Research Strategy

1. Introduction

The objectives of the Centre are outlined in the funding agreement with the Commonwealth Government. They are to:

1. research and develop state-of-the-art risk analysis methods across areas of interest to the Australian community. An early priority for the Centre will be the biosecurity risks confronting Australia;
2. engage the range of skills and sciences relevant to the analysis of risk, to ensure that Australia remains at the forefront of practical risk assessment. These skills and sciences would include mathematics, statistics, biophysical sciences, socio-economics and the sciences relevant to the communication and perception of and response to risk;
3. document and communicate research findings to ensure people in government and the wider community engaged in risk analysis have access to state-of-the-art risk analysis methods, and to raise the community's understanding of risk.
4. work to promote excellence in risk analysis in Australia; and
5. work with government in influencing international standards in risk analysis.

Given the Centre's priority for biosecurity risk, this outline deals mainly with the biosecurity context, although many techniques are relevant to other areas of risk management. In its Business and Work Plans, ACERA undertook to promote excellence in:

1. *Biosecurity framework development*: improved methods for hazard identification and emergency response that reduce the chances that important exposure pathways will be overlooked, and that response systems will operate effectively even under extreme conditions.

2. *Elicitation*: Innovations that reduce or eliminate arbitrary bias and imprecision in expert assessments of parameters and structures used in risk assessments.

3. *Risk analysis*: Improved transparency and repeatability of qualitative risk analyses through the use of formal, structured approaches to problem solving.

4. *Monitoring and surveillance*: More efficient and reliable systems and guidelines for their implementation that employ new developments in spatial statistics, statistical process control and surveillance optimisation.

5. *Communications and decision making*: Improved trust and community acceptance of risk analysis through the development, testing and verification of guidelines to engage stakeholders, communicate probabilities and achieve consensus among expert and stakeholder groups.

The purpose of this paper is to provide a broad overview of the risk domain and ACERA's place in it, with a particular focus on biosecurity risk. It will outline the theoretical and pragmatic motivations that support the choice of strategic themes.

2. Context for ACERA's research

Risk assessments support decisions. The risk analyst's job is to evaluate and communicate expected outcomes together with the nature and extent of uncertainty. Epidemiologists, toxicologists, engineers, ecologists, geologists, chemists, sociologists, economists, foresters, biosecurity analysts and many others conduct risk assessments routinely. The assumptions, methods for data collection, models, use of experts, and so on differ from group to group. In many instances, there is no substantive reason for different disciplines to perform risk assessments differently. Conventions arise in response to the timing of the development of risk analyses, international (legally binding) standards, the kinds of problems that present themselves, and the social context in which solutions are sought. Analysts often select methods for their convenience or familiarity. ACERA is motivated by the philosophy that, as far as possible, choices should be determined by data, questions, and analytical needs rather than by convention.

Many risk assessments are set in socially charged contexts. People stand to gain or lose substantially. Arguments are clouded by imprecise language. Prejudice and motivational biases may get in the way of constructive discussion. Decision-makers and stakeholders may be perceived to manipulate uncertainty strategically to achieve social, personal and organizational goals. ACERA's role is to develop tools and guidelines that can be used to deliver objective and transparent outcomes that will be effective in realistic operating environments.

The research will be conducted largely in Australian research institutions and public universities. There is a need to identify knowledge gaps, develop tools and create examples that are clearly relevant to biosecurity and related applications and that are sensitive to political and social realities. It is an important element of ACERA's role to assist research leaders to find and maintain an appropriate focus for their work, so that results are useful. The measure of ultimate success of ACERA's activities will be the extent to which they are adopted by government agencies at all levels, in conducting risk analyses.

3. Biosecurity framework development

ACERA is devoted, in the first instance, to developing tools, methods and guidelines for biosecurity risk analysis. Biosecurity is broadly interpreted to

include pre-border, border and post-border contexts. Thus, methodological development will be broad, and will include tools relevant to import risk assessment, detection, surveillance, prediction of invasion dynamics, spatial spread of pests, pathogens and diseases, uncertainty analysis in pathway and exposure analysis, and so on.

Biosecurity risk analysis has several unique features. The social environment often is contentious, even compared to other substantial and divisive debates about resource allocation and public policy. Many hazards are novel and decisions need to be made, sometimes with seemingly little or no direct means of measurement as to outcome. There are few or no data on failure rates or trends in processes because the public context demands a failure-free system, or at least, one in which failures are sufficiently rare that there are insufficient data to estimate parameters and detect trends or patterns. There are dangers in the application of tools that imply false precision or that demand data and understanding that are simply unavailable. The promise of technical innovation in risk analysis may create prospects for change that are not warranted by ultimate performance. Thus, developments will need to be inventive, perhaps broaching new domains in risk analysis or borrowing from disciplines that likewise demand very low failure rates (such as nuclear risk and terrorist management). The development of research plans should be predicated on a sound understanding of the limitations on risk analysis for biosecurity in Australia.

4. Elicitation

For many reasons, including those identified above, biosecurity risk analysis in all its contexts (pre-border, border and post-border, for both plants and animals) relies heavily on expert judgement. This circumstance is likely to remain for the foreseeable future, making it important to develop and evaluate innovations that reduce or eliminate the perception of arbitrary bias and imprecision in expert assessments of parameters and biological processes. Surprisingly little research has been done globally on structured, repeatable elicitation protocols, despite the widespread use of expert judgement in many disciplines. ACERA will devote major research projects to reviewing, collating, evaluating, developing and testing methods for eliciting parameter values and ideas about system function from experts, so that they are robust to sources of error, including framing, anchoring, motivational bias and visibility of data. It will explore behavioural and numerical methods for aggregating expert opinions, so that judgements can be consolidated transparently and repeatably.

5. Risk analysis tools

In technical arenas, developments in risk analysis focus primarily on numerical innovations. This can sometimes create an impression that quantitative risk analysis is captured by mathematicians and statisticians, divorced from the contexts, realities and limitations of real applications. Policy makers are obliged to consider all potential sources of uncertainty, including those not examined formally by risk analysts. In many circumstances, risks compete with one another

for attention. Some may be political or intangible. Some may affect policy makers personally. The newsworthiness of an event is important. Risk, costs and benefits are uncertain. Communication can be vague and ambiguous, even when measurable risks are thought to exist and best efforts are made to explain them. Decision options that reduce catastrophic possibilities are sometimes upgraded because of public perceptions and potential outrage.

ACERA will devote itself to developing risk analysis tools and methods that are robust taking into context available data, scientific understanding and technical capabilities. For instance, development, testing and application of risk analyses will be improved through the use of formal, structured approaches to qualitative risk analysis and modifications that make subjective procedures more robust.

It can be difficult to dissent from the predictions of a model, particularly if the modeler is part of a scientific discipline and the model's assumptions are either inaccessible or not totally revealed. ACERA takes the view that analysts are translators of ideas and perceptions. Successful implementation of risk analysis, then, relies on tools that diffuse the imprint of the analyst, counteract the possible or perceived prejudices of expert participants, and provide opportunities to employ methods appropriate for the kinds and quality of data at hand.

6. Communications, decision making and acceptable risk.

The most common frustration expressed by people involved in the broad spectrum of biosecurity risk in Australia relates to the different levels of understanding that exists and which thus affects the context of perceived risk between analysts, decision-makers and the broader community. ACERA will work on methods to support improved transparency and communication of process to assist to improve trust in and community acceptance of risk analysis outcomes. It will develop, test and verify guidelines to engage stakeholders, communicate analyses and achieve consensus decisions among experts.

Policy makers have to deal with advice from different risk analysts about the nature of risk and how best to deal with it. Risk analysis can be seen to have suffered from a naïve view of social context, believing that numerical sophistication and technical merit alone are sufficient to result in rational decisions. For example, Peter Sandman commented *'the essence of … risk for companies is the hazard itself, which they define in technical terms, where you multiply the magnitude of the hazard by the frequency of the problem… For the public, risk is not a technical phenomenon at all. It is influenced by factors like fairness, trust and who has control.'*

Decision-makers may involve stakeholders for several reasons including, to ensure public support and acceptance, because stakeholders are an appropriate source of value judgements, because they possess important factual knowledge, such as consumption patterns or responses to management, or because there is a legal obligation to do so. Engagement strategies may intend to gain information from stakeholders, give information to them, achieve a consensus or move them

to a pre-determined, preferred position. ACERA's philosophy will be that the objectives should determine the engagement strategy.

There is no general standard for acceptable risk. Time and experience lead to public acceptance of standards. Such standards cannot be identified in all technical and social circumstances. Acceptability is a social quality. It will always be influenced by context, visibility, transparency, trust and equitability.

Perhaps the most important challenge facing ACERA is to develop approaches to risk analysis that work effectively in real, social contexts. In the past, solutions have been sought among strategies for communication and the psychology of risk perception. There are substantial hurdles to overcome in these areas. More recently, social context, participation and community and stakeholder trust have emerged as important drivers. The technical tools for analyzing and communicating risk need to embrace the broader issue of social context. Solutions to these problems lie in social engagement theory, consensus techniques, methods for eliciting judgements from experts about model structures and the values of variables, methods for comparing risks, and methods for presenting information that are robust to the numeracy, context and motivations of the recipients.

7. Technical motivations

Model-based risk assessments may provide results that are internally consistent, relatively transparent and free of linguistic ambiguity. They make an attempt to incorporate uncertainty plainly and in doing so, oblige those who interpret the results to consider the reasons for and consequences of wrong decisions. Technical, scientifically defensible risk analyses are not necessarily probabilistic, or even entirely quantitative. New opportunities exist in methods that define and bound the things that are **not** known about a problem. Decision theory, set theory, Bayesian analysis, information theory, imprecise probabilities, intervals, p-bounds, evidence theory, control charting, and game theory may provide a wealth of opportunities. Part of ACERA's task will be to explore the horizons of innovations to search for methods that have utility in real biosecurity contexts.

The cost of technical approaches to risk analysis is that they encourage an apparent dichotomy of ideas ('rationality' on one hand, subjective judgment on the other). ACERA's motivation is to explore ways of using analytical tools that assist decision makers to deal with different values and preferences, and to engage with qualitative analysis in a structured and repeatable fashion. New tools hold promise to solve some aspects of qualitative risk assessment that have proven difficult in the past.

The full spectrum of decision possibilities is available only if we take the trouble to carry the full spectrum of uncertainties through chains of calculations (insofar as they are possible) and reasoning, and to present them in an accessible form. Monte Carlo and related probabilistic methods have been the standard tool for risk analysts. They are limited because they provide a relatively narrow view of the uncertainty in most real problems, yet they create a perception that they deal

with uncertainty in technically complex and complete ways. There is a place for these methods in understanding the nature of a risk, but other methods can be better conditioned to the task of dealing with uncertainty in chains of logic and reasoning, perhaps including interval, bounding and extreme value methods.

8. Conclusions

Centres of Excellence are devoted to research. ACERA is devoted primarily to applied research that, in the first instance, is relevant to biosecurity applications. In most respects, the difficulties that confront biosecurity are similar in many respects to those that confront many disciplines in which professionals make decisions in contentious social environments where there are few data, understanding of biological systems is poor, there is limited tolerance for failure and there are competing views on the benefits of the outcomes of those decisions.

The social context of biosecurity risk analysis means that innovations should be developed cautiously and tested thoroughly. New approaches may not result in better decisions than existing methods, they may be too difficult to use or too easily misused. For instance, we can guess that better risk analyses will make a closer marriage of the quantitative and qualitative dimensions of risk, but there is a great deal of work to be done in specifying how it could or should be done.

The key themes outlined above (Biosecurity Framework development, Elicitation, Risk analysis methods, Monitoring and surveillance, Communications and decision making) cover the essential elements of risk analysis and form the foundation for the development of projects. It is beyond the capabilities of technical risk analysts to anticipate the full range of legitimate points of view and ideas about cause and effect. The role of risk analysis is to cross-examine ideas, to ensure internal consistency, to eliminate linguistic uncertainty and other sources of arbitrary disagreement, to clarify the implications of assumptions, and to leave honest, scientific disagreements in plain view. The tools that ACERA develops should be subordinate to the quality of the data. Risk analysis has an essential role to assist people to critically examine their ideas and to understand the ideas and values of those with whom they disagree. It should avoid developing tools that aim to replace decision-making, and that over-ride the need for decision makers to consider a broader range of uncertainties and contingencies than can ever be encapsulated in a technical model.

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