Embedding Weather and Climate Services within an Agricultural Risk Management Framework

Holger Meinke

holger.meinke@wur.nl

… and too many colleagues to mention them all here

WAGENINGEN UR
For quality of life

International Symposium on PWS, WMO, Geneva, 4 Dec 2007

Risk Management = the systematic process of identifying, analysing and responding to risk. Strictly speaking, the term is a misnomer in relation to climate risk. With very few exceptions, managers can only respond (adapt) to climatic conditions, they cannot manage (mitigate) the event per se.

Adaptation = ‘responsive adjustment’, the implementation of prevention strategies that reduce the impact of risks associated with climate variability (CV) or climate change (CC).

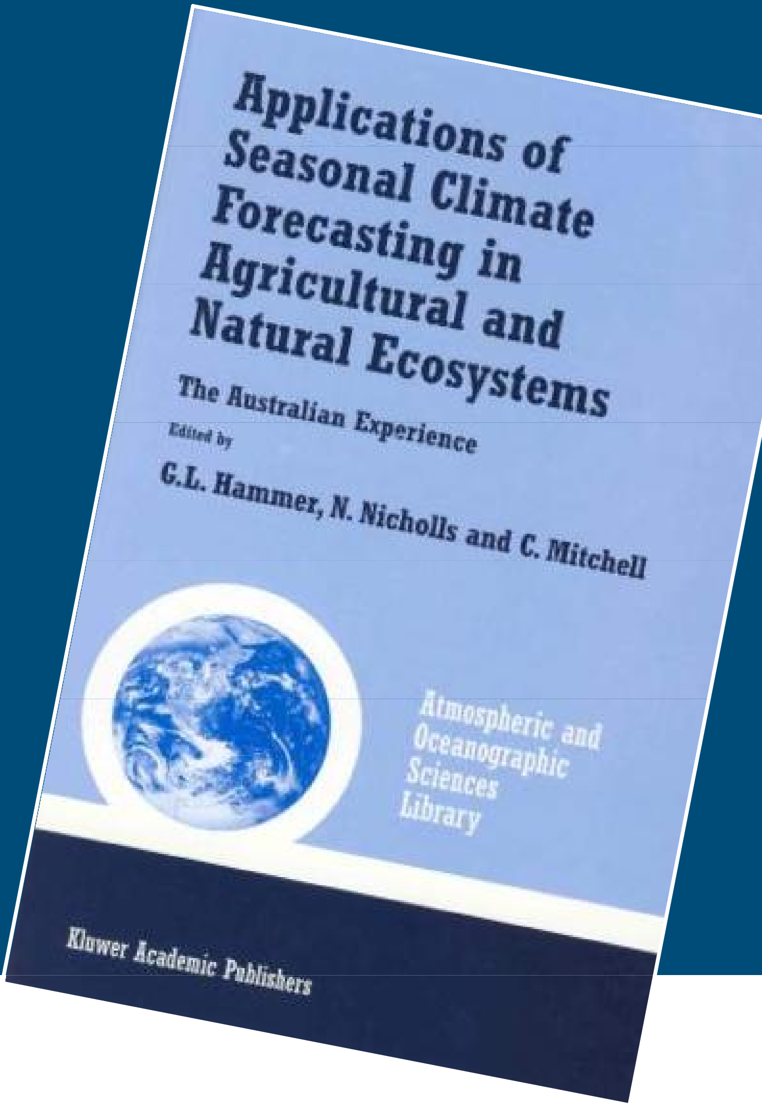
Mitigation = ex-ante reduction of risks themselves, i.e. any action taken to reduce risks before they occur.

Practical Outcomes = individual and societal benefits via improved risk management practices and better targeted policies.

A forecast has no value unless it influences decision making

Summary of collective experiences presented at a conference held in Brisbane, Australia in 1997.

Hammer, G.L., Nicholls, N., Mitchell C., 2000. Applications of seasonal climate forecasting in agriculture and natural ecosystems: The Australian experience. Kluwer Academic Publishers.



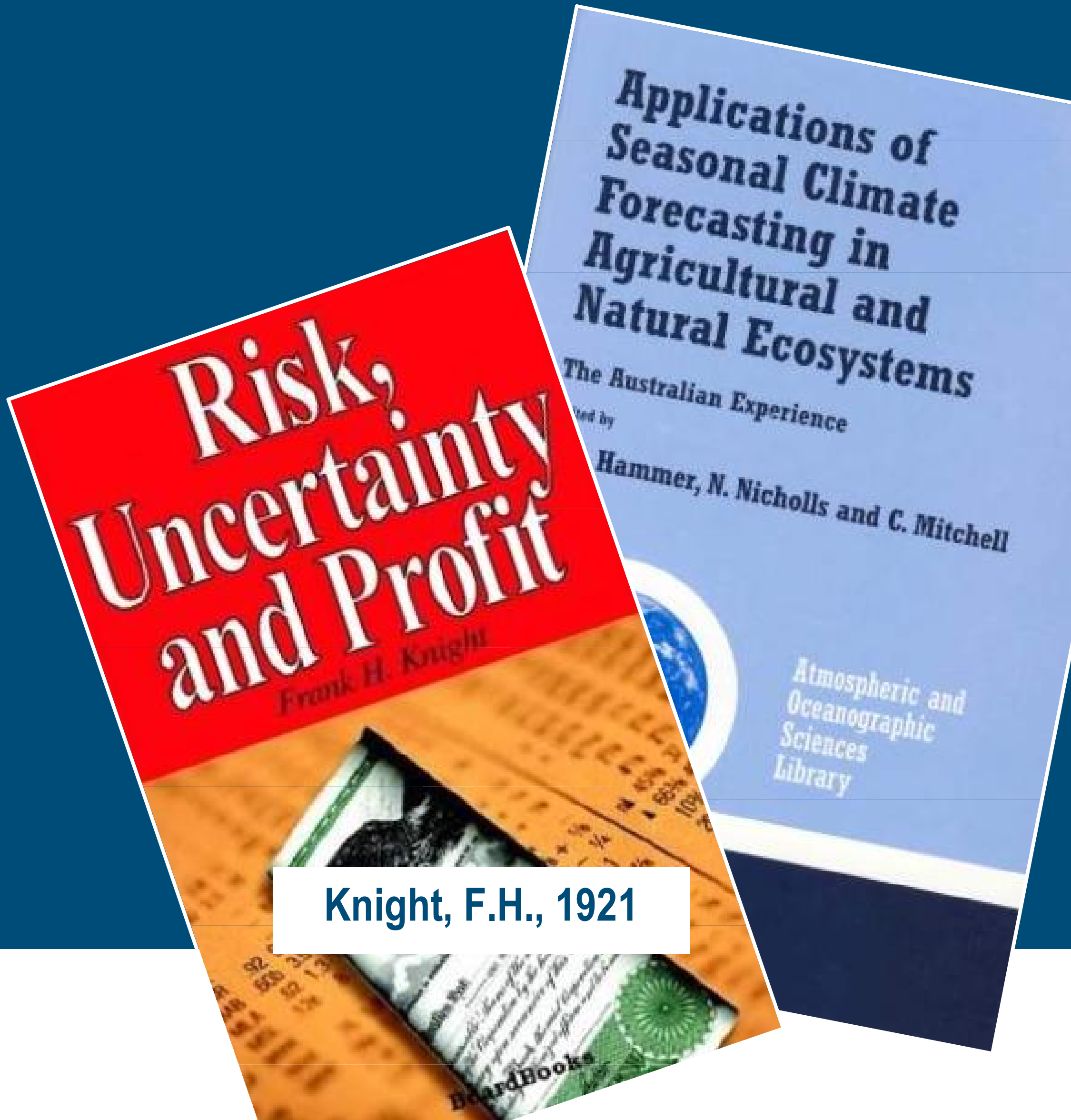
WAGENINGEN UR
For quality of life

A forecast has no value unless it influences decision making

Recently climate scientists have re-discovered risk management as a new concept.

Risk = randomness with knowable probabilities

Uncertainty = randomness with unknowable probabilities



Knight, F.H., 1921

WAGENINGEN UR
For quality of life

Pielke Jr. (2007) on science-based decision making:

… 'Without effective mechanisms to turn advice into options, and options into action, the often heroic efforts of scientists will amount to little more than academic exercises.' …

Pielke Jr. (2007) on science-based policy advice

… 'political conflict magnifies small differences over science as a proxy for political debate, making the management of expertise all the more important to prevent experts simply cancelling each other out.' …

Roger Pielke Jr., 2007. Who has the ear of the president? Nature 450, 347-348.

Risky decisions?

- Risks are largely culturally constructed - generally sufficient facts are unavailable.
- Decisions about risk are essentially decisions about social priorities.
- This means that mostly we get by with crude abstractions shaped by our beliefs.
- Climate knowledge can value-add to this process.

➔ It is more important to get it roughly right than precisely wrong!

Mark Burgman. 2000; Hayman et al., 2007

Different sources of risks

Episodic risks

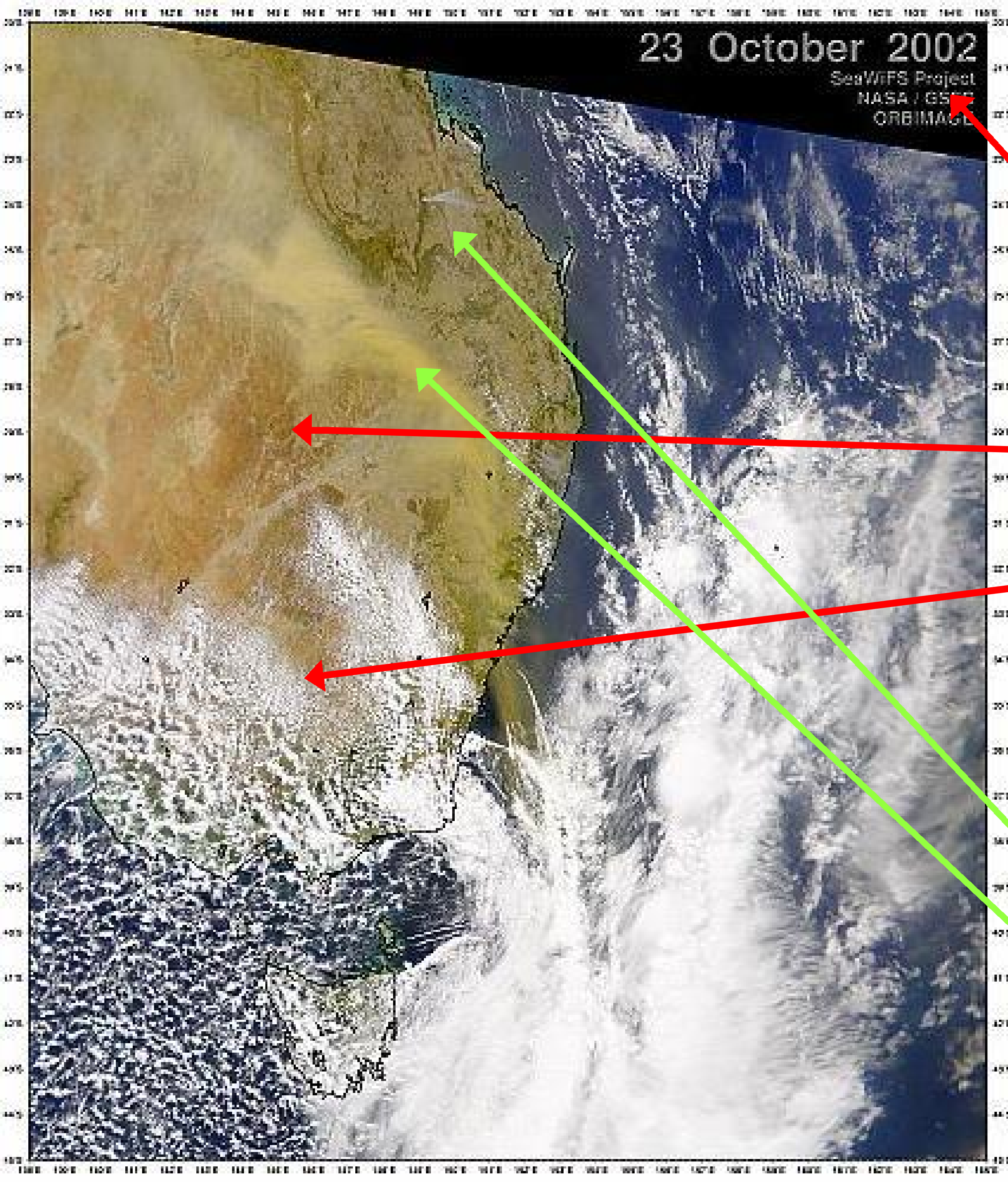
eg earthquakes, floods, storms, accidents, terrorist attacks, wild fires, dust storms:

- Impact very visible and photogenic
- Many straight-forward technological solutions to reduce vulnerability
- Adaptation strategies easier to communicate

Systemic risks

eg drought, climate change, AIDS, deforestation, salinity, desertification:

- Impact emerging over time, symptoms not easily attributable
- Require complex responses to reduce vulnerability
- Multi-faced adaptation strategies, difficult to communicate



Systemic risks

Drought

Desertification

Salinity

Climate Change?

Episodic risks

Bush fire

Dust storm

A Risk Management Framework

Function	Description
Identify	Search for and locate risks before they become problems
Analyse	Transform risk data into decision-making information; evaluate impact, probability, and timeframe, classify risks, and prioritise risks
Plan	Translate risk information into decisions and mitigating actions (both present and future) and implement those actions
Track	Monitor risk indicators and mitigation actions
Control	Correct for deviations from the risk mitigation plans
Communicate	Provide information and feedback internal and external to the project on the risk activities, current risks, and emerging risks;

Different sources of uncertainty

Epistemic Uncertainty

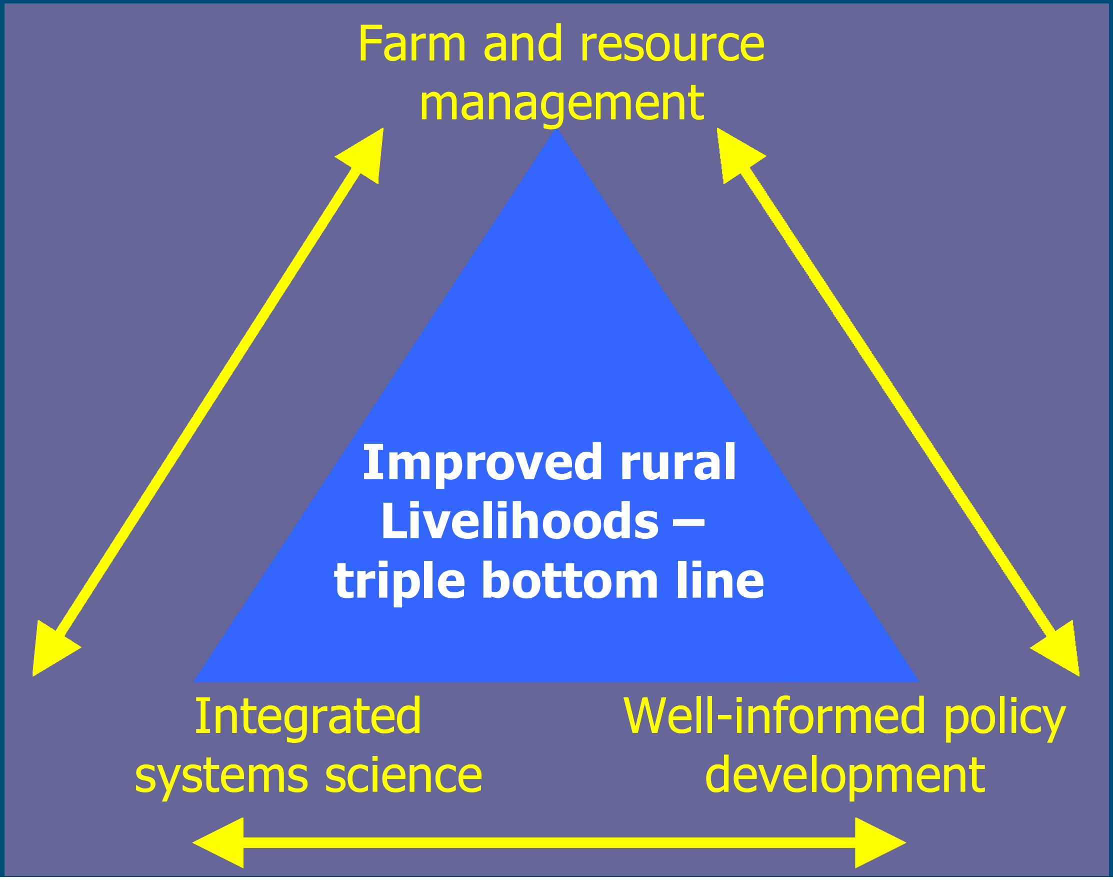
There is a fact of the matter…

- measurement error
- natural variation (individual, population, spatial, temporal)
- model misspecification
- Ignorance

Semantic Uncertainty

- Ambiguity (linguistic uncertainty)
- Vagueness (concepts allow borderline cases)

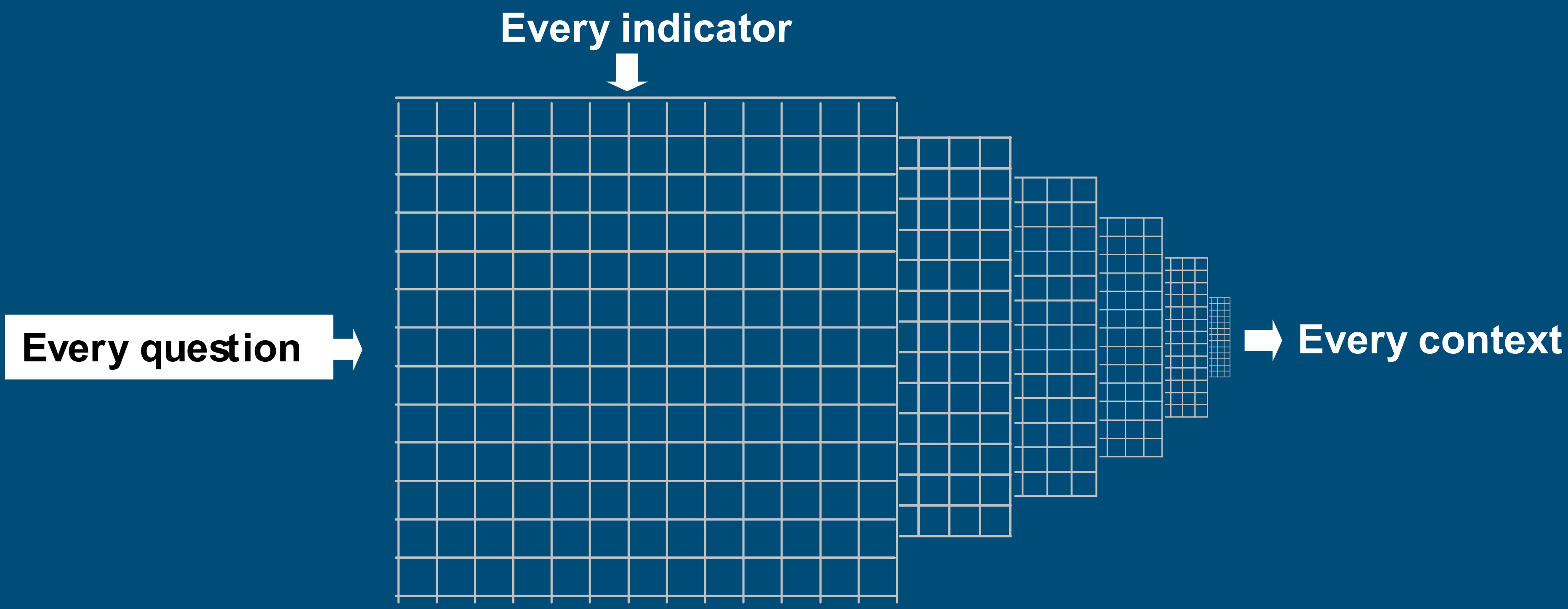
We need to know our clients – usually there are many!



WAGENINGEN UR
For quality of life

Data dump or targeted service provision?

A: The data dump



This leads to a loss of relevance and credibility because it provides users with large amounts of information over which they have no control ➔ 'the science relevance gap'

Rohan Nelson, pers com

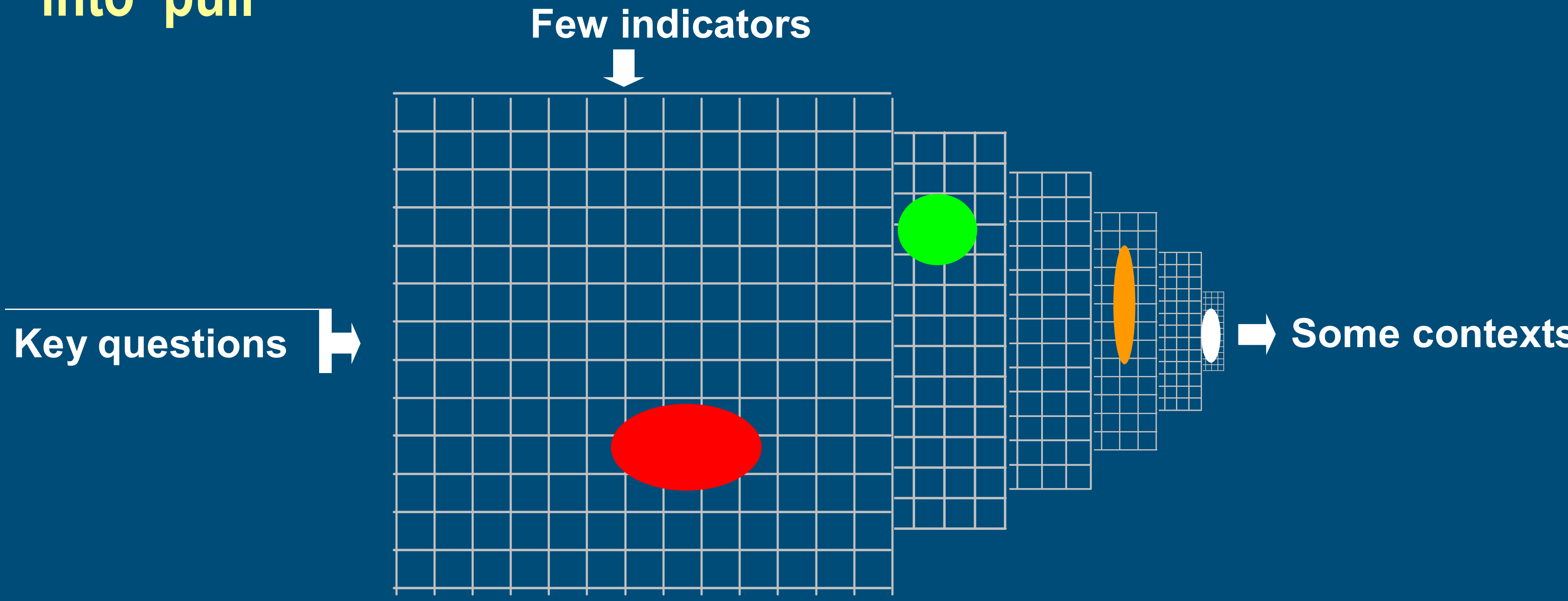
Where do data dumps come from?

- Self interest of scientists
  - *positivism* : collecting data is important for itself (“have I got a method for you”)
  - *reductionism*: measure because we can (“and btw I need lots of money to employ more scientists”)
- Lack of conceptual framework
  - we have no idea, so collect ‘just in case’
- Misunderstanding of participatory engagement
  - collect ‘to keep everybody happy’
- Decision makers surrendering responsibility
  - don’t know what to collect so collect whatever scientists tell us

Rohan Nelson, pers com

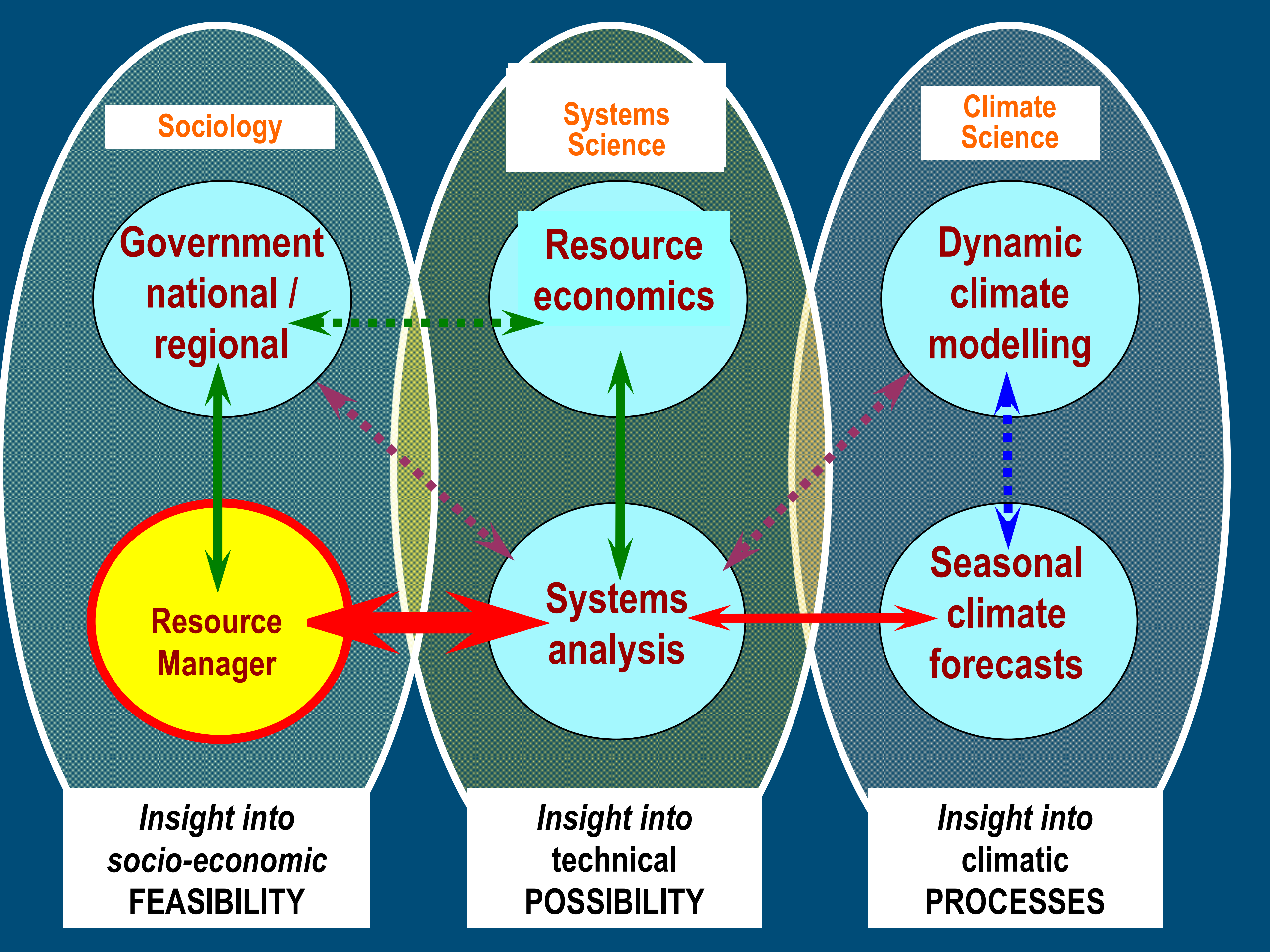
Data dump or targeted service provision?

B: Efficient and effective data collection – turning 'push' into 'pull'



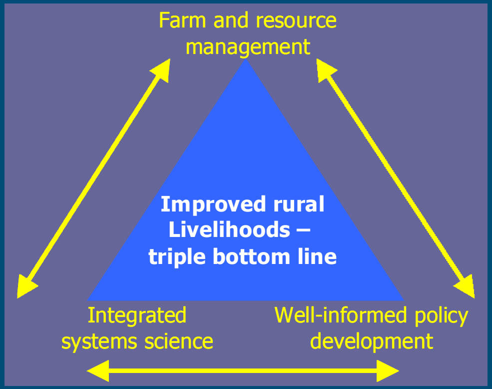
Or – as we heard yesterday: event driven, info oriented, interactive and collaborative

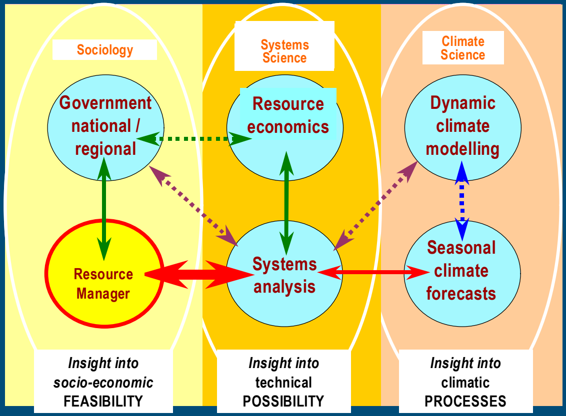
Rohan Nelson, pers com



Sociology
Systems Science
Climate Science
Government national / regional
Resource economics
Dynamic climate modelling
Resource Manager
Systems analysis
Seasonal climate forecasts
Insight into socio-economic FEASIBILITY
Insight into technical POSSIBILITY
Insight into climatic PROCESSES

Linking Research to Practical Outcomes – Essential Requirements





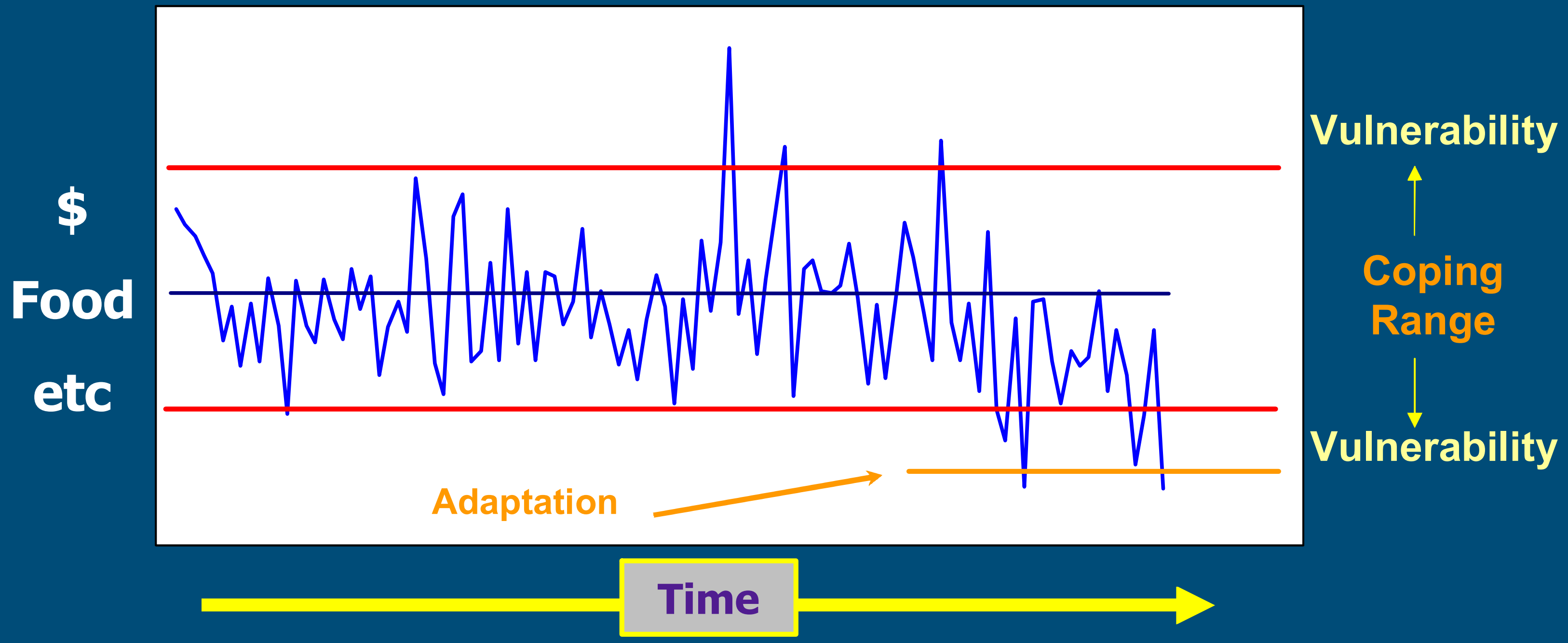
Effective risk management requires

'optimism of the will and pessimism of the intellect'

systems analysis can provide quantitative information about which way to lean.

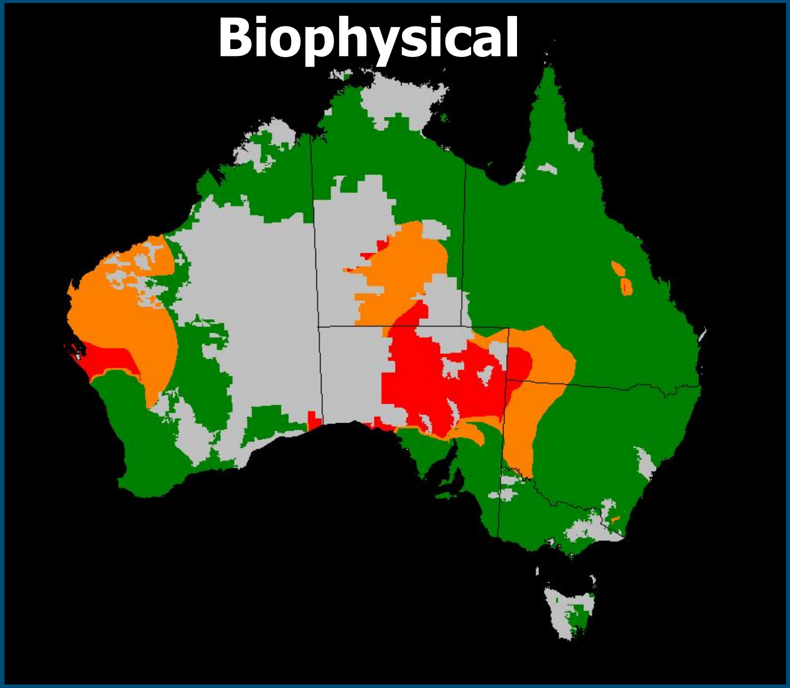
Outcome focused systems research is not rocket science – it is a lot harder!

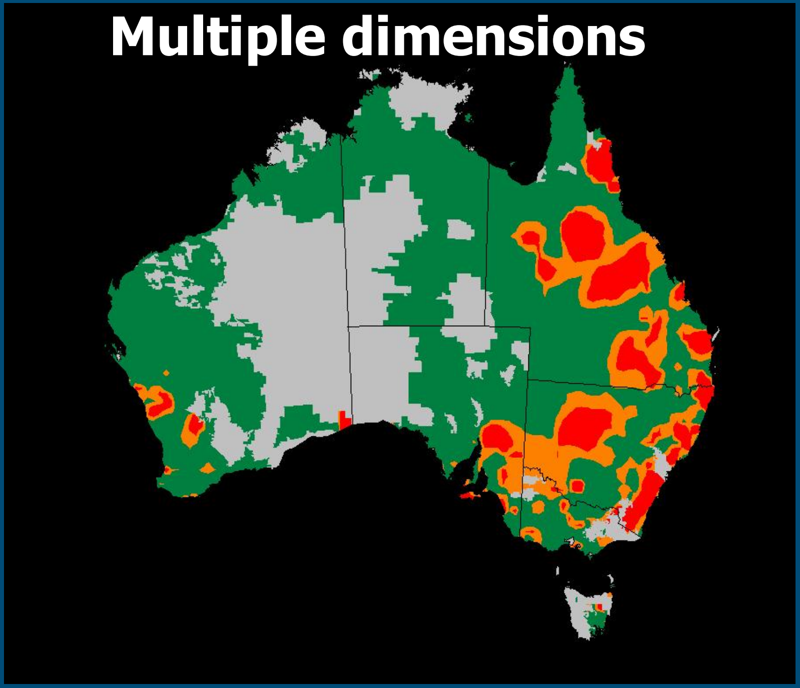
Risk exposure, vulnerability and adaptation



- A continuation of current climate trends (rainfall, max temperature) may result greater enterprise vulnerability.
- Given the difficulties in ensuring appropriate levels of adaptation, planning is required well ahead of these changes.

Vulnerability of Australian agriculture: Exposure vs Coping Capacity





- 10% (most extreme)
- 10 to 25% (extreme)
- below 25% (least extreme)

Meinke et al., 2006. Climate Research, 33: 101-110.

Three essential elements for user-relevant science

1) Salience

The perceived **relevance** of information

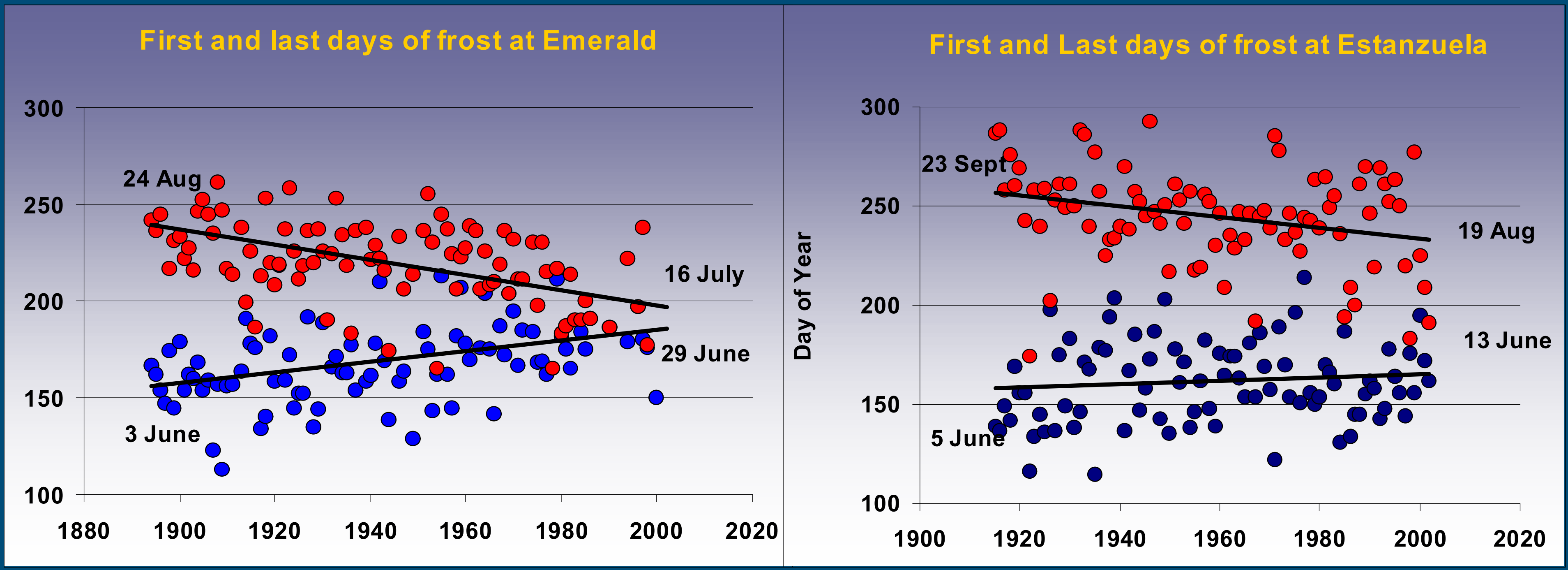
- Does the system provide information that decision makers need, in a form and at a time that they can use?
- For example, farmers need to know something about the environmental and economic impact of management options, as opposed to average expected rainfall over a season.

WAGENINGEN UR For quality of life

Meinke et al., 2006. Climate Research, 33: 101-110.

Three essential elements for user-relevant science

1) Salience



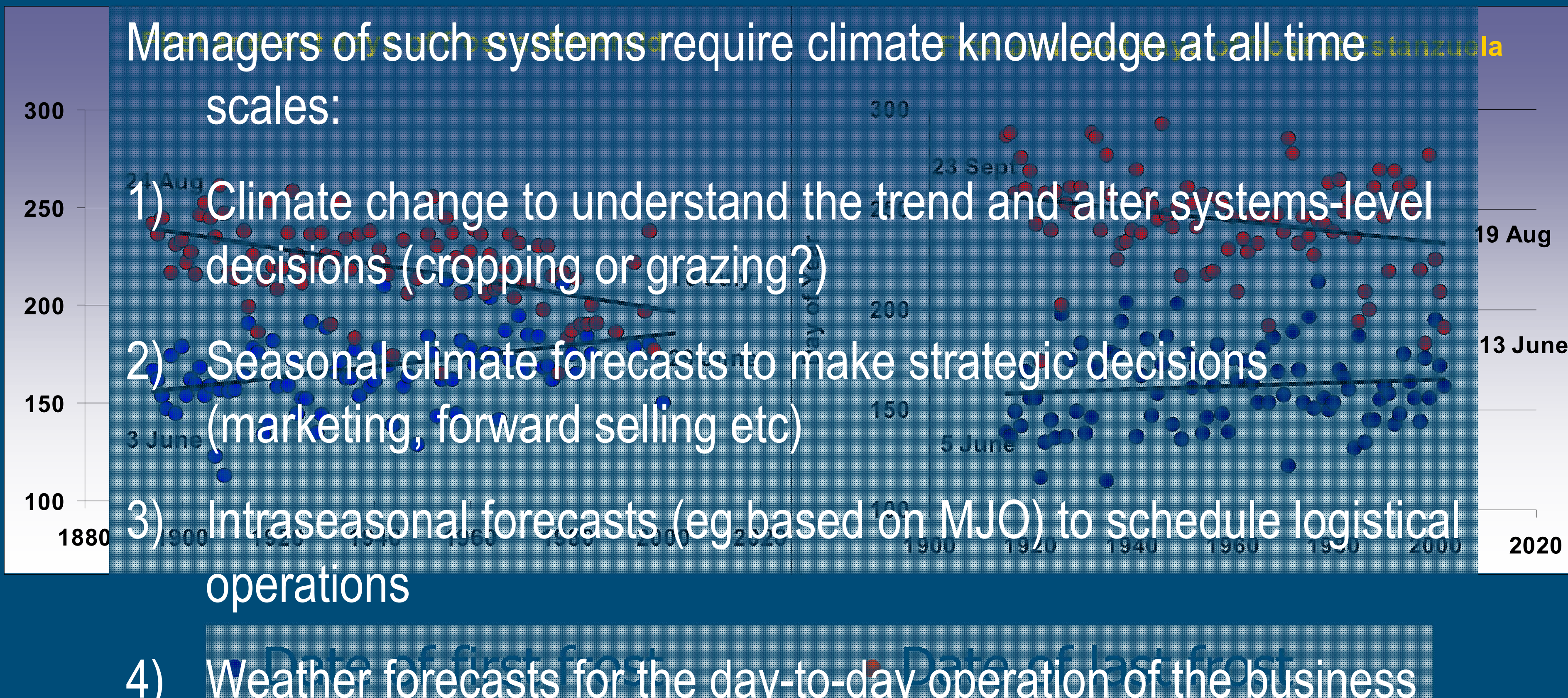
- Date of first frost
- Date of last frost

WAGENINGEN UR
For quality of life

Meinke et al., 2006. Climate Research, 33: 101-110.

Three essential elements for user-relevant science

1) Salience



Managers of such systems require climate knowledge at all time scales:

1) Climate change to understand the trend and alter systems-level decisions (cropping or grazing?)
2) Seasonal climate forecasts to make strategic decisions (marketing, forward selling etc)
3) Intraseasonal forecasts (eg based on MJO) to schedule logistical operations
4) Weather forecasts for the day-to-day operation of the business

Meinke et al., 2006. Climate Research, 33: 101-110.

WAGENINGEN UR
For quality of life

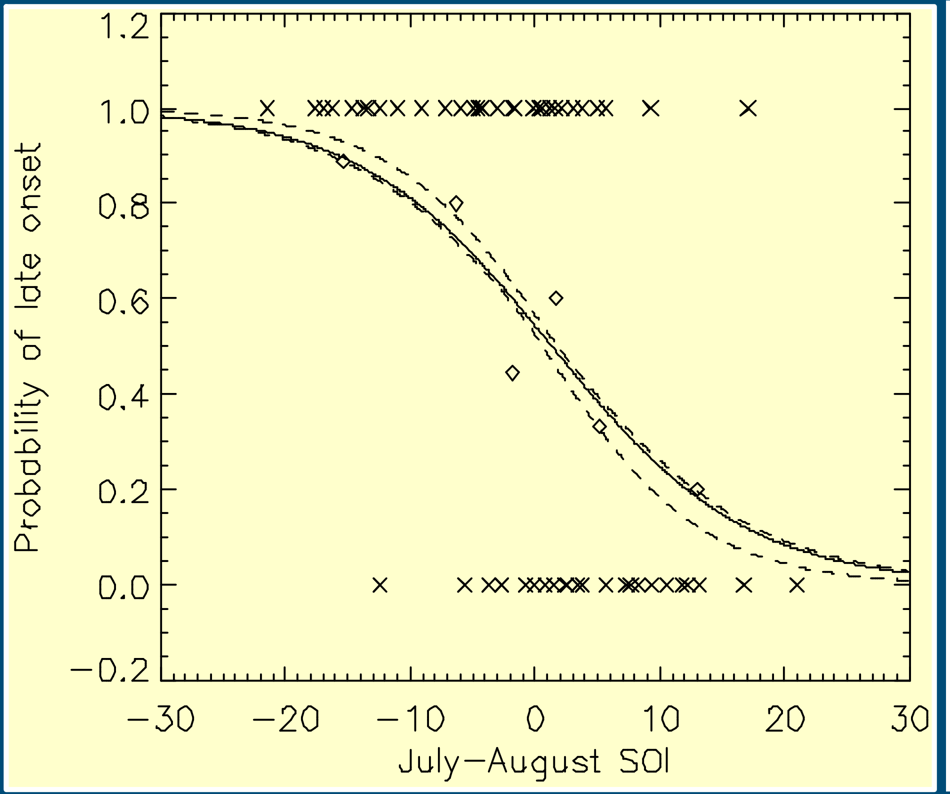
Three essential elements for user-relevant science

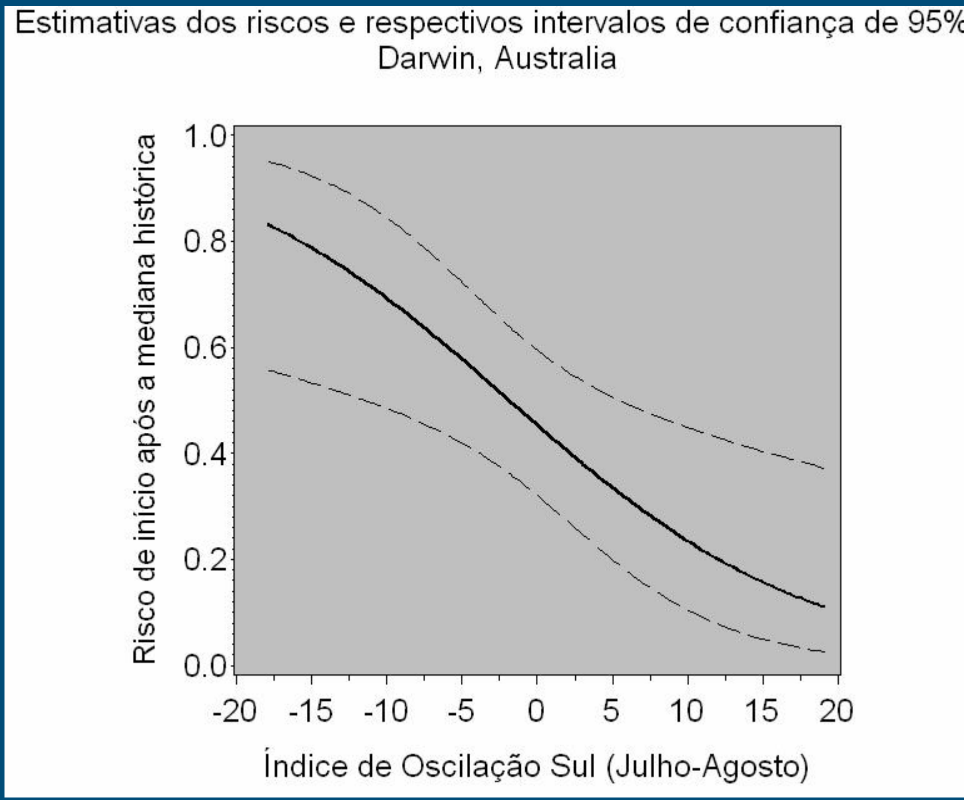
2) Credibility

The perceived **technical quality** of information

- Does the system provide information that is perceived to be valid, accurate and tested?
- Do other scientists agree with underlying assumptions of a model?
- Does ground-truthing of the approach confirm the general findings?
- Has the team a track record of successful delivery?

Meinke et al., 2006. Climate Research, 33: 101-110.



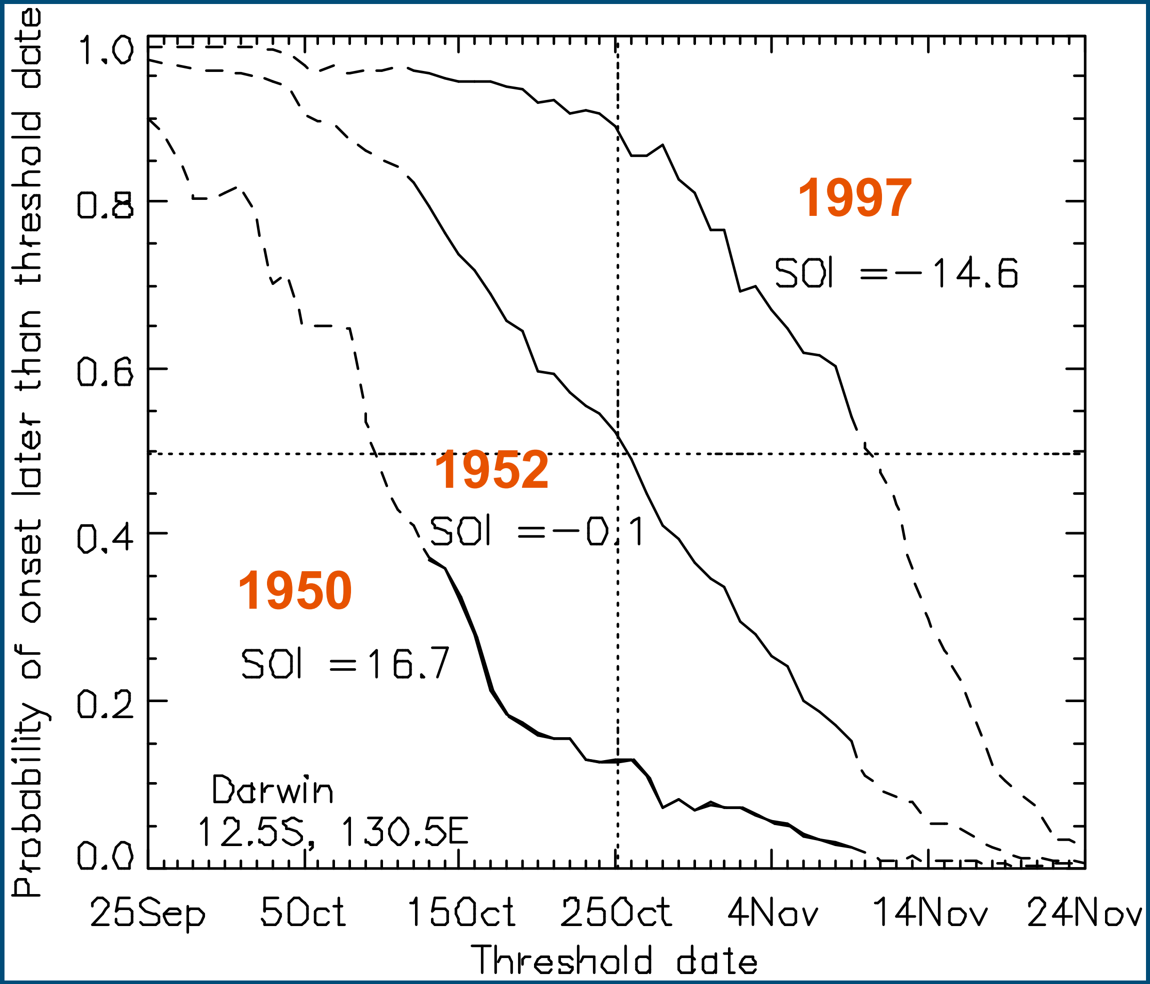


Providing confidence limits based on proportional hazards models (Cox, 1972). These models are widely used in medical analyses of survival data that examine the effect of explanatory variables on survival times. This allows the ranking of risk factors and quantitative assessments of their impacts. These methods are well established in medical research and used routinely for risk assessment in medical studies. Although highly relevant, they are rarely used in climatological research.

Confidence limits courtesy of Dr Aline Maia, Embrapa (unpublished)

Lo et al., 2007. Monthly Weather Review, 135, 3506-3520.

Cox, D.R., 1972. J. of the Royal Statistical Soc., Series B, 34, 187–220.



Probability of exceedance derived from the cross-validated hindcasts, for Darwin (12.5°S, 130.5°E) and for 3 different SOI years. Dashed lines are plotted when the model is developed with fewer than 10 observations of either a late of early onset, and thus represent where there is a higher level of uncertainty in the forecast. The mean onset date at this location is 25 October.

WAGENINGEN UR
For quality of life

Lo et al., 2007. Monthly Weather Review, 135, 3506-3520.

Three essential elements for user-relevant science

3) Legitimacy

The acceptance that **the system is fair** and not simply a vehicle for pushing agendas and interests of others

- Concerns about process or the peer group that the scientist belongs to such as
- Who is involved in producing the knowledge?
- How were those involved selected?
- When and how are stakeholders engaged?
- How are R&D agendas set?

WAGENINGEN UR
For quality of life

Meinke et al., 2006. Climate Research, 33: 101-110.

The limits of our present knowledge mean that scientific knowledge could be described as islands of understanding in oceans of ignorance (Lowe, 2002).

Politicians will have to accept that fuzzy answers may be the best expression of expertise; scientists will have to learn that the identification of the fuzzy borderline between knowledge and ignorance may be the sign of real competence (Walker and Marchau, 2003).

Although we cannot predict the future, science can equip us to prepare for it (alternative futures).

Biggest Challenges

- Science has a tendency to focus on the simple rather than the complex
- Complex, non-linear and stochastically forced systems are interacting across scales
- Discipline rather than outcome focus leading to ‘silo mentality’
- CC / CV / Weather - lack of research coordination and integration of service provision
- We need to communicate our knowledge as well as our ignorance
- Be prepared for success. Avoid disillusionment or frustration - have systems in place that can handle the demand you create

Complex systems resulting in intractability of cause and effect can be perceived as devaluing scientific input. We can avoid this by remembering the 3 pillars needed for successful applications:

Salience

Provide information that people need

Credibility

Tell people what we know AND what we don't know

Legitimacy

Avoid advocacy, be transparent and fair

References – for further details please contact holger.meinke@wur.nl

- Burgman, M, 2000. www.botany.unimelb.edu.au/envisci/about/staff/burgman.html#research
- Cash, D., Buizer, J., 2005. Knowledge–action systems for seasonal to interannual climate forecasting: summary of a workshop, report to the Roundtable on Science and Technology for Sustainability, Policy and Global Affairs. The National Academies Press, Washington, D.C. http://books.nap.edu/catalog/11204.html.
- Cox, D.R., 1972. Regression Models and Life-Tables (with Discussion), Journal of the Royal Statistical Society, Series B, 34, 187–220.
- Hammer, G.L., Nicholls, N., Mitchell, C. (eds), 2000. Applications of seasonal climate forecasting in agricultural and natural ecosystems: the Australian experience. Kluwer, Dordrecht.
- Hayman, P., pers. com. hayman.peter@saugov.sa.gov.au
- Hayman, P., Crean, J., Mullen, J. and Parton, K., 2007. How do probabilistic seasonal climate forecasts compare with other innovations that Australian farmers are encouraged to adopt? Aust. J. Agric. Res., 58, 975-984.
- Lo, F., Wheeler, M.C., Meinke, H. and Donald, A., 2007. Probabilistic forecasts of the onset of the North Australian wet season. Monthly Weather Review, 135, 3506-3520.Cox, D.R., 1972. J. of the Royal Statistical Soc., Series B, 34, 187–220.
- Lowe, I., 2002. The Need for Environment Literacy, www.staff.vu.edu.au/alnarc/onlineforum/AL_pap_lowe.htm.
- Maia, A., pers. com., aline.maia@cnpat.embrapa.br
- Maia, A.H.N., Meinke, H., Lennox, S. and Stone, R.C., 2007. Inferential, non-parametric statistics to assess quality of probabilistic forecast systems. Monthly Weather Review, 135, 351-362.
- Meinke, H. and Stone, R.C., 2005. Seasonal and inter-annual climate forecasting: the new tool for increasing preparedness to climate variability and change in agricultural planning and operations. Climatic Change, 70: 221-253.
- Meinke, H., Howden, M. and Nelson, R., 2006. Integrated assessments of climate variability and change for Australian agriculture – connecting the islands of knowledge. 3rd Biennial meeting of the International Environmental Modelling and Software Society, 9-12 July 2006, Burlington, Vermont, USA.
- Meinke, H., Nelson, R., Kokic, P., Stone, R., Selvaraju, R. and Baethgen, W., 2006. Actionable climate knowledge – from analysis to synthesis. Climate Research, 33: 101-110. Open access at http://www.int-res.com/articles/cr_oa/c033p101.pdf
- Meinke, H., Sivakumar, M.V.K., Motha, R.P. and Nelson, R., 2007. Climate predictions for better agricultural risk management. Aust. J. Agric. Res., 58, 935-938.
- Motha, R., 2007. Development of an agricultural weather policy. Agric. For. Meteorol., 142, 303-313.
- Nelson, R., pers. com. rohan.nelson@csiro.au
- Nelson, R., Kokic, P. and Meinke, H., 2007. From rainfall to farm incomes - transforming advice for Australian drought policy. Part II: Forecasting farm incomes. Aust. J. Agric. Res., 58, 1004-1012.
- Pielke, R. Jr., 2007. Who has the ear of the president? Nature 450, 347-348.
- Potgieter, A., pers. com., Andries.potgieter@dpi.qld.gov.au
- Walker, W.E. and Marchau, V.A.W.J., Dealing with uncertainty in policy analysis and policymaking, Integrated Assessment, 4, 1-4, 2003.

WAGENINGEN UR
For quality of life