Australian Government
Department of Agriculture, Fisheries and Forestry

Andrew Metcalfe AO
SECRETARY

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24 May 2013

Senator the Hon. Bill Heffernan
Chair
Rural and Regional Affairs and Transport References Committee
PO Box 6100
Parliament House
CANBERRA ACT 2600

Dear Senator Heffernan

I wrote to you on 22 May 2013 about a range of issues related to the current Senate inquires underway on pineapples, ginger and potatoes.

In that letter, I committed to provide the Rural and Regional Affairs and Transport References Committee with the best possible advice on risk assessment. To this end, I asked the Australian Centre of Excellence for Risk Analysis (ACERA) to review Mr Peace's report on Australia's risk estimation matrix. I enclose the ACERA report for your consideration.

I trust that the advice is of assistance to your committee.

Yours sincerely

(Andrew Metcalfe)

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May 22nd, 2013

Mr Andrew Metcalfe, AO
Secretary
Department of Agriculture, Fisheries and Forestry
18 Marcus Clarke Street, Canberra, 2601

Dear Andrew

It was a pleasure to meet you on Monday. Thanks for your letter of May 21st regarding the matter raised by the Rural and Regional Affairs and Transport (RRAT) Committee and Mr Peace's review.

The Australian Centre of Excellence for Risk Analysis (ACERA) has been working with Assoc. Professor Ann Nicholson of Monash University since September, 2011, reviewing the scientific assumptions surrounding Australia's risk estimation matrix. This work has included a comparison with alternative formulations including those recommended by Mr Peace, and those applied to biosecurity risk elsewhere around the world, and in other professional and technical domains. We are able to summarise the relevant aspects of this part of our work to date. We hope you'll forgive the somewhat technical nature of some of this advice, but some of Mr Peace's judgments require clarification.

We note on reading Hansard that Mr Peace, in his testimony to the public hearings of the RRAT, commented that for Australia's risk analyses using the qualitative matrices, if the overall assessment is 'negligible', there may be as much as a 10-15% likelihood of the risk being higher than 'negligible'. This comment was made, based on a qualitative interpretation of a qualitative risk analysis. While there is almost certainly at least some small chance that the risk is higher than negligible, there is no justification, nor any conceivable rational basis on which one could quantify this chance.

Mr Peace is critical of qualitative assessments that do not provide clear guidelines regarding the meaning of indicative probability distributions. In particular, in his testimony to the committee, he highlighted the difficulties of aggregating qualitative risk assessments without these. We agree that this raises a problem with the transparency of the overall assessment. We note that in other IRAs these indicative qualitative intervals are provided.

Mr Peace's report advocates the use of so-called "bow-tie analysis" in combination with a revised qualitative consequence/likelihood matrix and quantified fault tree and event tree analyses. Bow-ties graphically display the relationship between causes leading to an event of interest. They include explicit representation of so-called risk-sources, causes, initiating events, controls (i.e. intervention

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actions), and connections between consequences and objectives. These tools are used widely, especially in engineering applications, and are described in the methods associated with ISO31000. We agree with Mr Peace that they provide a way of visualising the causal process and hence should aid understanding. This kind of analysis can be qualitative or quantitative.

However, this approach has a few well-known weaknesses.

Because these are trees, rather than graphs, they cannot represent all kinds of conditional dependencies. This means that the simple arithmetic operations on probabilities may make incorrect independence assumptions, which may result in incorrect overall probabilities.

An event tree typically "fans out" to numerous possibilities, making them inherently limited for modelling the impact of many factors or intervention actions; we note that the "event tree analysis" on the right-hand side of Peace's generic bow-tie diagram does in fact show such additional influencing factors, as well as controls. Because an event tree does not allow multiple paths between nodes, there can be much redundancy of structure, which also reduces understandability. The limitations to binary combinations (in the fault tree) and binary splitting of alternatives (in the event tree) mean that when large numbers of factors become involved, the size of the trees increases exponentially. Together with the issues with structure redundancy in event trees, the methodology will become unnecessarily complex when applied to a full IRA.

While both fault trees and events trees individually have a reasonably well-defined syntax and semantics, their combination in the bow-tie is more problematic. Fault tree and event trees are combined in the bow-tie diagram when the hazard generating the fault tree is the same as the starting event for the event tree. Peace does not detail how he envisages the bow-tie will represent the full IRA. The key event may be a pest or disease incursion, or it might be used for each stage in the pathway. The important issue in this regard is no way to connect factors other than through the focal key event, even if another causal pathway exists, suggesting the approach is not comprehensive and may result in models that do not accurately represent the causal processes.

The bow-tie analysis is based around a single event, i.e. the introduction of a single pest, and does not appear to provide any obvious way to aggregate. Hence scalability seems to be problematic for the bow-tie approach.

To our knowledge, there are no case studies demonstrating how bow-tie anaylsis (combining fault-tree and event-tree analysis) can be used for IRAs (particularly in combination with Australia's qualitative matrices as proposed by Peace). It is not advocated for use in IRAs in the peer-reviewed research literature.

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More generally, advocacy of a tree-based approach, which is inherently more limited than a graph, seems naive and flawed. Overall, the approach is not scientifically readily defensible. In fact, we conclude from the results of several ACERA reports that Australia should not adopt alternative risk analysis methodologies advocated in the literature including quantitative analysis (stochastic simulation modelling), bow-tie analysis, or the methods deployed in the USA, Canada, the EU or New Zealand. When assessed against a range of objective scientific criteria, they are less defensible than Australia's current system.

Yours sincerely,

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