Risk Assessment Tool (DAISY) For Emerging Human Infectious Diseases

Health Analysis & Information For Action (HAIFA)

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1. DAISY Structure and Parameters

This technical report describes how the DAISY (Disease Attribute Intelligence System) risk assessment tool was constructed for six indicator diseases (campylobacteriosis, cryptosporidiosis, Neisseria meningococcal infectious disease, influenza, Ross River and dengue fevers) for the Health Analysis & Information For Action (HAIFA) climate change project.

Many current risk assessment tools are based on static elements that are inherent to the infectious disease. In an emerging infectious disease situation, climatic events and regional or local vulnerabilities are changeable and the level of risk is often difficult to determine (Morens ***et al.*** 2004). We developed a tool that would incorporate changing elements of risk during disease emergence (Ashford ***et al.*** 2003; Butler ***et al.*** 2006; Rotz ***et al.*** 2002; Wong ***et al.*** 2003).

The tool builds on a previous semi-quantitative dynamic risk assessment tool, DAISY (Disease Attribute Intelligence System). Using DAISY we monitored down to Territorial Land Authority (TLA) level changing risk for the six indicator diseases on a monthly basis from January 2008 to November 2009 using surveillance and outbreak data from ESR's EpiSurv system. This demonstrated how one can incorporate changing elements of risk during disease emergence.

The original DAISY tool consists of 25 risk attributes with five risk levels within each attribute. Using online information, DAISY profiled the daily risk of avian influenza spread into Europe during 2005 and 2006. DAISY was sensitive to the spread of avian influenza into Europe and the risk level for major agency interventions was noted. In addition, DAISY was used to risk rank 45 biological agents benchmarked against four standard lists of hazardous substances. Threat scores aligned well with the four standard lists and country-specific benchmarking enabled risk stratification of agents into preparedness categories. As a tool, DAISY was able to routinely and consistently assess levels of risk from day to day, according to attributes that apply across a wide range of biological agents, from both infectious disease and bio warfare perspectives.

This report is organised in the following way: Section 1 lays out the basic DAISY tool structure; Section 2 provides details of previous DAISY applications; and Section 3 describes the application of DAISY for the six climate change indicator diseases. There are also three Appendices containing supporting information.

1.1 Background

Most countries operate some form of emerging infectious diseases external surveillance through monitoring agencies such as World Health Organisation (WHO), Centre for Disease Control & Prevention (CDC), Health Ministries or Departments of Health, online agencies such as ProMed, GPHIN and various media sources (Appendix A). They are also likely to have some internal surveillance that monitors local incidence of specific diseases of concern.

Following the SARS outbreak in 2003 it was apparent that an ongoing threat of re-emergence still existed. In addition, the new risk of avian influenza was emerging and subsequently took hold in Vietnam and Thailand. Led by WHO, preparedness plans were created and desktop exercises carried out, while avian influenza spread into China, Indonesia, Europe, Middle East and North Africa. In the development of these plans two key questions emerged:

How does the level of risk with avian influenza (or any other new agent) compare with other emerging infectious diseases or bio-warfare agents (Rotz ***et al.*** 2002; Taylor ***et al.*** 2001)?

At what level of risk should the risk management plans be put into action (Crump ***et al.*** 2001; Heinrich 2001; Suzuki ***et al.*** 2005)?

To address these questions we developed DAISY, a risk assessment tool for infectious diseases and other biological agents. Our initial goal was to assess the risk of arrival and spread of avian influenza in New Zealand, but it became apparent that such a tool also has the potential to monitor risks from other new and existing threats from the perspective of any country. Our aim was to build a dynamic risk assessment

tool that would consistently score changing risk levels on a day-by-day basis using regularly updated surveillance and open source information. This would guide preparedness and response, based on the risk score for an agent reaching defined levels.

In addition, validation and benchmarking such a tool against various "gold standards" of hazardous agents such as the CDC Bio warfare categories A, B, and C (Rotz ***et al.*** 2002) would enable risk stratification of new and existing biological agents. Alignment of the risk assessment score to these categories would give a consistent approach to prioritising new agents and provide a broad preparedness framework based on the recommendations for each category.

1.2 Method of DAISY development

A literature review was performed from which we identified risk attributes of infectious diseases and biological agents as they apply to human health (Decker 2001; Geering ***et al.*** 1999; Kapan ***et al.*** 2006; Lammerding and Paoli 1997; Russell 1988; Skelton and Hastert 1998; Zochetti ***et al.*** 1996). Despite some overlap we were able to identify 25 key risk attributes. These were grouped into three categories on the basis of standard risk assessment theories of threat, vulnerability and exposure. Threat attributes were determined by descriptive texts of hazard or "dangerousness' (Ashford ***et al.*** 2003; Butler ***et al.*** 2006; Crump ***et al.*** 2001; Heinrich 2001; Morens ***et al.*** 2004; Rotz ***et al.*** 2002; Suzuki ***et al.*** 2005; Taylor ***et al.*** 2001; Wong ***et al.*** 2003). It was apparent that vulnerability should be divided further into the vulnerabilities of the closest affected region (which was assumed to be the most likely source of an incursion) and the independent vulnerabilities of the country or state or province within a country. Exposure risk was determined by the monitoring of global spread as well as a regional and local situation of the disease or agent in question. Finally we felt that although social and economic impact represented little risk with regard to incursion, this would have an impact when there was a perceived risk by the public. For this reason social and economic risk attributes were included but considered separately from the other four attribute groups; inherent risk, regional vulnerabilities, local vulnerabilities, and the monitoring of spread.

The 25 risk attributes that were identified were grouped into five categories as follows:

- *Threat*: inherent characteristics of the agent or the "at-risk" population, attributes 1-9.
- *Regional vulnerability*: attributes 10-13.
- *Local vulnerability*: in terms of surveillance, laboratory and risk management capability, attributes 14-18.
- *Monitoring of agents*: epidemic status globally, regionally and locally, attributes 19-21.
- *Social and economic impact*: including risk perception by major agencies, media and the public, attributes 22-25.

Next, five scenarios of increasing risk were assigned to each attribute. Where possible a numerical ascending scale was devised, such as for *Case fatality rate*. For more qualitative attributes descriptors were developed to provide an ascending scale of intensity. For example, the threat attribute *Effectiveness of treatment* was scored in the following way:

Score Descriptor

1. "Effective treatment or mild illness or self limiting"
2. "Effective if treated early"
3. "Effective for complications only
4. "Minimally effective" to
5. "Severe illness no effective treatment, supportive care only"

While we acknowledge these descriptors are subjective, we found clinicians frequently reported on the early clinical management of cases in such a way. For some attributes "not knowing" was considered a vulnerability e.g. *Incubation period* or *Period of communicability*. In our scoring system, such uncertainty was assigned the highest score of 5 until such time as information became available. Furthermore, where an agent had bio-warfare potential it was scored twice to reflect the differing *Modes of transmission*

or *Reservoir risk*. Take for example *Modes of transmission* for Q Fever. Naturally occurring Q Fever would score 2 as a "*Zoonotic disease*", yet if there was a possibility of deliberate release, it would score 5 as "*5 Bio terrorism (BT) dissemination*" because in this event it would carry the risk of being actively dispersed. The scales for the social impact attributes were based on studies of public perception and reaction to environmental and radiation exposure in the USA (Sandman ***et al.*** 1998; WHO 2001 and 2005) and WHO Outbreak Communication Guidelines (Brown 2002). The attribute for public perception was assigned increasing risk scenarios of "*1. Appropriate perception by public*" through "*3. Risks taken too seriously. Inappropriate cautionary behaviour*" to *5. Perception of lack of control by authorities, with fatal consequences*". Likewise the attribute for public reaction began with "*1. Pragmatic acceptance and ongoing trust*" through "*3. Fright reactions, panic buying, etc, and avoidance*" to "*5. Radical engagement to contest the social and institutional systems responsible*".

The Delphi panel process is described in Appendix B. The resultant tool was named DAISY (Disease Attribute Intelligence System). The DAISY categories, attributes and risk scores are shown in Tables 1 and 2.

TABLE 1: RISK ATTRIBUTES OF INFECTIOUS DISEASES OR BIOLOGICAL AGENTS OF CONCERN

Threats or hazards inherent to the biological agent	Vulnerabilities in surveillance and containment	Monitoring of biological agent or infectious disease	Media and Social impact
1. Risk related to difficulty in diagnosis 2. Risk related to type of reservoir 3. Risk related to mode of transmission 4. Risk related to length of incubation period 5. Risk related to period of communicability 6. Risk related to the susceptible population 7. Risks related to effectiveness of treatment or prophylaxis 8. Case fatality rate 9. Potential risk from the resources required for infection control and containment	10. Distance to closest affected region (Note 1) 11. Quality of human disease surveillance in the closest affected region. 12. Quality of Vector OR Reservoir OR Source Surveillance in the closest affected region. 13. Disease Containment capability in closest affected region. 14. Quality of human disease surveillance in scoring country 15. Quality of Vector OR Reservoir OR Source Surveillance in scoring country 16. Disease containment capability in scoring country 17. Lab capability in scoring country 18. Vaccination OR Prophylaxis strategy in scoring country	19. Epidemic status (Global) 20. Epidemic status in region (Note 2) 21. Epidemic status in scoring country	22. Media reaction /Economic implications for the region 23. Media reaction /Economic implications in scoring country 24. Public risk perception of risk in scoring country 25. Public risk reaction in scoring country

(Note 1) More than one region may be scored for closest affected region and that region reflecting the highest vulnerability is the one included.

(Note 2) Self defined: May be 4 or 8 hour flying time radius depending on preferred sensitivity.

TABLE 2: DAISY ATTRIBUTES AND RISK SCORES

	No	DAISY Attribute	Score				
			5	4	3	2	1
Attributes of the threat or hazard	1	Identification	No clear diagnostic clinical markers	Diagnostic investigating required but confirmatory test has poor specificity	Investigation required for confirmatory diagnosis e.g. CXR, PCR	Clinical signs high likelihood of correct diagnosis.	Clear clinical syndrome investigation not required
	2	Reservoir	Not Known OR Human to human OR BT Dissemination	Soil/Water/ Sea/ Environmental	Human / insect cycle	Zoonotic	Clinical specimens/ clinical lab/ research lab
	3	Mode of Transmission	Not Known OR BT Dissemination	Air/ respiratory droplet	Food /Water	Vector	Fomite transmission or Cx with infected fluids or tissues
	4	Mean Incubation period	Not Known OR 1-2days	2 to 7days	8 to 14days	15 to 30days	> 30days
	5	Period of communicability	Not known or > 30days	15 to 30days	8 to 14days	2 to 7days	<2days or no Human to human
	6	Susceptibility	General	Adult (20-65)	Child/teen (5 -19)	Infant /Child (0-4)	Elderly >65years
	7	Effectiveness of treatment	No Severe illness supportive care only	Minimally effective.	Effective for complications only	Yes, if treated early	Yes or mild illness and self limiting
	8	Case fatality	>25%	15 -25%	10 to 15%	5 to 10%	0-5%
	9	Method of control	Prolonged isolation AND CT AND Quarantine AND Surveillance of contacts	Temp isolation AND CT (with surv. of contacts) BUT NO quarantine AND Case find AND determine source	No isolation or CT but Case find AND search source	Determine source only	No action

	No	DAISY Attribute	Score				
			5	4	3	2	1
Vulnerabilities for region	10	Closest affected region (Note 1)	Local human cases or Immediate neighbour	Flying time less than 4 hours	Flying time 4 - 12 hours	Flying time 12+ hours or cruise ship	Greater than twice the 90% of the incubation periods globally OR N/A
	11	Human Disease Surveillance (Closest affected regional location)	Serious disease. (Threat score > 30) AND Nil surveillance	Minimal surveillance or passive internal surveillance (e.g. notifiable disease)	Passive + Sample based active or risk factor surveillance	Passive + comprehensive active or risk factor surveillance	Nil appropriate
	12	Vector OR Reservoir OR Source Surveillance (Closest affected regional location)	No surveillance AND serious disease (Threat score >30)	Minimal surveillance or passive internal surveillance (e.g. notifiable disease)	Passive + Sample based active or risk factor surveillancer	Passive + comprehensive active or risk factor surveillance	Nil appropriate
	13	Disease Containment (Closest affected regional location)	Lack resources and ability to implement disease control measures	Minimal ability to implement surveillance and disease control measures	Some ability to implement disease control measures	Able to implement adequate control measures	Nil required

	No	DAISY Attribute	Score				
			5	4	3	2	1
Vulnerability local	14	Human Disease Surveillance (Local)	Serious disease. Prv score > 30) AND Nil surveillance	Minimal surveillance or passive internal surveillance (e.g. notifiable disease)	Passive + Sample based active or risk factor surveillance	Passive + comprehensive active or risk factor surveillance	Nil appropriate
	15	Vector OR Reservoir OR Source Control (Local)	Serious disease. Prv score > 30) AND Nil surveillance	Minimal surveillance or passive internal surveillance (e.g. notifiable disease)	Passive + Sample based active or risk factor surveillance	Passive + comprehensive active or risk factor surveillance	Nil appropriate
	16	Disease containment capability (Local)	Lack resources/ ability to implement disease control measures	Minimal ability to implement surveillance and disease control measures	Some ability to implement disease control measures	Able to implement adequate control measures	Nil required
	17	Lab capability (Local)	No test available	Lab confirmation 15-28days	Lab confirmation 8 to 14days	Lab confirmation 2-7 days	Lab confirmation <2days
	18	Vaccination OR Prophylaxis (Local)	Serious disease (Prv score. 30) , Nil protection	Targeted during epidemic	Targeted prior to epidemic	Population Immunisation Programme	Nil appropriate

	No	DAISY Attribute	Score				
			5	4	3	2	1
Epidemic dynamics	19	Epidemic status (Global)	Multi-region outbreak > 4 hours flying time between sources	New outbreak in a region. Numbers increasing at greater than 1 per day	Sporadic cases increasing at less than 1/ day OR generally stable	> two inc periods with no cases but seasonal or regional epidemic in last 2 yrs	Nil globally
	20	Epidemic Status (Regional) (Note 2)	Multiple clusters	Single cluster, Links traced. No downgrade for 2 inc periods	Sporadic cases no downgrade for 2 inc periods	Infection in animals	Nil cases
	21	Epidemic Status (Local)	Widespread local transmission.	Multiple clusters, Attempts at containment	Single cluster, Links traced. No downgrade for 2 inc periods	Sporadic Cases OR Infection in animals	Nil cases.

	No	DAISY Attribute	Score				
			5	4	3	2	1
Risk Communication	22	Media reaction /Economic implications Regionally	Very High. WHO/ CDC Formal Travel advisory for country in region	High WHO/ CDC Formal Travel alert for country in region	World Media Coverage, WHO, ProMed Local Travel advice for country in region	Local or neighbouring media coverage only	Internal ministerial/ dept releases only
	23	Media reaction /Economic implications (Local)	Very High. WHO/ CDC Formal Travel advisory	High WHO/ CDC Formal Travel alert	World Media Coverage, WHO, ProMed Local Travel advice	Scoring country or neighbouring media coverage only	Internal ministerial/ dept only
	24	Public risk perception of risk	Perception of lack of control by authorities, with fatal consequences	Calls for action to reduce risk. Blaming of institutions and agencies	Risks taken too seriously. Inappropriate cautionary behaviour.	Risk exists but poor understanding by public	Appropriate perception by public
	25	Public reaction	Radical engagement to contest the social and institutional systems responsible	Fear and blaming. Some anger	Fright reactions, panic buying etc and avoidance	Risk exists but not taken seriously enough	Pragmatic acceptance and ongoing trust

Note 1: More than one region may be scored for closest affected region and that region reflecting the highest vulnerability is the one included.

Note 2: Self defined - May be 4 or 8 hour flying time radius depending on preferred sensitivity.

2. DAISY Applications

2.1 Monitoring of a single disease

Retrospective data to October 2005 and prospective data from February 2006 highly pathogenic avian influenza was scored using DAISY. For consistency the external information was sourced predominantly via ProMed postings (http://www.promedmail.org) although where further information was required this was sourced through approx 70 websites listed in Appendix A. Attributes that addressed surveillance systems and programmes were usually derived from online Ministry/ Dept of Health or Centres for Disease Control. Other attributes such as public perception and public reaction were assessed by examining the content of global and local media sources. It's acknowledged that these postings or items may understate or overstate the situation. Where uncertainty was such that a given attribute could have scored at either of two levels the higher risk level was taken. In addition, public perception and public reaction was assumed to persist for one week unless it was upgraded, as a result of ensuing reports.

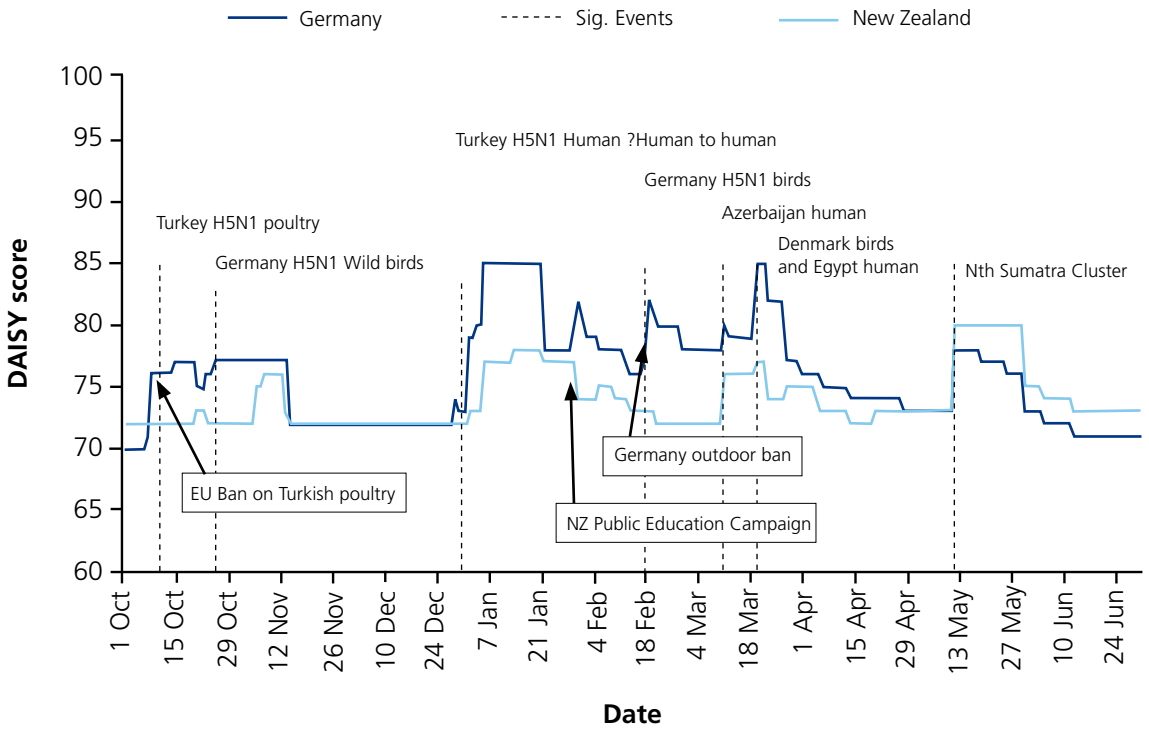
2.2 Use of DAISY to assess risk from a specific emerging disease (avian influenza)

The daily un-weighted DAISY scores were recorded for Turkey, Egypt, Azerbaijan, Indonesia and China, countries that had current or emerging avian influenza outbreaks in birds and humans. The scores were compared to those of Germany, and Denmark, which had incidents of avian influenza in birds but no human cases reported. The timing and level of risk at which definitive political, public health or animal agency action relating to avian influenza in these countries where human cases did not occur was noted. The daily risk of spread of avian influenza into New Zealand was also recorded. (Note, there has never been any importation of H5N1 avian influenza into New Zealand, nor has there been any outbreak of avian influenza of any subtype). The percentage variation by each group of attributes can be used to provide a simple sensitivity analysis.

An example of how DAISY is able to monitor the changing risk of a specific disease is shown in Figure 1. Here the DAISY score for avian influenza is shown for Germany and New Zealand and is observed to vary with the changes in risk associated with significant events. The risk levels varied as avian influenza spread into Turkey, at first with outbreaks of avian influenza in birds, and later in humans. Significant events were defined as first outbreaks of avian influenza in birds or humans in a given country, a cluster of human avian influenza in any country or the first implementation of a disease control measure. DAISY provided a method to determine a daily risk assessment for the incursion of an emerging infectious disease and monitor this for a specific disease over time. The validation of an action level while imprecise showed some consistency.

Using a similar methodology, the DAISY risk score for the six climate change indicator diseases were monitored at monthly intervals using EpiSurv surveillance and outbreak data (Section 3.2).

FIGURE 1: DAISY RISK SCORE MONITORING A SPECIFIC DISEASE (AVIAN INFLUENZA H5N1) IN GERMANY AND NEW ZEALAND



2.3 DAISY and risk ranking for a group of specific infectious diseases

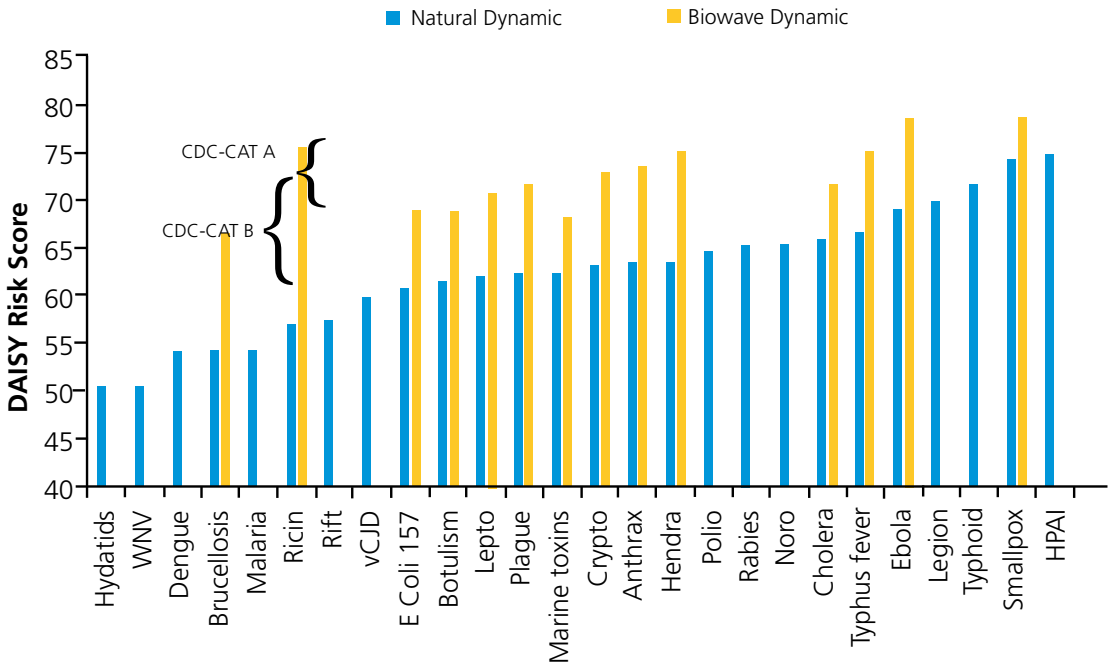
Forty-five infectious diseases and toxins were scored on June 1, 2006 using the weighted descriptor scores derived by the New Zealand DELPHI panel. The infectious diseases and toxins scored were those included in the AS/NZS Risk Groups (AS/NZS 2002), the COSHH Hazardous Agents list (HSE 2004), NIH Risk Groups of Hazardous Substances (HHS 1999; NIH 2006), and US CDC Potential Biowarfare Categories A, B, and C (each CDC category of Bio terrorism agent has specific recommendations with regard to levels of preparedness in terms of risk management)(Rotz ***et al.*** 2002).

These lists are categorised variously; some only incorporate laboratory or physical containment criteria, while others are based on expert opinion without specified attributes. The CDC categories were based on the potential for adverse public health impact with mass casualties (Morens ***et al.*** 2004) and include criteria for both naturally occurring and bio-terrorism warfare dissemination potential. None of these categorised lists consider regional and local vulnerability, or include an ability to monitor change, and few specifically consider media or social impact. Therefore, in the validation of DAISY only the scores for the nine threat attributes were used. The weighted scores were summed for each of the 45 agents and those identified by US-CDC as potential biological terrorism agents were rescored for biowarfare intent. The reference text for assigning DAISY scores for the threat attributes was "Control of Communicable Diseases Manual 18th Edition".

The mean weighted DAISY threat scores for each risk agent aligned well with the risk categories assigned by other systems especially the top two risk groups, Risk Group and Risk Group 3. This is less impressive for naturally occurring Risk Group 2 agents and does not hold true for Risk Group 2/Category C Diseases and Agents with biowarfare intent, which showed considerable variation. CDC – Our observation is that Risk Group 2 tends to be a "holding" category of agents "to be further assessed" for their public health risk.

Figure 2 shows the weighted total DAISY dynamic risk score for a selection of 25 of 45 agents scored as at 1 June 2006 from a New Zealand perspective. In this example, all five attribute groups were included and therefore the figure represents a snapshot of changing risk on the given day of 1 June 2006. This benchmarking process enables consistent linking of a DAISY risk score to established preparedness strategies. For example, in Figure 2 the range of DAISY scores assigned to the agents included in CDC Categories A and B preparedness recommendations are indicated (A: Specific outbreak plan; Purchasing strategy and stockpiling; Enhanced surveillance; Lab capability with surge capacity. B: A generic outbreak plan; Purchasing strategy; Surveillance; Lab capability).

FIGURE 2: DAISY RISK SCORE FOR 25 BIOLOGICAL AGENTS, NEW ZEALAND, 1 JUNE 2006



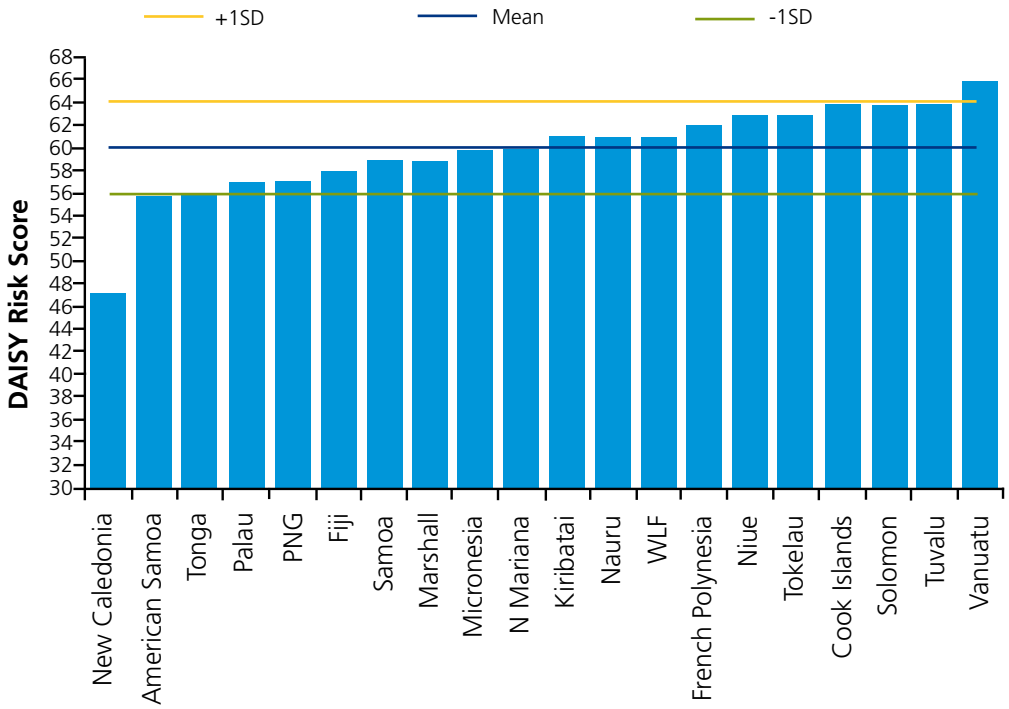
Thus, DAISY provides a consistent methodology for risk ranking infectious disease and other agents of concern. For this reason DAISY was used to risk rank and help identify four of the six climate change indicator infectious diseases (Section 3.1).

2.4 DAISY and ranking risk across regions

Figure 1 shows how the risk varies from country to country. A given country has different capabilities in animal and human surveillance, disease detection, abilities to institute disease control measures and communicate with its population. Figure 3 shows the DAISY scores of 20 Pacific Countries based on information from the Pacific Pandemic Preparedness Checklist designed and circulated by the Secretariat of Pacific Communities (SPC) in 2006. We used this information to populate a modified DAISY specifically for avian influenza and pandemic influenza in the Pacific context, to assess the range of preparedness across Pacific Islands Countries and Territories (PICTs).

We were able to demonstrate the extent of PICT to PICT variation in risk due to local vulnerabilities and risk communication many of which are modifiable and undergoing improvement. Within the limitations of the methodology we were able to identify the highest risk PICTs and the areas which could be addressed.

FIGURE 3: DAISY SCORE RANKING AVIAN INFLUENZA RISK ACROSS 20 PACIFIC ISLAND COUNTRIES AND TERRITORIES, JUNE 2007



Note: This study was undertaken before the outbreak and declaration of A(H1N1) as a pandemic influenza strain.

This variation in preparedness has relevance within countries as well as between countries. Different regions within a country also have region to region variation in surveillance, disease detection and disease control capabilities. DAISY therefore can be used to provide a picture of intra country risk variation. EpiSurv provides surveillance data down to Territorial Land Authority (TLA) level (of which there are 73) in New Zealand, enabling a month to month DAISY risk assessment of the six climate indicator diseases down to the TLA (Section 3.2).

3. DAISY and Climate Change

3.1 Risk ranking for climate change indicator disease selection

Disease risk ranking derived by the DAISY tool was initially used to inform the selection process for four of the six indicator diseases (campylobacteriosis, cryptosporidiosis, Neisseria meningococcal infectious disease, and influenza). The selection of the remaining two indicator diseases (Ross River and dengue fevers) were informed via a different process (see the HAIFA modelling report available from the HAIFA web site).

3.2 Modelling the climate change indicator diseases by TLA and by month

A model was then created to record the DAISY scores each month for each of the six indicator diseases from January 2008 to November 2009. It was felt that after the first 12 months of scoring that the two attributes, Public perception and Public reaction, were not relevant to the risk of emergence and that they were too difficult to score accurately. Thus, attributes 24 and 25 were subsequently discarded and the previous year re- scored using only Attributes 1 to 23.

The DAISY "Threat" scores (Attributes 1 to 9) remain constant as these represent the dangerousness of the disease. It is however possible that this set of attributes could score differently. For example if the mode of transmission altered, or a case fatality rate changed then the base score for threat would alter.

The DAISY "Vulnerability" score alters depending on the proximity of the closest affected country. Where there are cases occurring within New Zealand then Attribute 10 will score as "Local human cases or local cases for immediate neighbour" The remaining attributes 11,12, 13 then return to the vulnerabilities of the closest affected region identified by ProMed or Google Media Search for scoring. The surveillance and disease control capability varies throughout the region and this varies the DAISY scores based on the assumption that if a country has poor surveillance and poor disease control then their likelihood of exporting the disease is higher. The scores for vulnerability to New Zealand of having the disease in any particular "closest affected country" are recorded in surveillance of human population (Attribute 11), surveillance of vector (Attribute 12), and ability to contain the spread of disease (Attribute 13). These were derived from various sources:

- Department of Health websites, Ministry of Health published reports
- Pacific Pandemic Preparedness Checklist
- Personal communication

A summary of these vulnerability scores is shown in Table 3.

TABLE 3: VULNERABILITY SCORES FOR CLOSEST AFFECTED COUNTRY

Attribute	10	11	12	13	
Country Affected Country	Closest affected region	Human Disease Surveillance (Closest affected regional location)	Vector OR Reserviour OR Source Surveillance (Closest affected regional location)	Disease Containment (Closest affected regional location)	Total
American Samoa	4	2	4	3	13
Cook Islands	4	4	4	3	15
Fiji	4	2	3	3	12
Micronesia	4	2	2	4	12
Kiribatai	3	3	3	4	13
Marshall	3	3	4	3	13
N Mariana	4	2	4	3	13
New Caledonia	4	3	2	3	12
Nuie	3	5	4	4	16
Nauru	3	5	4	4	16
Palau	4	2	2	3	11
Papua New Guinea	3	2	3	3	11
French Polynesia	3	5	5	3	16
Solomon	4	5	4	4	17
Tokelau	4	5	3	4	16
Tonga	4	2	4	3	13
Tuvalua	4	3	4	4	15
Vanuatu	4	5	4	4	17
Wallia & Forrtuna	4	3	5	2	16
Samoa	4	3	4	3	14
Australia	4	2	3	2	11
Hawaii	3	2	3	2	10
East Timor	3	5	4	4	16
Indonesia	3	3	4	3	13
Philipines	3	3	4	3	13
Malaysia	3	3	4	2	12
Singapore	3	2	3	2	10
Taiwan	3	3	3	2	11
Hong kong	3	2	3	2	10
China	3	3	3	2	11
Korea	3	3	4	3	13
Japan	3	2	3	2	10

Source Pacific Island Countries and Territories:
Pandemic Influenza Risk Assessment of Pacific Islands Countries and Territories 2007

Current global distribution (Attribute 19) of the six indicator diseases was monitored by online data provided by ProMed. In addition, media information was captured utilising the Google News search engine. This also assisted in determining the degree of media coverage regarding new cases or emerging outbreaks in the region (Region was identified as 8 hours flying time). See Appendix C for this methodology.

Incidence of the six indicator diseases in New Zealand was monitored through monthly downloads of data from New Zealand's national notifiable disease database, EpiSurv. EpiSurv also records outbreak data and together with aggregate data for the whole of New Zealand (Attribute 20) the disease incidence was scored. The rule for scoring was as follows (New Zealand derived weighted scores were used):

Two or more outbreaks within 30 days of each other, score = 5
If outbreak reported, score = 3.58
If more than 10 cases but no outbreak, score = 3.42
If less than 10 cases, score = 2
If nil, score = 1

EpiSurv data are also available to the TLA level (Attribute 21) so the same rule was applied to the 73 TLAs to provide monthly individual scores for each TLA. A sample of the scoring table is shown in Table 4.

TABLE 4: DAISY RISK SCORE FOR CAMPYLOBACTERIOSIS BY MONTH AND TLA

Month	Far North District	Whangarei District	Kaipara District	Rodney District	North Shore City	Waitakere City	Auckland City	Manukau City	Papakura District	Franklin District	Thames-Coromandel District	Hauraki District	Waikato District	Matamata-Piako District	Hamilton City	Waipa District	Otorohanga District
Jan-08	57.4	58.3	57.4	58.8	58.8	58.8	58.8	58.8	57.9	57.9	57.4	57.4	57.9	57.4	58.8	57.9	57.4
Feb-08	57.5	58.0	57.2	58.9	58.9	58.9	58.9	58.9	57.5	57.5	57.5	57.2	57.5	57.5	58.9	57.5	57.5
Mar-08	58.1	58.1	57.8	59.5	59.5	59.5	59.6	59.5	58.1	58.6	58.1	57.8	58.1	58.1	59.5	58.1	58.1
Apr-08	58.1	58.1	57.8	58.6	59.5	59.1	59.6	59.5	58.1	58.1	58.1	57.8	58.1	58.1	58.6	58.1	57.4
May-08	57.7	58.2	56.7	58.2	59.2	59.2	59.2	59.2	57.7	57.7	57.7	57.1	57.7	57.7	58.7	57.7	57.1
Jun-08	58.4	58.4	58.4	59.4	59.8	59.4	59.8	59.8	58.4	58.4	58.4	58.4	58.4	58.4	59.4	58.9	57.7
Jul-08	58.4	58.4	58.4	59.8	59.8	59.8	59.8	59.8	58.4	58.4	58.4	58.4	58.4	58.4	59.4	58.4	58.1
Aug-08	57.7	58.7	57.7	59.2	59.2	59.2	59.2	59.2	57.7	58.7	57.7	57.7	58.7	58.2	59.2	58.3	57.4
Sep-08	58.3	58.9	57.9	59.3	59.3	59.3	59.4	59.3	57.9	58.3	58.4	57.9	58.9	58.4	58.8	59.3	57.9
Oct-08	57.1	57.5	57.1	58.5	58.5	58.5	58.5	58.5	57.1	58.0	57.1	57.1	57.5	57.5	58.5	58.5	57.1
Nov-08	58.6	59.6	58.6	60.1	60.1	60.1	60.2	60.1	59.6	60.1	58.6	58.6	58.6	58.6	60.1	59.6	58.6
Dec-08	58.7	59.2	58.3	59.7	59.7	59.7	59.7	59.7	59.2	59.7	58.3	58.3	59.2	58.7	59.7	59.7	58.3

DAISY risk scores were then transcribed into a suitable format for mapping in ARCGIS. The outcome is a dynamic map that shows the DAISY score by month by TLA from January 2008 to November 2009. Figure 4 shows an example screen shot of the dynamic map created from the DAISY score outputs using ARCGIS mapping software. Table 5 summarises which TLAs had the highest mean DAISY scores for each of the indicator diseases and which TLAs demonstrated the largest variation. This indicates which TLAs demonstrated the highest risk.

FIGURE 4: MAP OF NON-SEASONAL INFLUENZA AND MENINGOCOCCAL DISEASE FOR JANUARY 2008

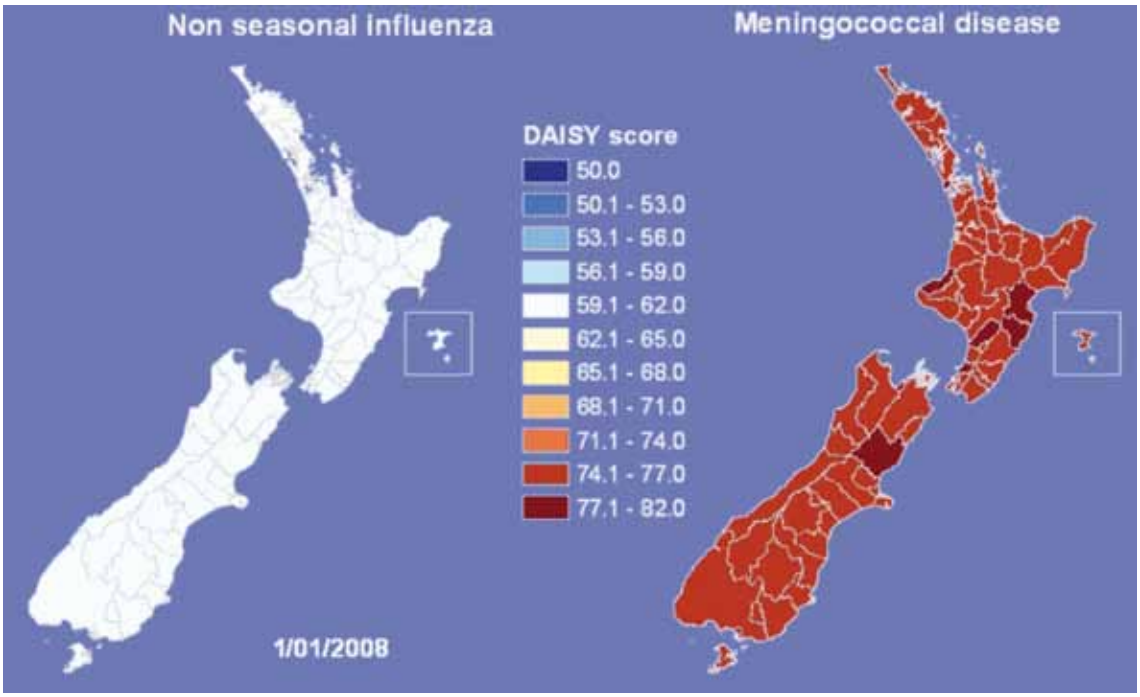


TABLE 5: LARGEST VARIATION AND HIGHEST MEAN DAISY SCORES FOR THE SIX INDICATOR DISEASES

	Highest mean	**Largest variation**
Campylobacteriosis	North Shore City, Auckland City, Manukau City, Wellington, Christchurch	Southland, Grey, Buller, Timaru, Selwyn ,Christchurch
Cryptosporidiosis	Auckland City, Rodney, North Shore City, Waitakere City, Christchurch	Franklin, Rodney
Meningococcal disease	Manukau, Auckland City, Wellington, Christchurch	Auckland City, Manukau, Papakura, Waipa, Whakatane, Wairoa, Palmerston North, Horowhenua, Porirua, Dunedin
Influenza	Manukau, Papakura, Franklin, Whakatane, Kawerau, Opotiki	Manukau, Papakura, Franklin, Whakatane, Opotiki, Gisborne, Napier, Hastings , Upper Hutt, Lower Hutt
Dengue fever	Auckland City, Manukau, North Shore City	Waikato, Manukau, Auckland City, North Shore City, Christchurch
Ross River fever		North Shore City

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Appendix A: Open Source Web Resources

Key Agencies

World Health Organisation

Home	http://www.who.int/en/
Media Centre	http://www.who.int/mediacentre/en/
Outbreak	http://www.who.int/csr/don/en/
WER	http://www.who.int/wer/en/
WPRO	http://www.wpro.who.int/
Avian Influenza Updates	http://www.who.int/csr/disease/avian_influenza/updates/en/index.html

Center for Disease Control

Media	http://www.cdc.gov/od/oc/media/
Outbreaks	http://www.cdc.gov/
Bio-terrorism	http://www.bt.cdc.gov/
MMWR	http://www.cdc.gov/mmwr/
EID Journal	http://www.cdc.gov/ncidod/EID/index.htm
ProMED	http://www.promedmail.org/pls/askus/f?p=2400:1000
Eurosurveillance bulletins	http://www.eurosurveillance.org/releases/index-02.asp?an=2005&display=ew

Specific Influenza Sites

WHO FluNet	http://rhone.b3e.jussieu.fr/flunet/www/
CDC Flu Activity	http://www.cdc.gov/flu/weekly/fluactivity.htm
European Flu Surveillance	http://www.eiss.org/index.cgi

Miscellaneous

SARS	http://www.sars.com.sg/index.php
Avian Influenza	http://www.sars.com.sg/birdflu/bfindex.php

Global Press Health Pages

Yahoo

Yahoo Reuters	http://news.yahoo.com/news?tmpl=index2&cid=594
Yahoo AFP	http://news.yahoo.com/news?tmpl=index2&cid=1507
Yahoo AP	http://news.yahoo.com/news?tmpl=index2&cid=534
BBC	http://news.bbc.co.uk/2/hi/health/default.stm
CNN (Health)	http://www.cnn.com/HEALTH/
Google Health News	http://news.google.com/news?ned=us&topic=m
Reuters Alert	http://www.alertnet.org/thenews/newsdesk/index.htm?rt=1&fb_topiccodes=152538

Online Country Resources

Malaysia

DPH	http://www.dph.gov.my/index.php
The Star Online	http://www.thestar.com.my/health/
New Straits Times	http://www.nst.com.my/

Brunei

Ministry of Health	http://www.moh.gov.bn/

Indonesia	
Jakarta Post	http://www.thejakartapost.com/headlines.asp
Thailand	
MPH	http://eng.moph.go.th/
Dept Disease Control	http://thaigcd.ddc.moph.go.th/Bird_Flu_main_en.html
The Nation	http://nationmultimedia.com
Bangkok Post	http://www.bangkokpost.com/
Philippines	
Dept of Health	http://www.doh.gov.ph/
ABS-CBN News	http://www.abs-cbnnews.com/
Philippine Star	http://www.philstar.com/philstar/index20051115.htm
Cambodia	
Dept of Health	http://www.cambodia.gov.kh/unisql1/egov/english/ministry.detail.html?link=9
Cambodia Post	http://www.cambodiajournal.com/
Vietnam	
Vietnam Net Bridge	http://english.vietnamnet.vn/
Vietnam News Agency	http://www.vnagency.com.vn/Home/tabid/117/Default.aspx
News	http://www.thanhniennews.com/
Laos	
Vientiane Times.com	http://www.vientianetimes.com/Headlines.html
Burma	
Burma Daily	http://www.burmadaily.com/
The Daily Star	http://www.thedailystar.net/
Bangladesh	
The News Today	http://www.newstoday-bd.com/index.asp
Nepal	
Nepal News	http://www.nepalnews.com/archive/main.htm
The Asian Age	http://www.asianage.com/
India	
The Times of India	http://timesofindia.indiatimes.com/
China	
Flu Info Centre	http://www.flu.org.cn/
MOH China	http://www.moh.gov.cn/
China People's Daily	http://english.peopledaily.com.cn/
Shanghai Daily	http://english.eastday.com/
Xinhua (English)	http://www.chinaview.cn/
Hong Kong	
Govt News	http://www.news.gov.hk
Centre for Health Protection	http://www.chp.gov.hk/
South China Morning Post	http://www.scmp.com/
Agriculture Fisheries & Conservation Department	http://www.afcd.gov.hk/news/news_e.htm
Taiwan	
CDC Taiwan	http://www.cdc.gov.tw/WebSite_En/index1024.htm
Taipei Times	http://www.taipeitimes.com/News

Japan	
MOH Japan	http://www.mhlw.go.jp/english/
National Institute of ID	http://www.nih.go.jp/niid/index-e.html
Mainichi Daily News	http://mdn.mainichi-msn.co.jp/
The Japan Times Online	http://www.japantimes.co.jp/
Kyodo News	http://home.kyodo.co.jp/
Japan Today	http://www.japantoday.com/e/?content=home
Korea	
CDC & NIH	http://www.cdc.go.kr/webcdc/english/index.jsp
The Korean Herald	http://www.koreaherald.co.kr/index.asp
The Korea Times	http://times.hankooki.com/nation/nation.htm
The Seoul Times	http://theseoultimes.com/ST/index.html
Australia	
Department of Health and Ageing	http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/publications-5
Communicable Diseases Australia	http://www.health.gov.au/internet/wcms/publishing.nsf/Content/Surveillance+systems-1
ABC News Online (Health)	http://www.abc.net.au/news/health/default.htm
The Australian (Health)	http://www.theaustralian.news.com.au/sectionindex1/0,5745,aushealth%255E%255ETEXT,00.html
Sydney Morning Herald	http://www.smh.com.au/
New Zealand	
Ministry of Health	http://www.moh.govt.nz/moh.nsf
NZ Herald	http://www.nzherald.co.nz/
ESR	http://www.esr.cri.nz/competencies/publichealthsurveillance/default.htm
United Kingdom	
CDR-Influenza	http://www.hpa.org.uk/infections/topics_az/influenza/seasonal/default.htm
Guardian	http://www.guardian.co.uk
Telegraph	http://www.telegraph.co.uk
USA	
Washington Post	http://www.washingtonpost.com/wp-dyn/content/health/index.html
USA Today	http://www.usatoday.com/news/health/front.htm
Canada	
Health Canada	http://www.hc-sc.gc.ca/index_e.html
BC-CDC	http://www.bccdc.org/
Toronto Star	http://www.thestar.com

Online Publications Regular Scanning

BMJ	http://bmj.bmjjournals.com/
NEJM	http://content.nejm.org/
The Lancet	http://www.thelancet.com/search
Int'l J. Epidemiology	http://ije.oxfordjournals.org/
American Journal of Epidemiology	http://aje.oxfordjournals.org/
Medscape	http://www.medscape.com/home
Eurosurveillance	http://www.eurosurveillance.org/index-02.asp
Science	http://www.sciencemag.org
J Epidemiology & Community Health	http://jech.bmjjournals.com/
Nature	http://www.nature.com/nature/journal/v444/n7121/index.html

Appendix B: DAISY Delphi Panel Methodology

The 25 DAISY attribute scales each of five levels of risk were peer reviewed by a DELPHI panel of 14 public health registrars and other scientists. At a face to face meeting, they were given a briefing on the risk assessment tool and then asked to assign a numerical score of 1-5 in order of increasing level of scenario risk to the descriptors that had been randomly mixed. This was performed separately for each attribute. The first nine threat attributes were scored at the face to face meeting and the remaining 15 were scored later by email by 12 members of the panel. Outliers were questioned as to whether their score represented a differing viewpoint or different interpretation of the level options. A differing viewpoint was taken as a valid score but if it was a differing interpretation of the descriptor, the meaning of the descriptor was clarified and they were invited to re-score the attribute. Their resultant scores were used to give a weighting by the following formula:

$$S1,2,3,4,5, = (1(n1\ ) + 2(n2) + 3(n3) + 4(n4) + 5(n5)) / N$$

Where:
S is the score for an individual descriptor 1,2,3,4,5
n is the number of responses for that descriptor
N is the total number in the panel
and where $\Sigma S1\text{-}5 = 15$

The panel therefore provided an order of risk level from 1 to 5 and a weighting between each of the levels. As these weighting may differ between countries, when the daily risk of an emerging disease was compared across countries, only the order scores 1 to 5 were used. Finally the 1 to 5 scores for each the 25 attributes were simply summed to give a total risk score. The minimum score possible was therefore 25 and the maximum 125.

The individual weightings between each of the levels were retained for validating and benchmarking against various "gold standards". For example the un-weighted scores represented an order for *Mode of transmission* of 1,2,3,4,5 but this assumed the level of risk was the same between each level. For later benchmarking, the actual weighted scores were used. For this attribute the weighted scores were 1.29, 2.29, 2.93, 3.71, 4.79. It is expected that such weightings would differ according to expert panels convened in other countries.

Appendix C. Methodology for Risk Communication & Reporting

First **Open** Google Web page http://www.google.com.au/,

Then **Enter** the disease e.g. "Dengue" in the search box and **Click** on the News tab,

This opens a new page, then **Click** on Advanced News Search,

Under **Date** click on the drop down list and choose "past month" or enter the exact dates,

Under **Source Location** enter "Australia" and later "New Zealand",

In the "**Sort by relevance**" box, you may want to choose a different option i.e. Sort by Date,

Click **Search**

Scan through the list looking for items that relate to new outbreaks or identify new countries that might now be the "closest affected country". Score these in the table in the "Media Analysis" sheet. This together with ProMed search identifies the closest affected region for Attribute 10 and the subsequent vulnerabilities associated with that country being the closest affected country and also provides the information required to score for Attributes 22 and 23.