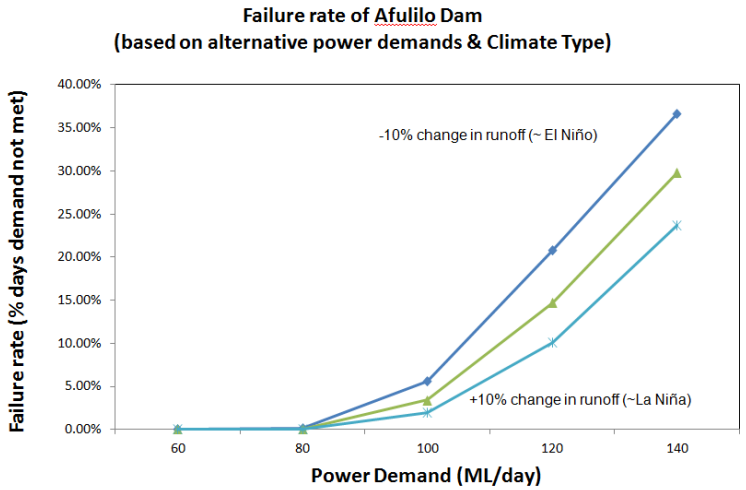
Australian Government
Bureau of Meteorology

PI-CPP – Engagement with the Energy Sector in Samoa



- Collaboration between Samoa's National Meteorological Service, Electricity Power Commission and the Bureau of Meteorology
- When commissioned in 1992, the Taelefaga hydropower scheme provided 80% of the (Upolu) island's power needs
- Increasing energy demand means only 50% of the demand is now met from more expensive thermal (diesel) sources
- Several months of drought create operational challenges for production

Seasonal Climate forecasts can improve the reliability and management of hydropower production especially for smaller capacity reservoirs.



Australian Government
Bureau of Meteorology

Conclusion

- Users want increased accuracy and reliability and so improved science/modelling is essential
- Engaging decision-makers also requires
  - Consulting users at early stage of product development to understand their needs
  - Integration and evaluation of forecasts in relevant decision-making systems
  - Effective communication of probabilities and uncertainties
  - Accessible forecasts with risk of misinterpretation reduced
  - Careful management of users' expectations

Australian Government
Bureau of Meteorology

Thank you for listening and to the APCC for their encouragement and support

Neil Plummer
Assistant Director Climate Information Services
n.plummer@bom.gov.au
+61 3 9669 4179

Australian Government
Bureau of Meteorology

SCO & ENSO Wrap-Up Review –
Lots of information, lots of problems, what do we do next?

"Make your presentation clearer. it is meaningless mumbo jumbo even to those with a scientific background."

•The groups which tended to dominate the sample were males (73%), those who were university educated and those in the older age groups (above).

OTHER SOURCES OF IN MATION USED

Research Institute for Clim
respondents (15%)
usiness (15%)
ated (14%)
mmunity (11%)
(11%)
(19%)

"Average is the popularly used term and I think people understand it better." (Research)

"It basically means the same for us; median and average means the same to us so we don't have an issue with the term median." (Finance)

"It has become prediction. Need me is there is a backing that up. week, the week a a cyclone due nex depressions like

Australian Government
Bureau of Meteorology

The problem statement

1) Text – words and sentences unclear
2) Design - need a ‘simple’ way to depict SCO

What was our problem-solving process?

Australian Government
Bureau of Meteorology

Problem 1: Plain text solution - better sentences

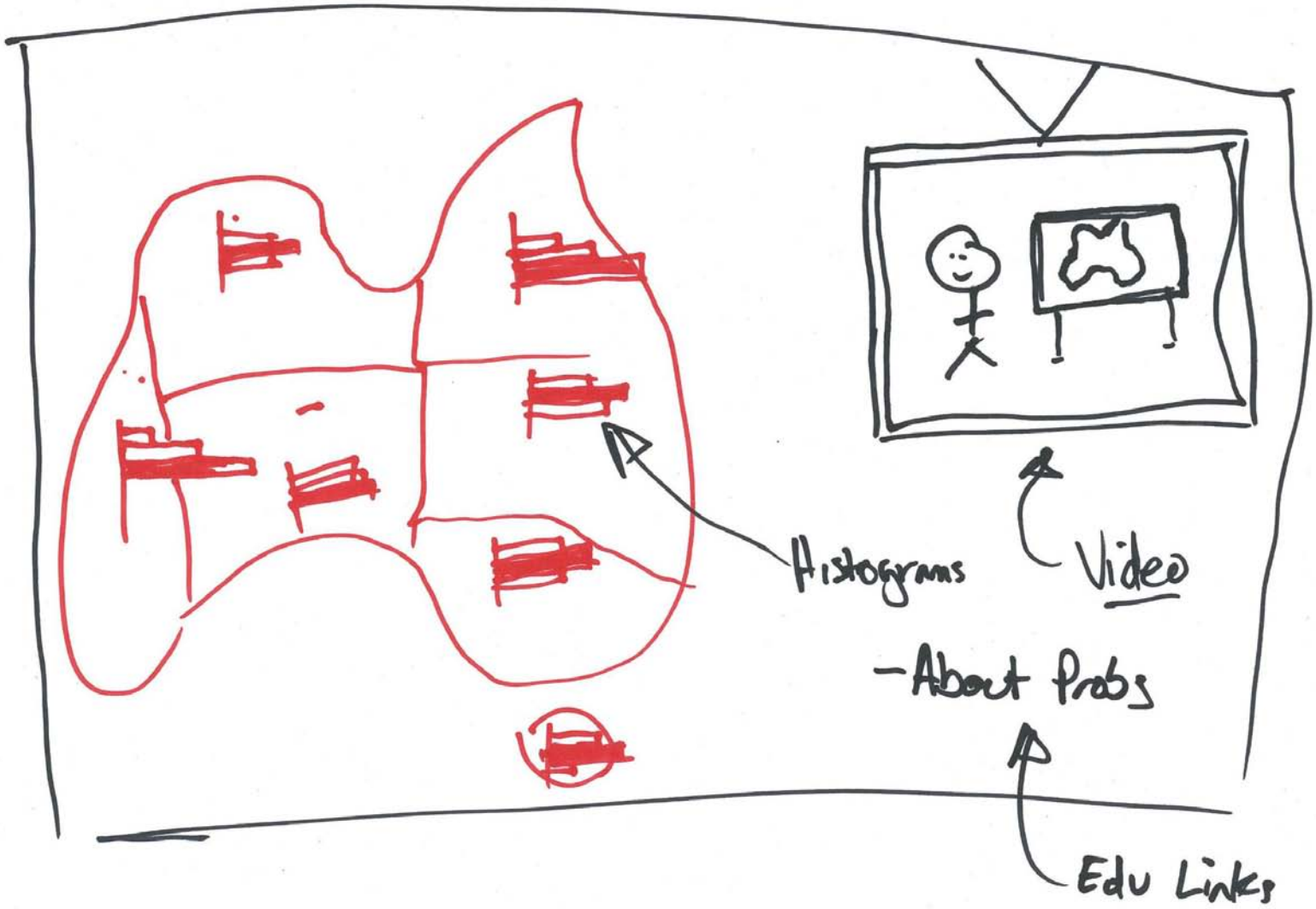
The national outlook for the April to June period shows a moderate to strong shift in the odds favouring a wetter than normal season over eastern Australia.

Eastern Australia is likely to be wetter than average from April to June.

(10) New - Simple 5-Tier version

"The summary 'above average/average/below average' is nice but perhaps a bit too simple - if you could give the user the option of adding in different views of the data, or increasing the complexity level, that might work."

(19) Internal design: Education & podcast link + horizontal bar-charts



Australian Government
Bureau of Meteorology

4) – User workshop

Dozen end-users gathered in Melbourne for a design workshop

User feedback allowed narrowing the design task

- Love podcast
- Like the idea of ‘tailoring’
- Need ‘simple’ and ‘advanced’
- Google maps/zoom
- Endorse ‘Overview Map’
- A “user experience”

Australian Government
Bureau of Meteorology

PI-CPP – Engagement with Renewable energy sector

Samoa – Afulilo dam hydro-electric project

- Aim – maximise hydropower production in favourable climate patterns (La Niña)
- Provide early warning indicators for energy shortage during prolonged droughts (El Niño).
- Training for decision makers in interpretation of seasonal forecasts.
- Operational water balance model developed to simulate climate and demand management scenarios on storage volume and dam reliability.

Australian Government
Bureau of Meteorology

PI-CPP – Engagement with agricultural sector

- PNG – management of sweet potato crops
  - Develop a drought forecasting / early warning system:
    - Via customising SCOPIC (Seasonal Climate Outlooks for Pacific Island Countries) software.
  - Analyse historical production data for a subsistence crop (sweet-potato) and climate data to identify the impacts of past climate on production.
  - Identify strategies to minimise the adverse impacts of climate and maximise opportunities in favorable seasons through discussions with key PNG agencies.
  - Build local capacity in key government agencies (NWS and NARI) to use and apply forecasting tools through targeted workshops and training in Australia and PNG.

Australian Government
Bureau of Meteorology

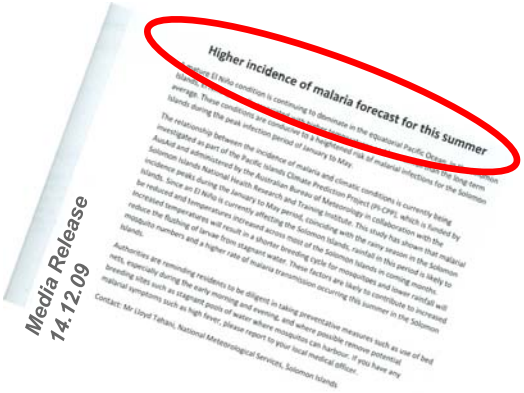
Yahya’s originals follow.. Next 3

Australian Government
Bureau of Meteorology

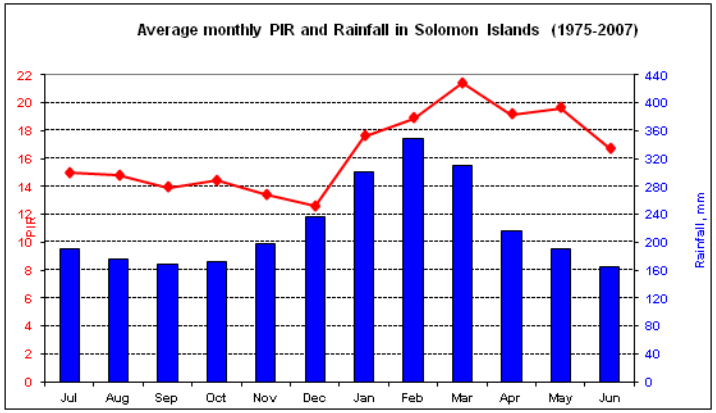
PI-CPP – Engagement with the Health Sector

In the Solomon Islands, malaria is one of the leading causes of morbidity. *Plasmodium falciparum,* the severe and life-threatening parasite, accounts for 60-70% of all confirmed cases.

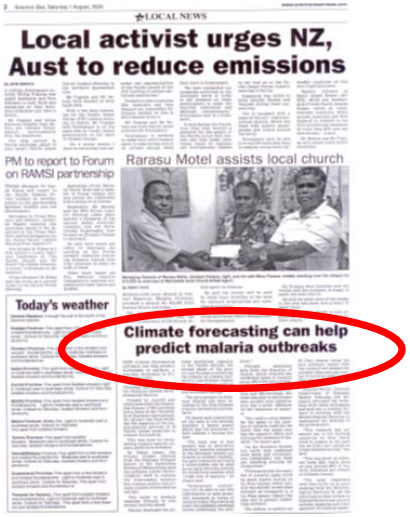
Conducted in collaboration with the Solomon Islands Medical Research Institute and National Metrological Services



Worldwide malarial epidemics tend to occur when environmental conditions such as rainfall, temperature and relative humidity create optimal mosquito breeding environments. Therefore Climate forecasting can provide an early warning to malaria epidemics.



Number of malaria case (PIR) peak during the rainy season


LOCAL NEWS

Local activist urges NZ, Aust to reduce emissions

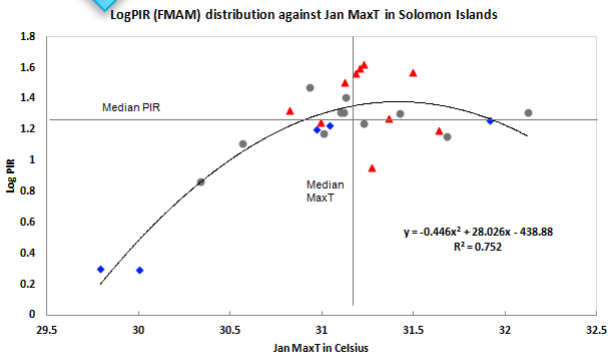
PM to report to Forum on RAMSI partnership

Rarasu Motel assists local church

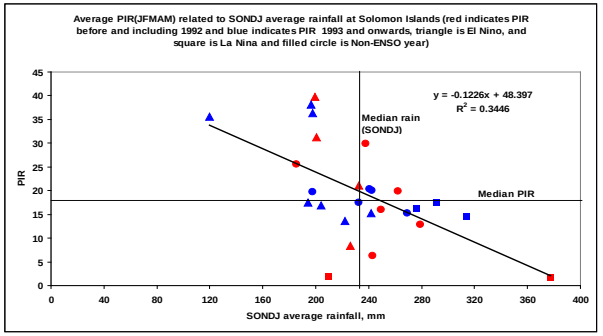
Today's weather

Climate forecasting can help predict malaria outbreaks

Higher temperatures during El Niño increases the risk of malaria



Too much rain (La Niña) tends to suppress the number of malaria cases possibly due to a flushing out of mosquito breeding sites.

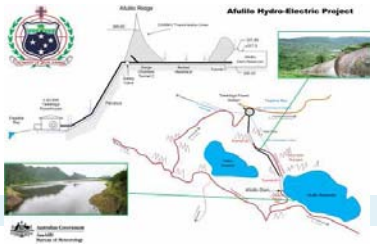


In the Solomon Islands higher cases of malaria occur during El Niño years from higher temperature and "lower" rainfall

Australian Government
Bureau of Meteorology

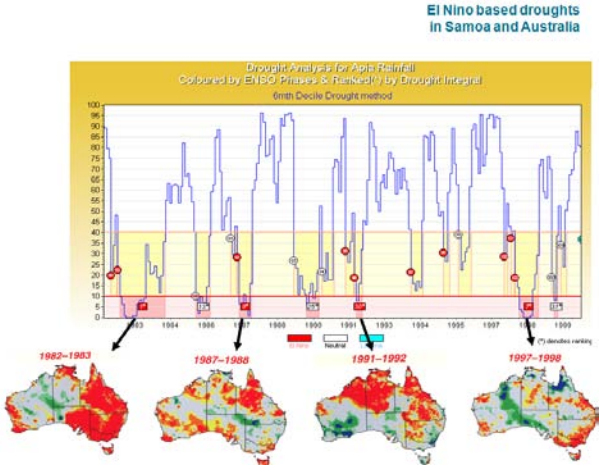
PI-CPP – Engagement with Energy Sector (Samoa)

Conducted in collaboration with Electricity Power Commission and National Meteorological Services in Samoa"

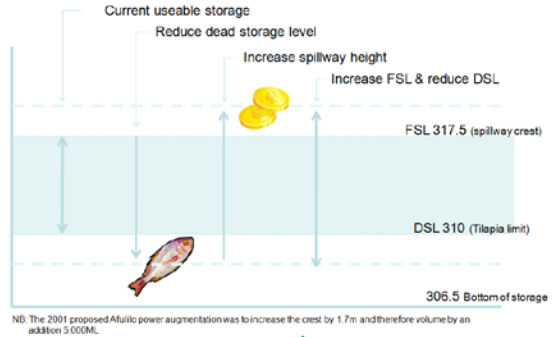


When commissioned in 1992, the Taelefaga hydropower scheme provided 80% of the island's power needs, but with increasing energy demand, about 50% of the demand is now met from more expensive thermal (diesel) sources.

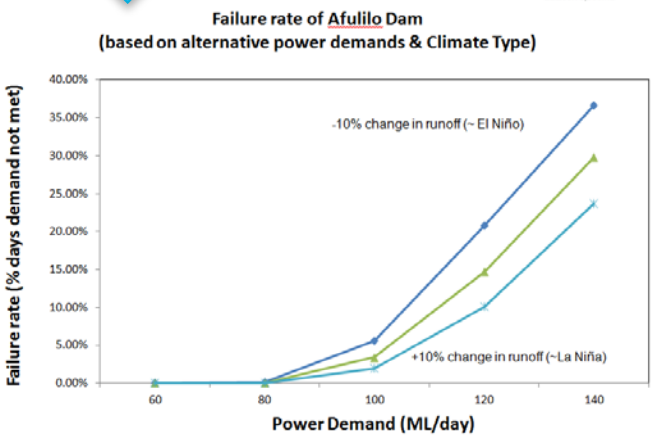
"Reservoirs can mitigate streamflow variability at short timescales, however, inter-seasonal variability and several months of drought create operational challenges for hydropower production."



"Seasonal Climate forecasts can improve the reliability and management of hydropower production especially for smaller capacity reservoirs.



The impact of ENSO on the climate of Samoa is similar to that of Australia with major droughts predicted during El Niño years. Rainfall predictability is high.



Increasing dam height or lowering usable storage level, is a possible solution to reducing "blackouts". However, this comes at a high economic and environmental costs.

Australian Government
Bureau of Meteorology

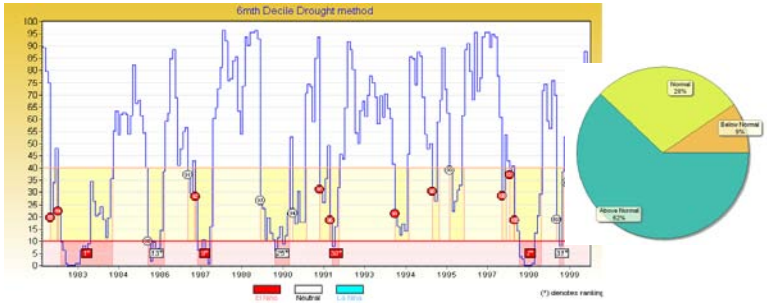
PI-CPP – Engagement with the Agriculture Sector

Coffee plantation , PNG

Many Pacific Island countries rely on subsistence farming and as such are most vulnerable to the impacts of climate variability and climate extremes (floods and droughts).

Sweet Potato in PNG provides more than 70% of nutritional requirement of the population. In extreme dry or wet years, yield can be adversely impacted either by the weather itself or by the outbreaks of crop-disease linked to the weather conditions. With provision of the forecasting and early-warning indicators, individuals, communities and governments can develop appropriate seasonal response strategies to mitigate the harmful impacts of extreme climate events.

Sweet Potatoes, PNG



Sugar Cane, Fiji

Rain at harvest can severely reduce the sugar content of cane (right) and cause damage to coffee beans (left). Rainfall forecast can help reduce this damage through early harvesting.

Australian Government
Bureau of Meteorology

Liz – adjusted Yahya's.. Next 3

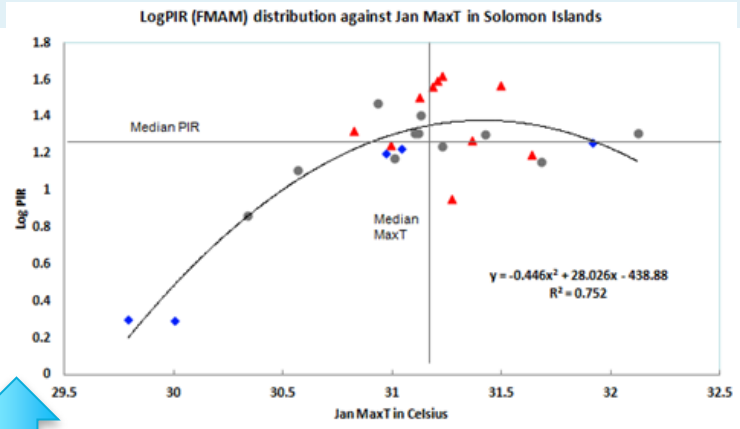
Australian Government
Bureau of Meteorology

PI-CPP – Engagement with the Health Sector in Solomon Islands

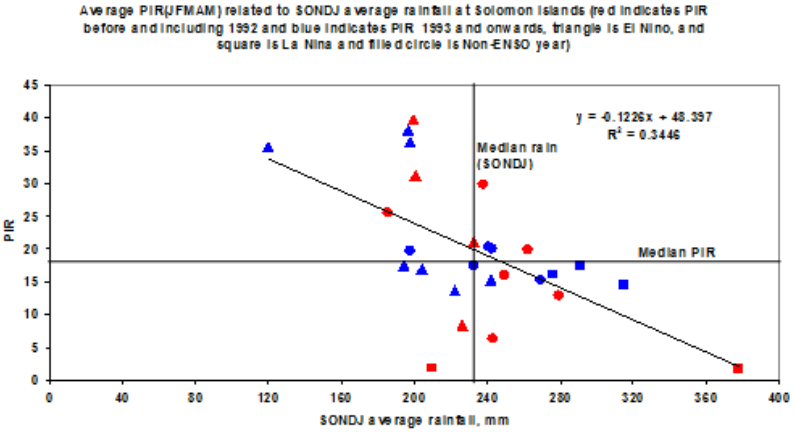
- Conducted in collaboration with the Solomon Islands Medical Research Institute and National Metrological Services
- In the Solomon Islands, malaria is one of the leading causes of morbidity.

PI-CPP – Engagement with the Health Sector in Solomon Islands

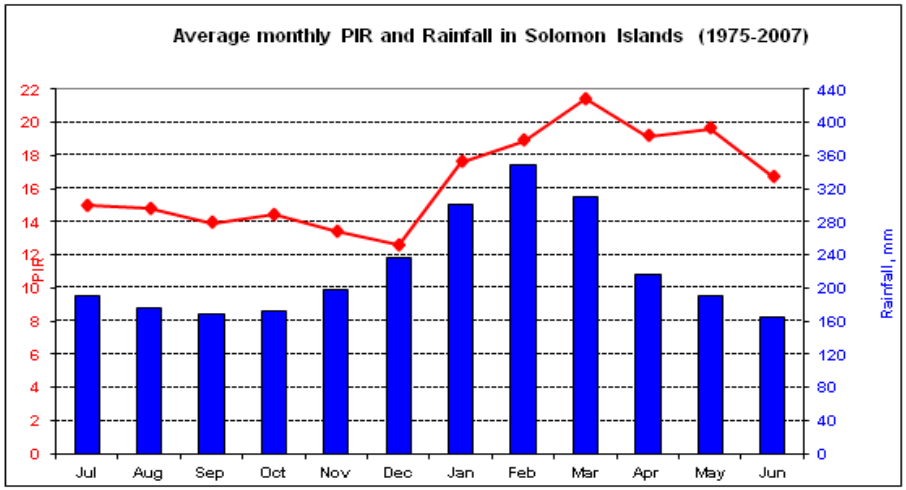
Australian Government
Bureau of Meteorology



Higher temperatures during El Niño increases the risk of malaria



Too much rain (La Niña) tends to suppress the number of malaria cases possibly due to a flushing out of mosquito breeding sites.



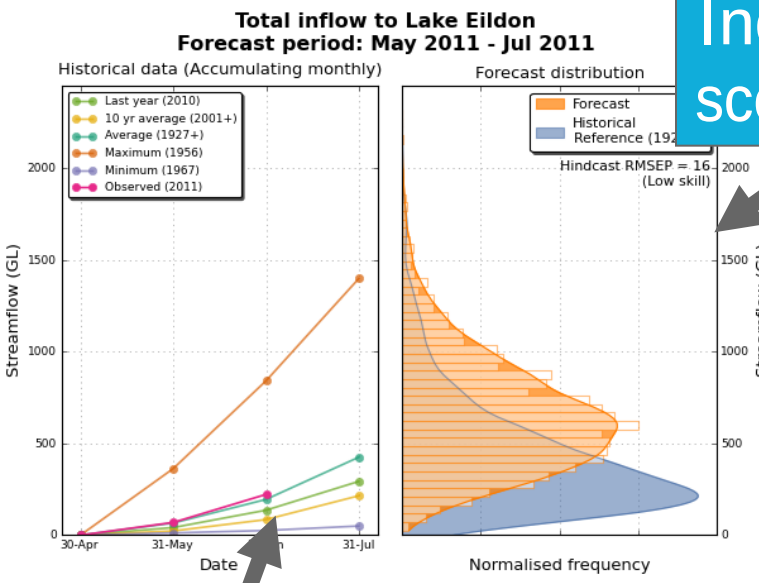
Number of malaria case (PIR) peak during the rainy season

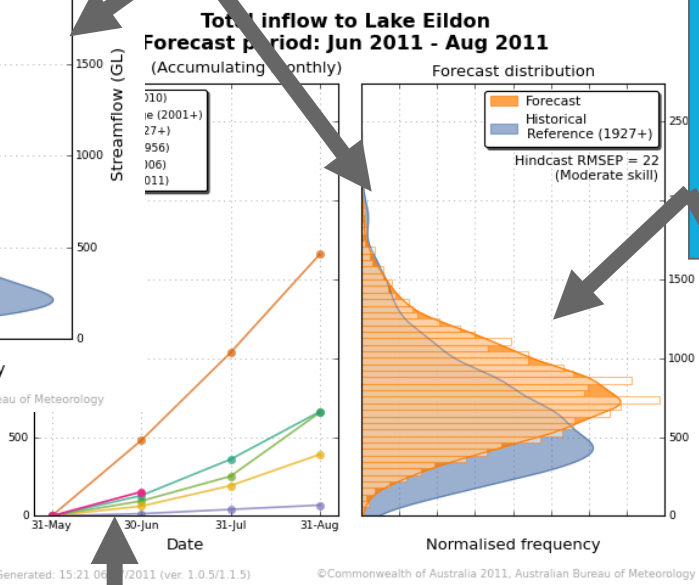
Australian Government
Bureau of Meteorology

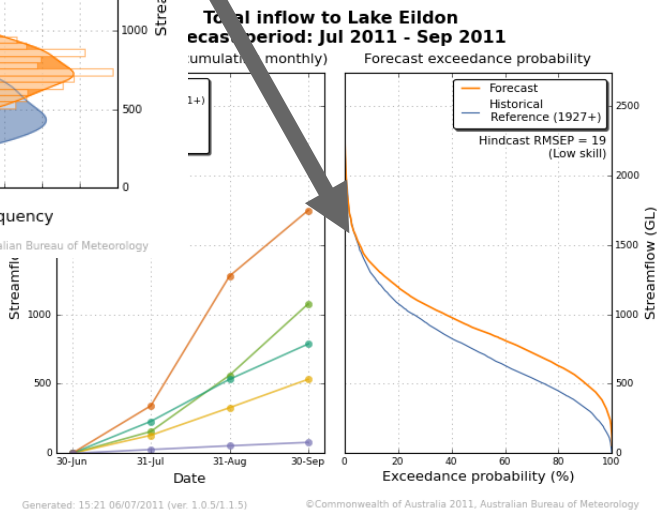
Stakeholder influence – product design

Include skill score

Visually compare forecast and historical probability distributions and exceedance probability curves







Historical analogues give context

Plot latest streamflow for verification

Australian Government
Bureau of Meteorology

PI-CPP – Engagement with the Agricultural Sector in PNG

- Sweet Potato in PNG provides more than 70% of nutritional requirement of the population
- In extreme dry or wet years, yield can be adversely impacted by the weather itself or by the outbreaks of crop-disease linked to weather conditions
- With forecasting and early-warning indicators, individuals, communities and governments can develop appropriate seasonal response strategies to mitigate the harmful impacts of extreme climate events.