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Environmental Health is a quarterly, international, peer-reviewed journal designed to publish articles on a range of issues influencing environmental health. The Journal aims to provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region.

The Journal publishes articles on research and theory, policy reports and analyses, case studies of professional practice initiatives, changes in legislation and regulations and their implications, global influences in environmental health, and book reviews. Special Issues of Conference Proceedings or on themes of particular interest, and review articles will also be published.

The Journal recognises the diversity of issues addressed in the environmental health field, and seeks to provide a forum for scientists and practitioners from a range of disciplines. *Environmental Health* covers the interaction between the natural, built and social environment and human health, including ecosystem health and sustainable development, the identification, assessment and control of occupational hazards, communicable disease control and prevention, and the general risk assessment and management of environmental health hazards.

Aims

- To provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region
- To promote the standing and visibility of environmental health
- To provide a forum for discussion and information exchange
- To support and inform critical discussion on environmental health in relation to Australia's diverse society
- To support and inform critical discussion on environmental health in relation to Australia's Aboriginal and Torres Strait Islander communities
- To promote quality improvement and best practice in all areas of environmental health
- To encourage contributions from students

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Call for Papers

The Journal is seeking papers for publication.

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Papers can be published under any of the following content areas:

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Guest Editorials address topics of current interest. These may include Reports on current research, policy or practice issues, or on Symposia or Conferences. Editorials should be approximately 700 words in length.

Research and Theory

Articles under Research and Theory should be 3000-5000 words in length and can include either quantitative or qualitative research and theoretical articles. Up to six key words should be included. Name/s and affiliation/s of author/s to be included at start of paper and contact details including email address at the end.

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Short reports of topical interest should be approximately 1500 words. Book reviews should be approximately 700 words and Review Articles should not exceed 3000 words in length.

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enHEALTH

The Environmental Health Committee (enHealth) is a sub-committee of the Australian Health Protection Committee (AHPC) which reports to the Australian Health Ministers' Advisory Committee.

OUR MISSION

The quality of life and health of Australians are underpinned by having clean water and air, safe food and housing, protection from pollutants and a program to intervene in the environment to prevent and control disease. enHealth will identify the Australian environmental health sector's role in developing and supporting infrastructure for health protection.

OUR RESPONSIBILITIES

enHealth, under the guidance of the AHPC, has responsibility for:

- providing nationally agreed health policy advice
- implementing the *National Environmental Health Strategy 2007-2012*
- consulting with key stakeholders and consumers
- developing and coordinating research, information and practical resources on environmental health matters at a national level

PRACTICAL SUPPORT FOR ENVIRONMENTAL HEALTH PRACTITIONERS

In 2008 key enHealth initiatives will include:

- a focus on supporting environmental health initiatives in Aboriginal and Torres Strait Islander communities
- more courses on disaster response (in conjunction with Emergency Management Australia)
- new resources to assist environmental health practitioners in their day-to-day work
- targeted training to enhance professional capacity

For more information go to the enHealth website at http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-environ-enhealth-committee.htm or email enhealth.secretariat@health.gov.au

The Environmental Health Committee (enHealth) sponsorship of the International Federation of Environmental Health 10th World Congress on Environmental Health received funding from the Australian Government, and the State Governments of Victoria, New South Wales, South Australia, Western Australia and Northern Territory.

Since the last issue, the 10th World Congress on Environmental Health has been held in Brisbane from 11-16th May. The Congress saw over 550 delegates attend each day with over 50 countries being represented. Over 120 keynote and other presentations were made and 100 concurrent sessions were conducted during the five day event. A draft Brisbane Environmental Health Charter was presented to delegates at the end of the Congress and this is now being finalised through a consultation process with the International Federation of Environmental Health (IFEH) delegates who attended the Congress.

At the Congress the Australian Institute of Environmental Health (AIEH) changed its name to Environmental Health Australia (EHA) and this was accompanied with a new corporate logo and corporate colours. This issue of the Journal reflects the new EHA corporate livery. Also at the Congress the President of IFEH launched the EHA's first Certified Environmental Health Practitioner (CEHP) Scheme signaling a renewed focus on professional development for environmental health practitioners including encouragement of practitioners to contribute to this Journal.

This Issue contains five articles that examine issues relating to the themes of sustainability and climate change. In addition, four of the keynote addresses on climate change at the 10th World Congress on Environmental Health are also included for readers. Harper et al. examined vermiculture and enteroccoci in domestic biosolids in a residential resort. This examination indicated that the current vermiculture methods that were in use at the resort to create worm castings for potting mixture might not satisfactorily pasteurise the biosolids. As a result, a significant number of pathogenic microorganisms might be present thus posing a potential health risk to workers and guests. The authors indicate that routine monitoring of pathogens is recommended for improved management of stockpiled biosolids.

Williams also conducted in field investigations into the environmental health risks associated with spa baths and the presence of *Pseudomonas aeruginosa* which is known to have the potential to cause heart, central nervous system, ear, eye, bone and joint, urinary tract, respiratory, gastrointestinal, skin and soft tissue infection. The author undertook a survey of water quality in randomly selected spa baths in a defined geographic area and found that water samples collected from the piping system had high concentrations of bacteria including *P. aeruginosa*. Williams recommends that uniform cleaning and maintenance procedures are required on the part of the motel and bed and breakfast industry to ensure safe spa baths. Both articles report on environmental health investigations into the built environment and how there continues to be a need for vigilance.

Olaris undertook an interesting and unique investigation into the community health sector and its capacity to respond to climate change. Given that community health services is a critical institution with a large potential to impact on public health, it is important to understand the capacity of such institutions to respond to large scale environmental change. The results of the investigation showed that the understanding of climate change by the sector was similar to that of the general population. Capacity building in the sector so it can respond to climate change required clear policy direction, support, funding and leadership from government. Leadership within the sector was also identified as an area for strengthening as was clear information about climate change. The article by Song and Tong is timely given that with climate change there is likely to be increased ultraviolet exposure. The authors examine the immunosuppressive properties and mechanisms of UVR and highlight the

need to understand better the biochemical and molecular biological consequences of UVR.

Shengo and Mansoj present a study of water pollution of rivers in Lubumbashi in the Democratic Republic of the Congo from domestic sources and by metallurgical industries. The authors describe the impacts of this pollution on the population dependent on the river for its water supply and the use of its waters for agricultural purposes highlighting the continuing issues associated with the interactions between economic development, environmental impact, and human health.

There are four keynote papers from the 10th World Congress that have been included in this issue. Two of these papers are focused on the environmental health challenges and opportunities associated with Indigenous environmental health (Calma) and the Western Pacific Region (Ogawa) and Pearce provides a paper on the national and international perspectives on disaster management. The last paper by Pinter and Hansen describes a system for recording sustainable development indicators. It is difficult to gain consensus due to the different priorities or unsystematic design of monitoring efforts and the availability and quality of time series data. *The Compendium on Sustainability Indicators: A Global Directory for Indicator Initiatives* is an attempt to bring together experience in one place on best practice for measurement from the global to the local level. The Compendium itself is intended to be a long-term, ongoing initiative.

In subsequent issues further keynote papers from the 10th World Congress will be prepared for publication in the Journal. As always we are keen to hear from anyone wanting to provide a manuscript for publication in any of the categories of the Journal and would like to thank all our contributors.

Jim Smith DrPH LFEHA
Editor-in-Chief

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The Efficacy of Vermicomposting on the Population Structure of Enterococci in Domestic Biosolids in a Residential Resort Community

J. Harper, W. Ahmed, A. Neller, N. Tindale, R. Neller & D. I. Kurtböke

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The effects that vermiculture (VC) treatment had on the population and community structure of enterococci in domestic biosolids in a residential resort in southeast Queensland were investigated by enumerating and typing enterococci with a biochemical fingerprinting method. Vermiculture beds with a substrate consisting of non-amended biosolids from an activated sludge sewage treatment plant were established. Various treatments (earthworms added and earthworms excluded) beds were sampled on three occasions. Enterococci numbers were significantly lower in the earthworm treatments than those without. Of the 300 isolates biochemically fingerprinted, 106 different biochemical phenotypes (BPTs) were identified. The overall mean diversity of enterococci in all beds was high (0.87 ± 0.13; maximum is 1), indicating a diverse enterococci population. The overall mean population similarity (Sp) value among beds was quite low (0.16 ± 0.10) also indicating a diverse population. Antibiotic resistance patterns (ARPs) of the 106 BPTs revealed that 83.6% were resistant to rifampicin, 59.6% were resistant to erythromycin, 21.9% were resistant to tetracycline, 7.7% were resistant to ampicillin and 2.9% were resistant to gentamicin and vancomycin. The results indicate that the current VC methods used in the residential resort to create worm castings for potting mixture might not satisfactorily pasteurise the biosolids and a significant number of pathogenic microorganisms could be present. There remains a potential health risk to workers and guests and routine monitoring of pathogens is recommended for improved management of stockpiled biosolids.

Key words: *Biosolids; Vermicomposting; Wastewater Treatment Plant; Enterococci; Biochemical Fingerprinting; Antibiotic Resistance Patterns*

Organic waste solids derived from wastewater treatment processes, known as biosolids, are increasingly being stored on land and/or used as an amendment to agricultural land. Biosolids contain elevated levels of nitrogen, phosphorus, potassium, calcium and other trace elements essential for plant growth (Barnes et al. 2000; Caberet et al. 2002), but might also contain potential pathogenic microorganisms, organic matter and heavy metals (Farrah & Bitton 1983). Because of this, stabilising (or pasteurising) biosolids is necessary and composting and vermicomposting (VC) are considered among the cheapest and most effective mechanisms available.

Composting reduces the health risks associated with pathogenic microorganisms by taking advantage of indigenous soil microbes and optimising their carbon cycle activities (Herman & Maier 2000; Sidhu et al. 2000). This is achieved by maintaining thermophilic temperatures in the sludge at a level that inactivates

pathogens (Herman & Maier 2000). Vermicomposting (composting using earthworms) has been suggested as an alternative to conventional composting (Eastman et al. 2001). This process achieves a stable end product (worm castes) more rapidly than conventional composting due to the combined action of both earthworms and microorganisms (Dominguez et al. 1997). In addition, worm castes contain higher levels of beneficial nutrients and microorganisms (Eastman et al. 2001).

With increasing affluence in recent decades there has been a proliferation of small settlements and resorts adjacent to and within environmentally sensitive areas, where suitable landfill sites might be scarce, the cost of incineration too high and the discharge of unstable biosolids to sea or waterways unacceptable in Australia. In these circumstances, biosolid management by composting and/or VC might be viable solutions. Indeed, VC has been adopted by one such residential resort community located adjacent to a World Heritage listed estate in Queensland, Australia. The resort maintains a sewage treatment plant (STP) licensed to operate under 2000 equivalent persons. The STP uses an activated sludge system that after settling is dewatered via a filter press. The resort then uses VC to stabilise the biosolids, together with kitchen scraps, garden clippings and shredded office paper, and finally mixes and stockpiles the resulting worm castes with local sands into a potting mix to grow culinary herbs and seedlings for landscaping.

The aim of this study was to investigate the effectiveness of (VC) in further treating secondary treated biosolids from domestic sewage with this existing system. The research focussed on VC to reduce pathogenic numbers in biosolids from activated sludge and its ability to alter enterococci community structure. To evaluate the treatment efficacy, we used biochemical fingerprinting and antibiotic resistance patterns (ARPs) on the abundance and population structure differences of commonly used faecal indicator bacteria 'enterococci' in the biosolids from the VC beds. Researchers have previously used faecal coliforms, *E. coli* or *Salmonella* as indicators, but enterococci are more persistent in the environment than these previously used indicators (Bajsa et al. 2003).

Materials and Methods

Preparation of treatment and sampling

Biosolids, derived from the domestic effluent from the residential resort community were used as source stock. Small experimental VC beds were established alongside the resort beds and consisted of plastic racks measuring 180 mm high, 485 mm long and 485 mm wide. Mimicking the resort beds, each experimental bed consisted of a 75 mm layer of biosolids topped with a sprinkle of a dried mixture of one part sawdust and three parts of dried sludge. Approximately 200 earthworms (*Eisinia fetida*) were then added to each. A total of six experimental beds were established, three with earthworms and referred to as 'worm treatment' (WT) and the remainder without earthworms referred to as 'no worm treatment' (NWT).

To each of these experimental beds a 25 mm layer of biosolids was added each week for six consecutive weeks, mimicking the dose rates and procedures used by the resort. The experiment was repeated on three different occasions during the year (in November, March and April) to examine any differences in indicator bacterial counts resulting from an increase in STP load during the Easter holidays. Annual maximum and minimum temperatures varied between 21.1 and

29.4ºC and 14.3 and 22.4ºC, while monthly rainfall varied between 51 and 168 mm.

Samples of the biosolids and dry sludge mix used in each the three trials were collected in sterile polyethylene bags, transported to the laboratory, stored below 4ºC and tested within 48 h (hereafter referred to as pre treatment [PT] samples). Samples were also collected from the three worm beds (WT) and three non-worm beds (NWT) using sterile garden trowels after six weeks of dosing. All samples from all beds were tested in triplicate. Samples were also taken from the resort's potting mix used to grow culinary herbs and landscaping seedlings.

Physical characteristics of biosolids

Moisture content was determined by drying 5 gm samples at 105ºC for 24 h and then reweighing. Ash content was determined by the loss on ignition method (Nelson & Sommers 1996). The same dried sample from above was ignited at 400ºC for 8 h in a muffle furnace. Organic content was calculated from ash content. The pH was determined for each sample by mixing 10 gm samples with 10 ml de-ionised water, allowing to stand for 10 minutes (Thomas 1996) followed by reading with an ISFET pH meter (IQ125, IQ Scientific, USA).

Isolation and identification of enterococci

In all, 81 sub-samples (i.e. 20 gm from each sub-sample) were collected from PT, WT and NWT beds. Samples were mixed with 180 ml of sterile de-ionised water. Appropriate serial dilutions were made, and the spread plate method was used for the isolation of enterococci. Aliquots (0.1ml) of each dilution were added to m-enterococcus (mE) agar plates (Difco, London, UK). All plates were incubated at 37°C for 48 h to grow faecal streptococci. Isolates from mE plates were also tested for esculin hydrolysis using bile esculin agar (Oxoid, London, UK) and incubated at 45°C for 1 h to confirm their identification (Manero & Blanch 1999).

Biochemical fingerprinting method with the PhPlate system

A biochemical fingerprinting method was used to type enterococci. The principle of this method with the PhPlate system (PhPlate AB, Stockholm, Sweden) has been described previously (Möllby et al. 1993). This method uses quantitative measurements of the kinetics of several biochemical reactions of bacteria in microtiter plates with dehydrated substrates. The typing reagents used in this method are specifically chosen for different groups of bacteria to give an optimal discriminatory power and reproducibility (Möllby et al. 1993). For each bacterial isolate, it yielded a biochemical fingerprint made of several quantitative data, which are used with the PhPlate software to calculate the level of similarity between the tested isolates. In this study, we used PhP-RF plates for typing enterococci and the reagents used in the plates have been described elsewhere (Vilanova et al. 2002).

From each sample, single and isolated enterococci colonies were randomly selected with sterile toothpicks directly from the bile esculin agar plates and suspended into the first well of each row of the plate containing only 350 µl of growth medium. Using a multichannel pipette, aliquots of 25 µl of bacterial suspension were transferred into each of the other 11 wells containing 150 µl growth medium. Plates were then incubated at 37°C and A_{620} was measured at 16, 40 and 64 h for enterococci using a micro plate reader (Lab-Systems Multiskan, Helsinki, Finland). After the final reading, the mean value for all three readings was calculated for each isolate. An identity (ID) level

of 0.965 was established based on the reproducibility of the system (Kühn et al. 1997). Isolates with similarity higher than the ID level were regarded as identical and assigned to similar biochemical phenotypes (BPTs).

The phenotypic diversity among the isolates was measured with Simpson's index of diversity (Di) (Atlas 1984). Diversity in the present study depends on isolates distribution into different BPTs. It is high (maximum of 1) for a population consisting of different BPTs and is low (minimum of 0) if the populations consist of few BPTs. The similarity between different bacterial populations in two or more samples was calculated as a population similarity (Sp) coefficient. The Sp coefficient calculates the proportion of isolates that are identical (i.e. having the same BPT) in two or more bacterial populations that are compared (Kühn et al. 1991). It is high (maximum of 1) if two populations contain similar BPTs, and is low (minimum of 0) if the populations contain different BPTs. Similarities between the isolates and populations were calculated as correlation coefficients and clustered according to the unweighted-pair group method with arithmetic averages (UPGMA) (Sneath & Sokal 1973). All data handling, including optical readings, calculations of population similarity values as well as clustering was performed using the PhPlate software version 4001 (PhPlate system).

Testing the isolates for antibiotic resistance

The antibiotics tested in the current study (ampicillin, erythromycin, gentamicin, rifampicin, tetracycline and vancomycine) are commonly used in the treatment of various infections. For example, rifampicin has been used to control tuberculosis, leprosy and staphlycoccal infections (Ashokraj et al. 2005) and vancomycin was regarded as the ultimate treatment of enterococcal infections until vancomycin resistant strains began to appear in European hospitals (Kühn et al. 2000).

The disk diffusion method was used to test for antibiotic resistance. One representative strain of each BPT was tested for antibiotic resistance patterns (ARPs). An inoculation loop full of suspending medium was taken directly from the PhPlates and streaked on mE agar plates. After 48 hours of incubation at 37°C, colonies were inoculated overnight into tryptic soy broth (TSB). A sterile swab was then used to spread the overnight cultures onto Mueller-Hinton (Oxoid, USA) agar plates. As soon as the surface of the plates dried, one antibiotic disk each of ampicillin (5 µg), erythromycin (10 µg), gentamicin (200 µg), rifampicin (5 µg), tetracycline (30 µg) and vancomycin (30 µg) (Martin et al. 2005) was pressed onto the inoculated plates not closer than 25 mm to each other, using sterile forceps. Plates were then incubated at 37°C for 24 hours. Zones of inhibition, represented by clear circular areas of no microbial growth around the antibiotic disks, were measured to the nearest millimetre. These measurements were then compared to antimicrobial disk susceptibility performance standards (World Health Organization [WHO] 2000) and given a rating of susceptible, intermediate or resistant.

Statistical analysis

The aim of the statistical analysis was to test the null hypothesis that WT has no effect on the numbers or the community structure of enterococci after a period of six weeks relative to NWT. Two-level nested analysis of variance (ANOVA) with Tukey's post hoc tests was used to test the effect of earthworms on enterococci numbers. Since three samples were taken from each of the three beds for each

treatment, samples were nested within beds. The main factors (presence of earthworms and time of experiment) were then tested for their effect on enterococci numbers. The effect of the covariate factors pH, moisture content and organic matter content were also factored in. One-way ANOVA was used to compare the significance of the difference of enterococci diversity in experimental beds. These analyses were performed using the SPSS statistical package v.11.5 (SPSS, Chicago, USA).

Results

Abundance of enterococci

Enterococci numbers in untreated biosolids (i.e. PT) ranged between 2.47 and 3.83 log10 cfu/gm (i.e. equivalent to 300 - 6,800 cfu/gm) (Figure 1). The numbers of enterococci in biosolids from NWT were differed significantly ($F_{2, 78} = 14.298$, $p=0.001$) than both the PT and WT beds.

There was a significant interaction ($F_{4, 64} = 4.670$, $p= 0.002$) between the presence of worms and experimental time (November, March and April) so enterococci numbers for each experiment time were examined separately. Tukey's post hoc analyses indicated that for the November and April beds there were significantly lower numbers of enterococci in the biosolids in the presence of earthworms compared to those where the earthworms were excluded (Nov $F_{2, 16}= 22.076$, $p=0.001$; Apr $F_{2, 16}= 15.996$, $p=0.001$) (Figure 1). During November and April there was no significant difference found in enterococci numbers between PT and WT beds (Figure 1). There was also no significant difference found in enterococci numbers between treatments (i.e. PT and WT) in the March beds ($F_{2, 16}= 0.291$, $p=0.752$) (Figure 1).

Results from a general linear model indicate that pH has a significant effect on enterococci numbers. In the November and March beds, higher enterococci numbers were found in treatments with higher pH (November $F_{1, 21} = 9.425$, $p=0.006$; March $F_{1, 21} = 0.018$, $p=0.018$) (Figure 2). In contrast, no such relationship was found in the April beds ($F_{1, 21} =0.802$, $p=0.381$).

Figure 1: Number of enterococci in the pre treatment (PT), work treatment (WT) and no worm treatment (NWT) during November, March and April

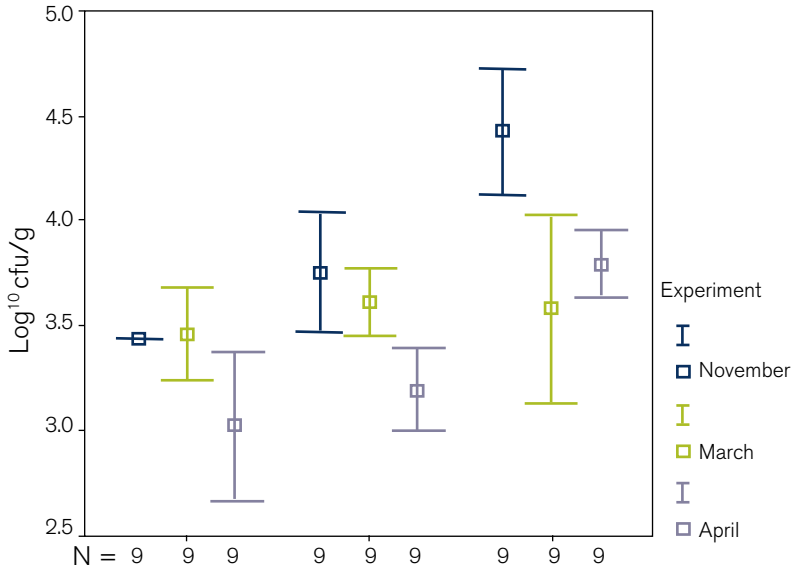
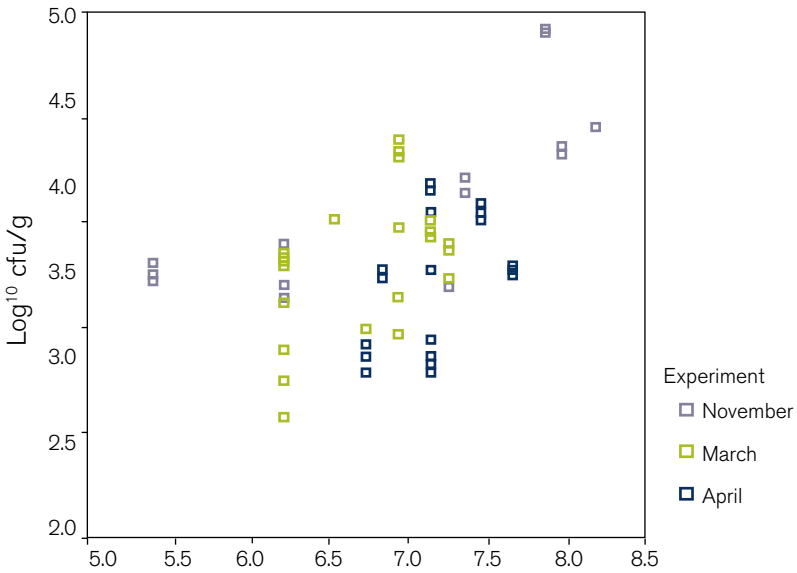


Figure 2: The relation between pH and enterococci numbers in experimental beds during November, March and April



Biochemical fingerprinting

From all experimental beds a surprisingly high 300 enterococci isolates representing a total of 157 BPTs were typed of which 106 unique BPTs were identified (Table 1). The diversity of enterococci in all experimental beds was also quite high, with an overall mean diversity of (0.87 ± 0.13). There were also no significant differences in enterococci diversity among experimental beds when samples from all 3 occasions were pooled.

BPTs obtained from the experimental beds on each occasion were then compared to each other. In all, 45 BPTs were found in the November beds, of

Table 1: Number of isolates tested and their diversity index (Di) in pre-worm treatment (PT), worm treatment (WT) and no worm treatment (NWT) on 3 sampling occasions (November, March and April)

Occasions	Experimental beds	No of isolates tested	Diversity	No. of BPTs found	Occurrence of BPTs UQ (%)	SH (%)
	PT	19	0.95	14	8	6
Nov	WT	39	0.93	18	7	11
	NWT	39	0.68	13	4	9
Sub-total		97	0.85	45	19 (42)	26 (58)
	PT	38	0.98	27	23	4
Mar	WT	29	0.95	18	10	8
	NWT	34	0.96	19	8	11
Sub-total		101	0.96	64	41 (64)	23 (36)
	PT	25	0.62	6	3	3
Apr	WT	38	0.84	19	13	6
	NWT	39	0.95	23	9	14
Sub-total		102	0.80	48	25 (52)	23 (48)
Total		300	0.87 ± 0.13*	157	85 (54%)	72 (46%)

**Mean and standard deviation*

UQ = unique, SH = shared

Table 2: Population similarity (Sp) value of enterococci populations among experimental beds on different occasions (November, March and April)

Experimental beds	PT-Nov	WT-Nov	NWT-Nov	PT-Mar	WT-Mar	NWT-Mar	PT-Apr	WT-Apr	NWT-Apr
PT-Nov	1.00								
WT-Nov	0.24	1.00							
NWT-Nov	0.12	0.24	1.00						
PT-Mar	0.03	0.08	0.06	1.00					
WT-Mar	0.24	0.27	0.10	0.07	1.00				
NWT-Mar	0.20	0.29	0.11	0.06	0.33	1.00			
PT-Apr	0.13	0.18	0.04	0.02	0.09	0.18	1.00		
WT-Apr	0.07	0.17	0.38	0.02	0.07	0.10	0.01	1.00	
NWT-Apr	0.20	0.33	0.19	0.12	0.24	0.34	0.19	0.22	1.00

PT: pre-treatment; WT: worm treatment; NWT: no worm treatment

which 42% were unique (UQ) to specific beds and 58% were shared (SH) among beds. Equivalent figures for March and April were 64% UQ and 36% SH, and 52% UQ and 48% SH respectively (Table 1). A population similarity (Sp) analysis was further performed between the enterococci populations from each bed on all occasions. Of interest was the low Sp-values obtained, with only three of the 36 comparisons having Sp-values exceeding 0.3 and none exceeding 0.4 (Table 2). The overall mean Sp-value among all beds on three occasions was 0.16 ± 0.10. These results indicate that enterococci populations from all experimental beds were quite diverse. Few types were shared among treatments and/or experiment times. These results further suggest that there does not appear to be any pattern relating survival (but not abundance) of enterococci isolates with the presence or absence of earthworms.

Antibiotic resistance patterns

Of the 106 representative enterococci BPTs/isolates tested for antibiotic resistance, 94 (84%) were resistant to rifampicin with a further 7 (7%) classified as having an intermediate resistance. A total of 23 (22%) isolates were resistant to tetracycline and three (3%) were resistant to vancomycin. Resistance to erythromycin was evident in 62 (60%) isolates while resistance to ampicillin and gentamicin was found in eight (8%) and three (3%) isolates respectively. All three isolates resistant to vancomycin were resistant to at least three other antibiotics with two resistant to five of the six antibiotics tested. Those isolates resistant to vancomycin were isolated from NWT during March, while the other two were isolated from NWT during April. Similarly, the eight isolates resistant to ampicillin were also isolated only once each. Only seven out of 106 isolates were susceptible to all six antibiotic tested, five of which were isolated once each. Of interest was the level of resistance evident particularly against vancomycin, gentamicin and rifampicin.

Discussion

Organisms that could present a public health risk could still be present after the composting process applied to biosolids such as helminths, protozoa and viruses. In this study, however, only enterococci were used as indicator microorganisms for the presence of potential pathogenic microorganisms in an operational VC system. While most previous studies used faecal coliforms, *E. coli* or *Salmonella* as indicators (Bajsa et al. 2003; Cardosa Vigueros & Camperos 2002; Eastman et al. 2001) an advantage of enterococci as a bioindicator is that these bacteria are more persistent in the environment than

faecal coliforms (Gleeson & Gray 1997). It has been reported that the survival rate of enterococci is better than faecal coliforms or *Salmonella* in various traditional composting systems (Christensen et al. 2002).

Our results indicate high variations in enterococci numbers from PT samples and this could be due to variations in the occupancy rates and diverse and transient nature of the population. The presence of pathogenic microorganisms depends on several factors such as size and health of the population, infection rate in the community, seasonal change and the efficacy of treatments to reduce pathogens (Sidhu et al. 2000). The population associated with the studied system is constantly fluctuating as international guests might stay for a couple of days to several weeks. It has been reported that travellers are more susceptible to endemic gastro-intestinal pathogens than local populations (Cruickshank et al. 1988) and travellers might, therefore, be considered vectors of exotic endemic pathogens to the sewage system.

The present study mimics the standard operating practices at the VC facility whereby fresh biosolids are added to the worm beds each week. Not surprisingly, no significant differences were found in enterococci numbers between the PT and WT samples, while enterococci levels in the NWT beds increased. In this operating environment VC handles the additional loads much better than traditional composting, but it might be prudent for the facility to alter current practices to a single feed stock system.

The diversity of enterococci isolates in the STP and VC systems was quite high. In all, 106 BPTs were found among 300 enterococci isolates typed. These data can be compared with those of another study in which 110 BPTs were derived from 1072 enterococci isolates typed from 35 residential septic tanks using the same biochemical fingerprinting method (Ahmed et al. 2005). The nature of the current population is such that a variety of BPTs would be expected. Indigenous diet, cultural practices and climate might all affect the diversity of intestinal micro-flora of humans (Sattar 2003) and a population with diverse international origins, may become centres of high enteric microbe diversity.

Only 11.8%, 5.4% and 2.5% of the BPTs were isolated from PT, WT and NWT respectively and the population similarity values among treatments were low, ranging from 0.01 to 0.38. These results contrast with results of Vilanova et al. (2002), whose study of five Spanish STPs showed similarities between populations as high as 0.57. This lower rate in the current study might be due to the transient population of the residential resort and the application of additional biosolids (and potentially new BPTs) throughout the experiment. Similarly, no pattern emerged after analysing ARPs of enterococci isolates when compared to pre-treatment. However, some interesting comparisons can be made with other studies. The current study revealed only seven BPTs out of 106 were susceptible to all antibiotics tested and multiple antibiotic resistance (MAR) was evident in 67 out of 106 (63.8%). This contrasts with a European study in 1983, which concluded that MAR was rare in environmental samples (Bayne et al. 1983). However, the current study had disturbingly similar results to a Brazilian study where MAR was identified in 67% - 84% enterococci isolates from an intensive care unit (Titze-de-Almeida et al. 2004). Enterococci are part of the normal intestinal flora. While they are not considered to be highly virulent, their intrinsic resistance and ability to acquire resistance to several broad-spectrum antibiotics has led to them becoming the second most common cause of nosocomial infections (e.g. accounting for 12% of nosocomial

infections in the US) (Linden & Miller 1999). Importantly, they are known to spread resistant genes to other species including *Staphylococcus aureus* and *Listeria* spp. via horizontal gene transfer (Kühn et al. 2000; Menichetti 2005).

With respect to management and health considerations for VC facilities the current study did not explore the full process adopted at this facility. Immediately after vermiculturing at this facility the castings are stockpiled for at least six months, and then used as potting mix. Nonetheless, the current VC methods used to create worm castings in the facility do not satisfactorily pasteurise the biosolids. At the end of the VC process, as it is currently operated, a significant number of pathogenic microorganisms appear to be present in the biosolids. There is also a high level of antibiotic resistance among enterococci isolated from the biosolids. These diverse ARPs could again be due to the addition of extra biosolids during the VC process. Since pathogens are present in the vermicomposted biosolids there is a potential health risk to workers. It is recommended that the practices at the facility be modified to cease the addition of fresh non-amended biosolids during the vermicomposting process. The effectiveness of the vermicomposting system to reduce overall pathogen loads across all groups (bacteria, viruses, helminthes, protozoa) could then be re-assessed.

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Spa Baths in Motel Accommodation and *Pseudomonas* Risk

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Few people realise when they fill a spa bath and lie back to enjoy the relaxing hydrotherapeutic effects of the warm, agitated water, that they are potentially exposing themselves to dangerous bacteria. The accumulation of soap film, hair, dead skin, body oil, dirt and faeces in the piping system increases nutrient load and creates ideal conditions for bacterial survival and multiplication. The rapid growth of the opportunistic pathogen, Pseudomonas aeruginosa *in spa baths, which are commonly installed in modern motel rooms and even domestic homes, has the potential to cause cardiac, central nervous system, ear, eye, bone and joint, urinary tract, respiratory, gastrointestinal, skin and soft tissue infection. A case of folliculitis prompted an environmental health investigation that identified a spa bath in a Newcastle motel as a possible source. The spa bath and piping system water was sampled and high levels of* P. aeruginosa *were detected. The system was decontaminated and a cleaning and maintenance program established with the assistance of water treatment professionals. A sampling program also commenced to monitor the efficacy of the maintenance program. As a result of the investigation, a survey commenced to determine the water quality in randomly selected spa baths installed in motel and bed and breakfast establishments in the Hunter Region of New South Wales (NSW). Water samples were collected from spa piping systems and high concentrations of bacteria including* P. aeruginosa *were commonly found. Where* pseudomonas *was detected or total plate counts were above 100 colony forming units per millilitre, systems were decontaminated and a cleaning and maintenance program commissioned with the assistance of a water treatment professional. A sampling program regularly to monitor water quality was also recommended. There is a clear need for a strong partnership between health agencies, motels and water treatment industries to establish uniform cleaning and maintenance procedures to ensure safe spa baths.*

Key words: *Spa Bath;* Pseudomonas Aeruginosa*; Folliculitis*

The presence of *Pseudomonas aeruginosa* in heated water bathing locations is not uncommon. Swimming pools, spa pools, whirlpool baths, hot tubs and spa baths, have all been shown to accommodate this causative agent and to be implicated in waterborne disease outbreaks (Reynolds 2001).

The risk of infection associated with spa baths is affected by water temperature and agitation, body emersion, underlying medical conditions and water treatment. Spa baths installed in motel, hotel and domestic residences can provide ideal growth opportunities for *P. aeruginosa*. The closed circuit piping and irregular use serve as a haven for bacterial multiplication.

Spa Baths

Unlike commercial swimming pools and spa pools there are no legislative requirements for hotel, motel or domestic spa baths to have water filtration and treatment systems or monitoring equipment installed. Spa baths are typically watertight tubs filled with warm to hot water and agitated by the pumping of air and water through a piped system to jets below the water level. Tubs are usually drained directly to a waste system through an outlet in the base of the unit.

These 'piped tubs' do not completely drain all water from the system to waste. The closed circuit pipe work retains water through suction and moist internal pipe surfaces provide a moist, dark and warm environment conducive to the growth of bacteria. The introduction of dead skin, hair, fats, soap debris and scum into the tub by users allows formation of a biofilm on the inside walls of the pipe work and fittings. This biofilm provides a protected environment for bacterial multiplication. When the tub is next used this accumulation of matter and bacteria might be carried by fresh water and reintroduced into the clean tub water.

Routes for microbial infection in spa baths include aerosol mists, direct ingestion of water or skin contact. The oral exposure route is less common, due to the fact that submersion of the head is not routinely practised. The aerosol route might be increased due to the use of mist-producing jets for water circulation and massage (Reynolds 2001).

Pseudomonas aeruginosa

The primary disease-causing microbial agent associated with spa baths is the opportunistic pathogen *P. aeruginosa* (Highsmith 1985). This bacterium is capable of survival in water systems, being able to proliferate under warm and moist conditions.

P. aeruginosa is a gram-negative aerobe belonging to the family Pseudomonadaceae. It is rod shaped, occurring singly, in pairs or in short chains. It is mobile, with polar, monotrichous flagella. It can metabolise more than 30 organic compounds to allow multiplication. It has minimal nutritional requirements, and is able to grow in distilled water. It can tolerate a wide variety of physical conditions and temperatures, contributing to its ecological success and ultimately to its role as an effective opportunistic pathogen. The bacteria grow optimally between 37°C and 42°C. *P. aeruginosa* can cause cardiac, central nervous system, skin, ear, eye, bone and joint, urinary tract, respiratory, gastrointestinal, and soft tissue infections. It is the micro-organism most commonly associated with outbreaks of dermatitis and folliculitis in users of spa baths. Susceptibility to dermatitis or folliculitis has been linked to three main factors: (i) immersion in water colonised by *P. aeruginosa*, (ii) skin hydration with altered skin flora, and (iii) toxic reaction to exotoxins produced by *P. aeruginosa* (Morrison 1984).

Although shedding from infected humans is the predominant source of *P. aeruginosa* in swimming pools, spa pools and spa baths, the surrounding environment can be a source of contamination. The warm, moist environment on decks, drains, benches and floors provides an ideal environment for the growth of *P. aeruginosa*, that bathers might then introduce from their feet and hands into the water. The heated water in spa baths promotes bather perspiration and desquamation, which adds to the nutrient load for the growth of *P. aeruginosa* (Pollock 1990).

The epidemiology of *P. aeruginosa* reflects its predilection for a moist environment. This is apparent in its natural habitat, where it is associated with soil, water and on plants in humid environments. Similarly, human

colonisation occurs at moist sites such as the perineum, axilla, and ear. Human *Pseudomonas* disease is also associated with water-related reservoirs of infection, including swimming pools, whirlpools, hot tubs, spas and lens solutions (World Health Organization 2001).

P. aeruginosa rarely causes disease in healthy persons, although it is a common human saprophyte (Pollock 1990). In most cases the disease process begins with some alteration of normal host defences. This may involve a disruption in the integrity of physical barriers to bacterial invasion, such as skin or mucous membranes. In other instances an underlying dysfunction of specific immune mechanisms contributes to a colonisation by *Pseudomonas*. Its adaptability to a wide variety of physical conditions, minimal nutritional requirements, and relative resistant to antibiotics, allows it to survive in large numbers close to prospective hosts (World Health Organisation 2001).

Folliculitis

A hair follicle is a small skin cavity in which a hair develops. Inflammation or infection of hair follicles is called folliculitis. Spa bath folliculitis is an infection of the hair follicles that occurs after spa bath exposure. The primary disease-causing microbial agent associated with spa bath folliculitis is *P. aeruginosa* (Pollock 1990).

The visible signs of folliculitis usually occur within three days of exposure, with an itchy, raised rash usually on the trunk, arms, legs, buttocks and especially in areas where bathing suits hold infected water against the body. The rash comprises small fluid filled blisters called pustules. Untreated, pustules might progress into dark red, tender, hard nodules, also known as furuncles or boils (Mandell, Bennett & Douglas 2000).

Folliculitis is transmissible between people, and individuals with folliculitis should wash their hands thoroughly and use separate towels and wash cloths. People with this condition should not use a hot tub until the condition has cleared. Infants should be excluded from school and childcare (National Health and Medical Research Council 2005).

A recent case of folliculitis linked with use of a spa bath in a Newcastle motel, prompted a survey of similar establishments to determine public health risk. In this incident a patron who had used a spa bath in a motel room presented within 48 hours at a local hospital with a severe rash on her trunk and arms. In the ensuing 24 hours the rash developed into an irritating mass of pustules. *P. aeruginosa* was confirmed on laboratory diagnosis. Samples from the implicated spa bath were positive for *P. aeruginosa* and the spa bath was decontaminated and with the owner's cooperation a new maintenance and cleaning regime was introduced to control the growth of pathogens in and around the spa bath.

Method

Twenty-two of the 150 motels in the Hunter Region of New South Wales were randomly selected to determine the microbial condition of water in their spa baths. Selection was limited to one premise from each motel chain. Initial contact was made with the owner/manager of the motel to gather information on location, number of rooms, and number of spa baths installed on the premises.

Initial inspections exposed difficulties in sample collection of water in the closed circuit pipe work or pump due to unit design, limited installation space and surrounding décor. A sampling protocol was developed to provide a representative sample of circulating spa bath water. Each spa bath was filled with clean warm

water from the reticulated water supply to a level above the jets and the water intake valve to allow the water trapped in the spa bath pipe work to be circulated through the system and released into the clean spa bath water for sampling. The pump was turned on and a 250ml first flush sample collected from a jet outlet.

Thirty-four spa baths were sampled at the 22 motels over an 8-week period and samples were forwarded to the Institute of Clinical Pathology and Medical Research (ICPMR) laboratory for *Pseudomonas* and Total Plate Count analysis. The samples were collected, labelled, refrigerated and transported overnight in cooler boxes to the laboratory for analysis. Arrangements were made with the laboratory that should early observations indicate a presumptive failure the officer be notified by telephone to enable the specific spa bath to be decontaminated. Decontamination was accomplished by following the recommended cleaning procedure of circulating water containing 50ppm free available chlorine throughout the pipe work and pumping for 30 minutes. The spa bath was then drained and the procedure was repeated using circulating water containing 5ppm free residual chlorine. The spa bath was then flushed with clean reticulated water, drained and wiped dry (New South Wales Department of Health 2004). Owner/managers were requested to prepare a policy and procedure document outlining the operation, treatment, maintenance and ongoing monitoring of all spa baths installed on their premises. This work was to be done with the assistance of a water treatment professional. Spa bath water quality bacteriological criteria were determined using the South Australian Spa Bath Criteria (South Australian Standard) and the NSW Commercial Swimming Pools and Spa Pools Guidelines (New South Wales Department of Health) (Table 1).

Table 1: Bacterial criteria for acceptable operation of spa baths

Heterotrophic Plate Count	100 Colony Forming Units (CFU) per mL
Thermotolerant coliforms	Nil per 100 mL
Pseudomonas aeruginosa	Nil per 100 mL

Source: New South Wales Department of Health 1996, p. 18

Results

Three of the 34 samples were discarded for Total Plate Count (TPC) analysis while results for *P. aeruginosa* and thermotolerant coliforms were available for all samples. All samples had TPC above 100cfu/mL, with 90% above 1000cfu/mL and 52% above 20,000cfu/mL (Table 2). Most specimens (77%) had *P. aeruginosa* detected with 53% above 10 cfu/mL. Thermotolerant coliforms were detected in 18% of samples with 9% above 10cfu/mL.

Table 2: Bacterial results of spa bath sampling in 22 motels from the Hunter

	Total Plate Count/mL (*n*=31)	*P. aeruginosa*/ 100mL (*n*=34)	Thermotolerant Coliforms/100mL (*n*=34)
Exceedence (15%CI)	31	26	6
% Exceedences	100	76.5 (62.2 - 90.7)	17.6 (4.8 - 30.5)
Range (cfu)	150 - 140K	0 - >2,000	0 - >200
Mean (cfu)	29,445	159	8
Criteria for Exceedence	100	0	0

Note: Mean values are calculated using result cut-off values where results are given as 'greater than n' (e.g. >2000)

Discussion

This survey identified widespread pathogenic bacterial contamination in a sample of spa baths from motels and bed and breakfast establishments in the Hunter Region of NSW. As the NSW Health Department currently does not have specific microbiological parameters for motel spa bath operation and maintenance, the parameters from the NSW Health Department's 1996 'Public Swimming Pool and Spa Pools Guidelines' were used to provide reference standards.

In order to maintain healthy environments in and around spa baths, owner/operators need to conduct proper and consistent maintenance, use appropriate disinfectants designed for spa baths, and ensure effective residual concentrations of disinfectants.

The operation of spa baths and more specifically closed circuit hydraulic systems must be understood by persons in charge of premises and maintenance staff controlling their use. Cleaning and maintenance procedures need to be strictly observed, especially between room occupations. The owner or manager of premises where a spa bath is installed should prepare a policy and procedures document in consultation with water treatment professionals outlining the operation, treatment, maintenance and monitoring of each spa bath so that a safe environment can be assured. In addition a water-sampling program should be used to monitor the efficacy of the cleaning and maintenance program in order to minimise the possibility of disease outbreak.

P. aeruginosa might be introduced into spa baths from the external environment on the feet or clothing of users. The use of an appropriate cleaning regime on the spa and its surrounds between each different booking will reduce the presence of *P. aeruginosa* in the spa bath environment. Community awareness of safe use of spa baths should be guided by signage and user guides in the immediate vicinity of spa baths. In addition, to encourage spa bath infection control practices, facilities like showers should be readily available. The preparation of educational fact sheets would assist owner/managers and patrons of premises where spa baths are installed.

Conclusion

The almost universal presence of bacterial coliforms and widespread occurrence of *P. aeruginosa* in this survey of motel spa baths indicates an inherent problem with maintaining standards of hygiene and sterilisation of spa baths within the motel and bed and breakfast industry. Regular maintenance and cleaning with appropriate disinfectants between each use is critical to ensuring the safety of these facilities.

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Community Health Services and Climate Change: Exploring the Sector's Capacity to Respond

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This study aimed to determine the capacity of metropolitan Community Health Services (CHSs) in Victoria to respond to climate change. This included outlining the current understanding of climate change among the staff of CHSs; documenting the extent to which CHSs implement climate change policy and practices; and identifying the barriers affecting the capacity of CHSs to respond to this issue. Representatives from over half of the CHSs were interviewed in June and July 2007. Results showed that the understanding of climate change by the sector was of a level which was probably similar to that of the general population. Climate change had not yet registered as a strategic issue, however, most CHSs were implementing an array of environmental policies and practices. All participating CHSs believed that climate change is an important issue for Community Health and all wanted to be doing more. Barriers to the capacity of the sector included a lack of policy direction, support, funding and leadership from government. Leadership within CHSs was also identified as an area for strengthening. The provision of clear information about climate change and related evidence based practice would increase the sector's ability to undertake effective action. Results of this study are of potential relevance to other community organisations.

Key words: *Climate Change; Climate Change Action; Community Health; Community Health Services; Environmental Action; Global Warming*

Climate change is arguably one of the greatest environmental challenges in recent history and is predicted to have significant impacts on lifestyles, economy and health in the future. An adequate response to this important issue requires timely and robust actions at an international, national, state and local level.

The impact of climate change on human health is predicted to be substantial and of a predominantly negative nature (Australian Medical Association 2004; McMichael & Woodruff 2002). Climate change is an issue of considerable relevance for the health sector. The Community Health (CH) sector as a major provider of primary health care in Victoria has an important role to play, particularly at a local level. Community Health Services (CHSs), like all in the community, have a social responsibility to decrease their carbon imprint and thereby contribute to the mitigation of climate change.

The aim of this study was to determine the capacity of metropolitan community managed CHSs in Victoria to respond to climate change. The term 'community managed' CHSs has been used to describe CHSs which are independently governed by a Board of Management representing their local communities. The objectives of the study were to determine the current understanding of climate change within CHSs; document the extent to which CHSs currently implement policy and practices that respond to climate change; and identify the barriers affecting the capacity of CHSs to respond to climate change.

Climate Change

Definition

Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) (2004, p. 4) as "a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer)".

Causes of climate change

The major drivers of climate change are significantly increased atmospheric concentrations of greenhouse gases, particularly carbon dioxide (CO_2), methane and nitrous oxide. CO_2 is the most significant of these, constituting 77% of all global greenhouse gas (GHG) emissions in 2004. Increases in greenhouse gases (GHGs) have been caused predominantly by human activity; in particular the use of fossil fuels, such as coal, oil and natural gas; the clearing of land and to a lesser degree agricultural activity (Intergovernmental Panel on Climate Change 2007a & 2007b).

Effects of climate change

Climate change is already occurring. Temperatures have increased by an average of 0.13ºC per decade over the last 50 years, and 11 of the 12 years from 1995 - 2006 were the warmest since record keeping began in 1850. There have been fewer cold days and nights and more hot days and nights across most of the globe, and more sustained and intense heat waves and droughts (Intergovernmental Panel on Climate Change 2007a).

Other trends observed in the late twentieth century include increased extreme weather events, and altered patterns of precipitation and winds. Sea levels have risen by an average of 3.1 mm per year from 1993 - 2003 as a result of factors such as the decrease in glaciers, ice sheets and snow cover, and an increase in ocean temperatures which causes seawater to expand (Intergovernmental Panel on Climate Change 2007a).

The IPCC predicts that current patterns of change are likely to worsen in the future with adverse impacts on plant and animal communities, coastal systems, agriculture and forestry. By the end of this century global surface temperatures are estimated to increase by 1.1 - 6.4ºC and sea levels to rise by 18 - 59 cm (Intergovernmental Panel on Climate Change 2007a).

In Victoria the annual number of days over 35ºC is expected to grow by 1 - 3 days by 2030, and 3 - 13 days by 2070. Drought risk will increase and water supplies will be reduced by 4 - 15% by 2020 and 10 - 40% by 2050. Other predictions include an increased incidence and severity of bushfires and increased solar radiation due to less cloud cover (Victorian Government 2006a).

Effects on human health

Human health has already begun to be affected by climate change, however, the impacts will appreciably increase in the future. Forecasts include altered rates and distributions of some food, vector and water borne infectious diseases; food and water insecurity; increased malnutrition and diarrhoeal disease; and decreased air quality leading to an increased incidence of respiratory and cardiovascular illnesses (Australian Medical Association 2004; Intergovernmental Panel on Climate Change 2007c; Preston et al. 2006; Tong 2000).

Rates of heat related morbidities and mortalities will increase (Preston et al. 2006; Tong 2000). Victorian data predict 582 to 604 annual heat related deaths by 2020 compared to 289 in 2006. Increased solar radiation in Victoria will have probable impacts on skin cancer rates (Victorian Government 2006a).

The potentially devastating effects of extreme weather events include injuries, spread of infectious diseases, stress related disorders, poor access to safe food and water, homelessness and loss of life (Tong 2000). Rising sea levels will have a significant impact on agriculture and fresh water sources and will cause vast numbers of people living in low lying areas around the world to be displaced (McMichael & Woodruff 2002; Tong 2000).

Effects on the economy

Climate change has the potential to cause considerable economic impact, however, there is growing evidence to suggest that this will not be excessive if prompt action is taken (Australian Business Roundtable on Climate Change 2006; Stern 2006). For example, there is considerable consensus that developed countries need to cut their GHG emissions by a minimum of 60% by 2050, from 2000 levels (Preston & Jones 2006). If Australia has significant responses in place by 2013 and achieves a 60% emissions cut, analysts estimate the cost will be a modest 0.1% of our Gross Domestic Product. If action does not begin until 2022, the cost will increase threefold (Australian Business Roundtable on Climate Change 2006).

Responses - adaptation and mitigation

If GHG emissions are decreased by 60% by 2050, temperature increases this century are predicted to be restricted to 1.5 - 2.9ºC. This would avoid some of the most devastating effects of climate change, however, there would still be significant changes in our environment (Preston & Jones 2006). It is, therefore, imperative that responses to climate change are implemented urgently and that these actions incorporate strategies both to adapt to, and mitigate the effects of, climate change.

Adaptation is described as "the development of additional capacity within communities to cope with the many environmental, social, economic and health impacts that climate change will bring" (Climate Change and Development Roundtable 2006, p. 9). An example of an adaptive response is the Victorian government's proposed development of a Victorian Heat Wave Strategy (Victorian Government 2006b) which aims to strengthen community capacity to respond to heat waves and, therefore, minimise heat related morbidity and mortality.

Mitigation refers to actions to diminish the effects of climate change by decreasing GHG levels. This includes actions to reduce emissions from energy use, to improve agricultural and waste management practices and to increase forestation (Intergovernmental Panel on Climate Change 2007b, p. 14). While international and national actions, such as the developments of climate policies, agreements, regulation methods, standards and charges and increased research and development, are strongly advocated, local actions also play a role in the mitigation of climate change. Actions that result in lifestyle or behavioural change, and management practices that educate, reward, monitor, document and implement climate change actions can be effective in reducing energy use. Local level voluntary activities might, however, be of limited benefit unless part of a broader array of strategies (Intergovernmental Panel on Climate Change 2007b).

Social justice and social responsibility

The developed, industrialised nations are by far the world's greatest producers of GHGs, however, ironically, climate change will have the greatest impact on the poorest of the world's populations in developing countries (Australian Medical

Association 2004; Intergovernmental Panel on Climate Change 2004; Climate Change and Development Roundtable 2006). The vulnerability of a population to climate change is dependent on geographical factors, economic, material, and technological resources, and on government systems (McMichael & Woodruff 2002). For this reason, climate change will increase health inequities across the world.

Even within developed countries like Australia, vulnerable groups will suffer more significantly from climate change. For example, those on lower incomes, those with less choice about where they live, those with chronic diseases, elderly people, Aboriginal people, and those with poorer access to information and to health care, are likely to suffer more significantly from climate change (Australian Medical Association 2004; Lee 2007; United Nations Environment Programme, 2007). Climate change is a significant social justice issue.

Australia ranks 14th in the world for CO_2 emissions and sixth for per capita rates of GHG emissions (World Bank 2007). Australia is also the largest exporter of coal in the world, thereby contributing to the growing level of GHGs produced by other nations (Climate Change and Development Roundtable 2006). As one of the wealthier nations of the world, and a significant contributor to global GHG emissions, Australia has a social responsibility to undertake effective responses to climate change.

Community health services

Climate change is an issue of considerable relevance for the Victorian CH sector which utilises a primary health care approach incorporating illness prevention and health promotion. The work of the sector is underpinned by a commitment to social justice and to the social model of health. CHSs thereby aim to address the medical, biological, social and environmental determinants of health (Department of Humans Services 2003). They have a strong record of working in partnership with other sectors, and the community, in order to address these determinants. CHSs seek to address health inequalities by providing relevant and accessible services to those most disadvantaged in the community. They have a mandate to provide local responses to health and wellbeing issues that affect their communities of interest (Victorian Department of Human Services 2007a). CHSs also respond to local health needs by advocating change at both a state and federal level.

Methods

This qualitative study targeted metropolitan community managed CHSs in Victoria. Community managed CHSs are independently governed by a Board of Management representing their local community. Rural CHSs and those CHSs managed by acute health services were excluded because they might be subject to different organisational arrangements, government policies, funding opportunities and accountabilities.

A convenience sample of 12 CHSs, which equates to 52% of possible CHSs, participated in telephone interviews in June and July 2007. CHC participation was voluntary and all results have been de-identified. Participating CHSs were asked to identify a staff member who would be best placed to respond on behalf of the organisation to questions relating to the study's objectives. It was requested that this person consult with others in the organisation prior to the interview if required to facilitate an organisational response. An information sheet which outlined the topics to be covered in the telephone interview was given to participants at least two weeks prior to

their interview to facilitate consultation and the development of an organisational response.

Data analysis was undertaken manually thorough immersion in, and thus familiarity with, the written records of the interviews. Descriptive analysis of quantitative data was undertaken where it produced a meaningful addition to the qualitative data.

Results and Discussion

Twelve CHSs (52% of possible CHSs) agreed to participate in the project. All metropolitan regions of Victoria were represented. See Table 1. Those interviewed were mostly either Chief Executive Officers or members of management of a level that reported directly to the Chief Executive Officer. See Table 2.

Understanding of climate change

To determine the level of understanding of the issue by staff of CHSs, representatives were asked to provide a definition of climate change and to identify causes and effects of climate change. Most of the interviewees were able to provide a reasonable definition. These included "a significant change in climate over a period of time"; "the impact of human activity on the climate and environment...leading to changes in weather patterns, increasing average temperatures and impact on species"; and "our natural environment is heating up and becoming more volatile".

Eleven of the 12 respondents referred to increased fossil fuel use and/or its by-products as a major causative factor. Half of the respondents also spoke of lifestyle factors, using descriptions such as living in a "disposable society" and the rise of "consumerism". These answers were consistent with an understanding of the causes of climate change. None referred, however, to agricultural activities or deforestation as a cause of GHG emissions, possibly due to the metropolitan base of those interviewed.

When asked about the effects of climate change, the combined responses from the CHSs covered most of the major impacts. See Figures 1 and 2. Interviewees on average named four factors (with each individual direct health impact named counted separately). Of the nine respondents who commented on specific health impacts, generally, only one or two were named by each. In total seven different direct health effects were mentioned. Notable omissions were heat related disorders, apart from one reference to dehydration, and diarrhoeal disease.

Representatives of the metropolitan CH sector were therefore able to demonstrate a fundamental understanding of climate change, although this was probably at a level that was no greater than that

Table 1: Regional breakdown of participating CHSs as a percentage of possible CHSs

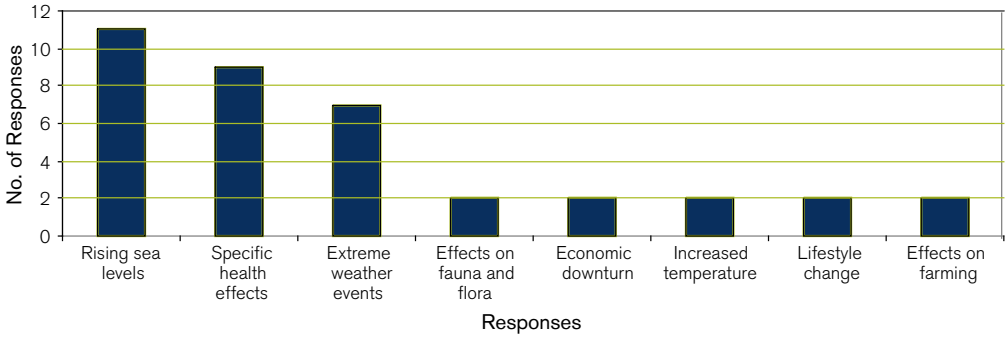
	North & West Metropolitan Region	Eastern Metropolitan Region	Southern Metropolitan Region	Total
Participating CHS	5	3	4	12
Total number of CHS	12	7	4	23
% Participating	41.7	42.8	100	52.2

Table 2: Respondent's position within organisation

CEO	Senior Manager	Middle Manager	Staff member	Total
5	5	1	2	13*

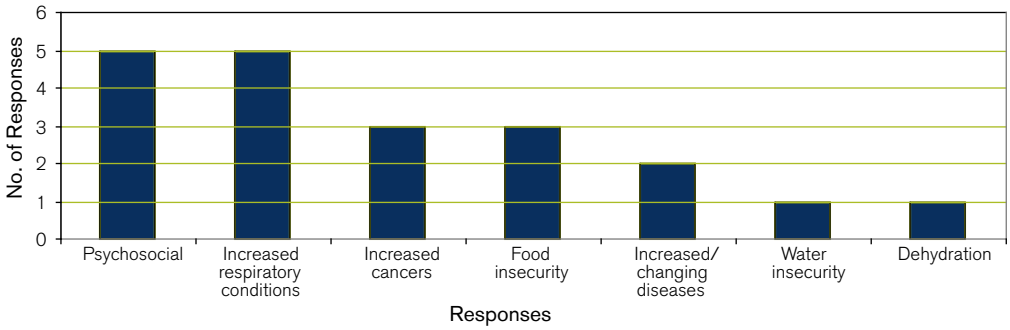
Note: One organisation put forward two people for its interview - the CEO and a staff member who was a member of its environment committee. This is counted as one response/interviewee elsewhere in this paper*

Figure 1: Perceived effects of climate change



Note: More than one response was allowed per respondent

Figure 2: Perceived direct health impacts of climate change



Note: More than one response was allowed per respondent

which would be seen in the general population. They were able to provide reasonable basic definitions of climate change, and had a good understanding of the major causes of climate change. The understanding of the effects of climate change was quite broad but not particularly in depth, even in the area of health. Many people interviewed openly expressed that they were not confident in their level of knowledge. This is not surprising given the complexity of the issue and the fact that climate change has not as yet registered as an area of focus for CH, as will become evident later in this paper.

Current policy and practices

To ascertain if climate change action was being addressed in a strategic way, interviewees were asked if their CHC had a policy relating to climate change, which had been endorsed by their Board of Management; an organisational plan which refers to the issue; a person or committee who is assigned responsibility for action; any systems of monitoring, measuring, or reporting on action areas; and any resource allocation for climate change.

Responses indicate that climate change is not being addressed in a strategic manner by many CHSs (see Figure 3). Five CHSs answered "no" to all five of these questions and none answered "yes" to all of the questions. Four interviewees reported that

Figure 3: Climate change action - policies & plans

action within their organisation was being driven strongly "from the ground up" and as such a systematic and strategic response had not as yet occurred.

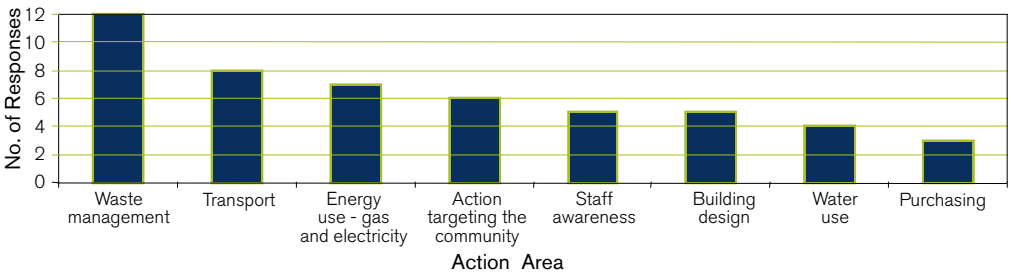
Three CHSs each had an environmental policy which had been endorsed by its Board of Management. Two organisations made reference to environmental sustainability within their strategic plans and two had environmental plans. Four CHSs had assigned responsibility for climate change within the organisation and in all cases this was to an environmental working group. These had management involvement or feedback mechanisms. Another CHS with an environmental working group was yet to allocate formal responsibility to the group.

Three CHSs undertook occasional monitoring of aspects of the organisation's response such as reviewing power or paper use. None of those interviewed reported systematic monitoring or evaluation of environmental activities within their organisations. Resource commitment was mostly described in terms of staff time to attend internal working groups. Only one organisation had an explicit recurrent budget assigned to climate change action.

It became clear, however, when asked about climate change practices, that many CHSs were taking action in a number of areas (see Figure 4). All CHSs had some practices in place around waste management. Waste paper was collected for recycling by 10 CHSs and most also utilised a range of strategies for reusing and reducing use of paper. Kitchen recycling was practised by seven agencies and composting by four, although this was often reliant on staff to drive. Other actions included waste management policies, and recycling of toner cartridges, mobile telephones and computers.

Transport was the next most common action area. Three organisations had liquefied petroleum gas (LPG) vehicles as a result of funding through the Home and

Figure 4: Climate change action - practices



Note: More than one response was allowed per respondent

Community Care program. Two agencies were paying to carbon offset their fleet. A number of CHSs had practices and structures in place to encourage staff to ride bikes, including one organisation which was initiating a staff bicycle fleet.

Actions relating to energy use were described by representatives of seven CHSs. These included awareness raising strategies, installation of timers and sensor lighting, purchasing low energy appliances and obtaining electricity from renewal energy sources.

Six CHSs were reported to be undertaking some work in the community on the issue of climate change. Some examples included involvement in Neighbourhood Renewal environmental programs on public housing estates, local tree planting days, and transport advocacy activities. One agency had organised bicycle education courses for public housing residents and a community education session on 'greening your home'.

Staff awareness actions were undertaken by five CHSs, however, these were mostly described as informal and led by staff. They predominantly consisted of 'green tips' circulated via email, staff meetings and newsletters. Some described more formalised campaigns on issues such as transport and energy conservation.

Seven CHSs had made environmental alterations to their buildings or incorporated environmental planning into the design of new buildings. Agencies which had received external funding described the most substantial actions, such as installation of solar panels and water tanks. Others made smaller changes such as separating some lights onto individual switches and building staff showers to encourage bike riding. A number of CHSs had plans for new buildings which incorporated environmental design, however, they were not confident that this would be funded.

Four CHSs were taking action in relation to water conservation. This mostly consisted of simple strategies such as signs promoting economical water use, installation of dishwashers and mulching of gardens. Two CHSs had water tanks.

Three CHSs had policies that encouraged consideration of climate change when choosing and buying goods, however, none were confident that these were being adhered to due to decentralised purchasing practices.

All CHSs were taking action in some areas, although the magnitude and scope of the actions varied considerably. On average respondents reported four areas with practices that addressed climate change within their organisation. A strong relationship was evident between agencies with environmental working groups and those undertaking systematic climate change action (see Table 3). CHSs with such a group were taking action in five to seven areas. Only one CHS without a working group rated higher than the average. This organisation had been successful in external funding applications and was taking action in response to these.

Table 3: Relationship between CHSs with Environmental Working Groups and the number of climate change action areas

	Participating CHSs											
	1	2	3	4	5	6	7	8	9	10	11	12
Environmental working group	x	x	x	✓	✓	✓	x	x	x	x	✓	✓
No. of Policy or Practice Action Areas	6	3	2	5	7	6	1	4	4	3	6	5

Potential scope of action

In order to ascertain the barriers affecting the capacity of CHSs to respond to climate change, respondents were first asked whether climate change is an important issue for the CH sector, and what they perceived as the potential scope of action for CHSs.

Representatives of all participating CHSs reported that climate change is an important issue for the sector. Most gave more than one reason for this. Ten of the 12 interviewees assigned its import to the issue's alignment with the work and philosophy of the CH sector. This was described varyingly with reference to the fit with the health promotion and social justice approaches taken by the sector, and the mandate of CHSs to respond to issues affecting the health and wellbeing of their communities. Four of the 10 mentioned that climate change would have greater impacts on the disadvantaged sections of the community with whom their organisation worked.

Ten respondents also thought that climate change was an important issue because of the health implications of climate change. References were made to the links between health and the environment, and to direct health impacts of climate change.

Five thought that CHSs have a social responsibility to respond to climate change within their organisation. They gave reasons such as to "be a good organisational citizen", or that it is "everyone's responsibility". Two organisations gave social responsibility as the sole reason for climate change being an important issue for CH.

Interviewees described the possible scope of the action and role of CHSs in responding to climate change. They unanimously reported that their organisations wanted to be doing more to decrease their environmental impact. They identified that they would like to be able to undertake more significant practices that would decrease GHG emissions such as carrying out organisational environmental audits; purchasing hybrid cars, solar power and hot water; and improving the energy efficiency of their buildings. Eight reported a desire to develop a more strategic response to climate change by developing and embedding policies, structures and plans to ensure a sustainable and integrated approach at all levels of their organisation.

Involvement in a multifaceted health promotion response was identified by 11 interviewees. Despite differing opinions as to whether CHSs should have a lead role in this response, there was agreement that a partnership approach was required. Local government, local agencies, schools, the community and VicHealth were named as potential partners. A range of health promotion actions were suggested, including the development of a robust advocacy strategy. It was felt that this should include lobbying in relation to public policy and legislation. Issues such as the development of sustainable energies, improved public transport and the need to respond to emerging social justice concerns were identified.

Five interviewees reported that CHSs have a role in directly responding to specific health effects of climate change. It is interesting that more respondents did not mention this role. This is probably because this would not constitute a significant change in function within their organisations.

Five respondents commented that CHSs should be doing more work together as a sector, and with other key stakeholders including peak organisations such as Victorian Healthcare Association (VHA) and Victorian Council of Social Service (VCOSS). It was expressed that collective action would facilitate a stronger response to climate change in areas such as enhancing buying power, knowledge,

health promotion work, advocacy and lobbying strategies, and research.

Representatives of CHSs, therefore, clearly believed that climate change is an important issue for the sector and were able to elucidate a vision for their role in responding to this significant challenge.

Barriers to action

Interviewees identified a large number of barriers affecting their capacity to respond to climate change (see Figure 5). Funding was described as the "major hurdle" for the sector. Many respondents complained of an inability to afford capital improvements and purchases that would improve their energy efficiency. It was thought that specific funding was required to enable the sector to move forward in a significant way.

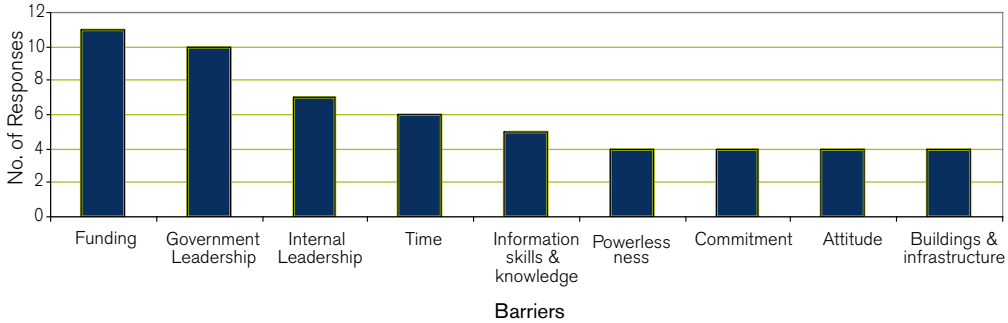
Government leadership was the next most commonly mentioned barrier. The focus of most responses was the Victorian government, which is not surprising as it provides the majority of funding to CHSs. These responses centred on the lack of policy regarding climate change that is applied to CH, and the resultant lack of profile which climate change has attracted within the sector. Interviewees thought that the issue was not being driven at the level of CH by the state government.

The Victorian government (2006) does have a strong commitment to environmental sustainability as documented in *Our Environment, Our Future; Sustainability Action Statement 2006*. Unfortunately, very few, if any, of the strategies contained within this document, or other state government policies, refer to CHSs or have thus far been applied to the CH sector.

One example cited by a respondent was energy reduction targets. The Victorian government has an energy reduction target of 20% by 2010 (Sustainability Victoria Website 2007). The Department of Human Services (DHS) has applied these to their departments, however, the CH sector has not been incorporated into this strategy. The Victorian government has also allocated $7.2 million for hospitals and aged care facilities to become more energy and water efficient (Sustainability Victoria Website 2007). While these facilities are likely to be greater users of energy and water, the CH sector is also in need of assistance to improve its environmental sustainability.

Another example was environmental building regulations. DHS has developed sustainability guidelines for healthcare facilities (Victorian Department of Human Services 2007b), however, these guidelines currently are not applied consistently to CHSs.

Figure 5: Major barriers affecting the capacity of CHSs to respond to climate change



Note: More than one response was allowed per respondent

Additionally, some respondents thought that climate change action would be facilitated by its inclusion as a requirement in agency funding and service agreements, and by the identification of climate change as Victorian health promotion priority. Health promotion guidelines in Victoria recommend that the bulk of health promotion work undertaken by CHSs addresses state-wide health promotion priorities (Victorian Department of Human Services 2006c). CHSs have access to a considerable amount of information and support for work undertaken addressing these priorities. Climate change is not currently a nominated health promotion priority area (Victorian Department of Human Services 2007c).

In relation to the federal government (which at the time of the interviews was the Howard Coalition government), respondents expressed concern regarding the lack of public policy responses to climate change and the government's perceived scepticism about the issue. Frustration was voiced about the inability of CHSs to access LPG gas conversion rebates, and about tax legislation which results in a lower fringe benefits tax rate for fleet vehicles that are driven further.

Internal leadership and support was also reported as an area for strengthening by a majority of interviewees. They clearly recognised the need for strong high level management support to improve their responses to climate change. This correlated with the earlier stated desire of many CHSs to develop a more strategic response to climate change, and also with their belief that a lack of support and direction from government had resulted in climate change not being given due priority within organisations.

Lack of time was reported by 50% of respondents. This was often qualified by references to competing interests and demands. Others stated that as climate change was not identified as a priority in their organisation, it was unlikely that it would be given adequate time allocation.

Representatives of five CHSs reported that a lack of skills, information and knowledge about climate change was a significant barrier. This reinforces the earlier finding about the lack of an in depth understanding of the impacts of climate change by the staff in CHSs. The respondents reported that despite the quantity of information available, there was a lack of clear and concise evidence based information about the issue and about effective strategies. Many were seeking to assess their organisation's environmental impact in order to develop an organisation plan, but did not know how to go about this. Subsequent to the completion of this study the DHS released a useful document on climate change and health (Victorian Department of Human Services 2007d).

Four interviewees commented on a sense of powerlessness in their CHSs in relation to climate change. This was expressed in language such as "It feels bigger than Texas. What do we actually do, how do you break it down?" and we "need to be able to feel that we are going to make a difference - is saving a few buckets of water any use whilst industry continues to use such enormous amounts of water. We need to be a part of something bigger". These feelings are possibly related to the previously described lack of clear information and funding to facilitate effective climate change responses. It is also likely that the perceived lack of government leadership on the issue, particularly the federal government, can make strategies at the grass roots level seem somewhat meaningless. These findings underline the importance of an advocacy strategy as a part of the CH sector's response to climate change.

A lack of commitment to climate change within organisations was cited by four respondents. Conversely, the same number of interviewees specifically noted that commitment was not an issue with comments such as "we have support from the majority of staff and management" and "staff are very committed. I think this is true across the sector, including management and Boards of Management".

A less commonly reported barrier was that of negative attitudes to climate change action. One respondent thought that the issue had a "hippy/greenie stigma" and another that there was some "anti - zealot" feelings towards those championing the cause in their organisation. It is unlikely that negatives attitudes are a significant issue despite the small number of CHSs reporting these, unless a case could be made that staff within CHSs are more negative about climate change action than the general public. A survey undertaken in early 2007 by the Chicago Council on Global Affairs found that 92% of the Australian public are in favour of strategies to combat global warming, the highest figure of any of the 17 countries surveyed (Klienman 2007).

Four organisations commented on ageing buildings and infrastructure. Reference was made to the lack of an adequate source of funding for buildings and infrastructure in the CH sector. Some organisations that were renting buildings felt that this resulted in less control over their energy efficiency.

There are, therefore, a significant number of barriers that the CH sector has identified which, if addressed, would considerably strengthen the capacity of CHSs to respond to climate change.

Conclusion

CHSs are an integral part of the Victorian health system. The CH sector with its strong focus on health promotion, its record of working in partnership with others, and its close connection with vulnerable sections of the community, has an important role to play in responding to climate change.

The capacity of CHSs to respond to climate change is currently limited by a number of significant factors. These include insufficient availability of specific funds for climate change action; a need for greater policy direction and support from the state government, which is the major provider of funds to CH; and a need for strong federal government leadership. This lack of government leadership and direction has resulted in climate change not yet registering as a priority for strategic action by many CHSs. The provision of clear information about climate change and related evidence based practice would also greatly assist the sector to increase its knowledge base and its ability to undertake effective action.

The metropolitan community-managed CHSs in Victoria have, however, displayed an interest, a willingness and an ability to respond to climate change. All CHSs involved in this study agreed that climate change is an important issue for the sector. They have identified a range of climate change action areas for the CH sector. These are to decrease the environmental impact of individual CHSs, to be involved in multifaceted health promotion activities incorporating an advocacy strategy, and to provide direct responses to the health impacts of climate change. They also identified that an effective response would be facilitated by working together as a sector and with other relevant partners in response to climate change. It was thought that peak organisations such as VHA and/or VCOSS could coordinate this collective action.

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Suppressive Effects of Ultraviolet Radiation on the Immune System

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Human exposure to solar ultraviolet radiation (UVR) can exert a variety of biological effects, including induction of skin cancer, exacerbation of infectious diseases, premature skin ageing and inhibition of the immune system. The immunosuppressive properties of UVR are of major biological relevance since suppression of the immune system is related to a variety of diseases, ranging from the exacerbation of infectious diseases to the induction of skin cancer. The evidence shows that UVR can influence the immune system, cause damage to DNA, disturb the metabolism of Urocanic acid (UCA), and alter cellular redox equilibrium leading to free radical formation and membrane lipid peroxidation. Finally, UVR can induce contact hypersensitivity (CHS) and delayed type hypersensitivity (DTH). These changes might be related to local and systemic immunosuppression. Hence, understanding the immunosuppressive mechanisms of UVR in human diseases becomes of primary importance in the protection and improvement of human health.

Key words: *Immune System; Suppressive Effect; Ultraviolet Radiation*

Sunlight is important for the development and continued existence of life on Earth. The wavelengths of sunlight range widely, including infrared rays, the visible spectrum and ultraviolet radiation. But the ultraviolet component is largely responsible for the deleterious effects associated with sun exposure.

Ultraviolet (UV) radiation includes three parts of the spectrum. UVC (200-290nm) is not biologically relevant since it is completely absorbed by the stratospheric ozone layer. However, both UVA (320-400nm) and UVB (290-320nm) reach terrestrial surfaces at significant levels and therefore cause biological effects (van der Leun et al. 1991, 1994, 1998; van der Mei et al. 2007). UVB is much more effective than UVA at causing biological damage and solar UVB contributes about 80% towards the harmful effects associated with sun exposure, with solar UVA contributing to the remaining 20% (Clydesdale et al. 2001).

Along with the change of elevation of the sun above the horizon, or solar altitude, both the quality (spectrum) and quantity (intensity) of terrestrial ultraviolet radiation vary greatly. On a summer day, UVB comprises approximately 5% of terrestrial ultraviolet, and UVA the remaining 95% (Diffey et al. 1998). The variations in the atmospheric total ozone column amount are of direct importance to surface UV radiation. An important consequence of stratospheric ozone depletion is the increased transmission of solar ultraviolet radiation to the Earth's lower atmosphere and surface (Frederick et al. 1992).

UV radiation can modulate immune responses in animals and humans. This effect is not only to exert beneficial effects on some skin diseases (e.g., psoriasis) but also to cause some allergic and certain

autoimmune diseases such as multiple sclerosis (Abel 1999; Garssen et al. 1999; McMichael et al. 1997; Van Loveren et al. 2000). UV-induced immunomodulation might also lead to several deleterious health consequences. For example, UVB-induced immunomodulation has played an important role in the process of skin carcinogenesis (Kripke 1981; Nishigori et al. 1996). UVB exposure can also impair immune function against bacterial, viral, parasitic, and fungal infections (Garssen et al.1995; Gilmour et al. 1992-1993; Giannini 1986; Goettsch et al. 1994; Goettsch et al. 1996; Goettsch et al. 1996; Jeevan et al. 1990; Ryan et al. 2000). Evidence shows that UVB is an immunosuppressive agent, and the mechanisms responsible for this are partly understood (Schwarz 2002). In this article, we conduct a literature review of major relevant studies in this area.

UV Radiation and the Immune Function

UV radiation affects the function of the immune system and causes immunosuppression. Romerdahl et al. (1998) reported that UV-induced skin tumours in mice are highly immunogenic and thus are rejected upon transplantation into naive syngeneic hosts. However, if the recipient animal was immunosuppressed by drugs, the inoculated immunogenic UV-induced tumours were able to grow progressively, clearly indicating that the rejection is immunological in nature. The same observation was made when the hosts were exposed to low doses of UV radiation instead of immunosuppressive drugs, suggesting that UV radiation can exert immunosuppressive features. Toews et al. (1980) found similar immunological results in the in-vivo model; that is the induction of contact hypersensitivity (CHS). CHS is a special form of a delayed type hypersensitivity (DTH) response, which is induced by epicutaneous application of low molecular weight reactive chemical compounds (e.g. dinitrofluorobenzene and oxazolone), called haptens. Putting haptens on skin areas which have been exposed to low doses of UVB (around 1J/m^2) did not induce CHS, whereas application of the hapten at an unirradiated site caused a normal CHS response. Inhibition of CHS induction correlated with a reduction in the number of Langerhans cells at the site of exposure and with changes in their morphology (Aberer et al. 1981; Toews 1980). In vitro studies show that UV-mediated alterations of Langerhans cells, which are the crucial cells in the epidermis for sensitization, are associated with a loss of the antigen presenting function of these cells (Stingl et al. 1983; Toews 1980).

Animal data show that ultraviolet irradiation of the skin is known to cause local, systemic immunosuppression (Kripke 1990) and allergen specific tolerance (Kim 1990). Local immune suppression refers to the situation in which the hapten is applied directly to the UV-irradiated skin. In systemic immune suppression, the UV radiation is applied to one site, and the hapten or antigen is applied to a distant non-irradiated site. In both cases, immune suppression is generated. Antigen (or hapten)-specific suppressor T cells are found in the lymphoid organs of the UV-irradiated mouse, and long-lasting tolerance can be induced (Shreedhar 1998).

UV-induced local immunosuppression

Langerhans cells (LCs) of skin form a dendritic cell network which can capture invading microorganisms, ingest them, and then process their antigens into a form that can be recognized by T cells. During migration out of the skin and into the draining lymph node, the Langerhans cell matures and arrives at the lymph

node ready to present the microbial antigens to T cells to start a protective immune response (Kripke et al. 1990). UV-exposure alters epidermal Langerhans cell function and destroys the dendritic cell network. Mice sensitized through UV-irradiated skin fail to generate a CHS response to contact allergens (Toews et al. 1980). Moreover, haptenspecific suppressor T cells could be found in the spleens of mice sensitized through UV-irradiated skin (Elmets et al. 1983).

LCs were also affected by UV radiation. Compared to the response found in mice injected with normal LCs, the immune response observed in mice injected with UV-irradiated LCs was suppressed significantly. These findings confirm that UV-irradiated Langerhans cells mediate the induction of local immune suppression (Cruz et al. 1990).

UV-induced systemic immunosuppression

Systemic immune suppression refers to the situation, where the site of UV irradiation differs from the site of antigenic immunization. It is now clear that depending on the antigen used, systemic immune suppression can be induced with relatively low doses of UV. For example, the data show that significant immune suppression to *Mycobacterium bovis* Bacille Calmette-Guérin (BCG), after a single exposure with as little as 0.35 kJ/m^2 of UVB radiation (Jeevan et al. 1990). When local and systemic immune suppression are compared, much of the phenomena are similar. The experiment found that the UV dose-response curves are identical (Noonan et al. 1990), defects in antigen-presenting cell function are noted, cytokines are involved, and suppressor T cells are induced. UV induced pyrimidine dimer formation also appears to be an important molecular trigger that promotes systemic immune suppression (Applegate et al. 1989). One real difference between the local and systemic immunosuppression is the sequence of events leading to immune suppression. The initial step in the pathway of local immune suppression is an alteration in Langerhans cells antigen-presenting cell function, which is a consequence of the formation of pyrimidine dimers in UV-irradiated epidermal Langerhans cells (Vink et al. 1997, 1996). Although defective antigenpresenting cell function is also a key event in systemic immune suppression (Ullrich 1995), it appears to be downstream of cytokine production in response to UV exposure.

UV-induced immunologic tolerance

Toews et al. (1980) found that painting of contact allergens onto UV-exposed skin does not result in the induction of contact hypersensitivity but induces tolerance, since application of the same hapten several weeks later again does not induce CHS. This indicates that the initial application of the hapten onto UV-exposed skin induces long-term immunologic unresponsiveness. This also implies that the immunologic unresponsiveness induced by UV radiation is hapten-specific, a phenomenon called hapten-specific tolerance. Induction of UV mediated tolerance was observed in both local and systemic immunosuppression (Kripke et al. 1986). UV-induced tolerance appears to be mediated via the generation of hapten-specific T suppressor cells (regulatory T cells).

Mechanisms of UV-Induced Immunosuppression

The immune components of skin include the keratinocytes which synthesise an array of immunoregulatory cytokines, the Langerhans cells as the major antigen presenting cells, the dendritic cells (DCs) and macrophages as antigen presenting cells, a special set of T lymphocytes with

homing receptors which facilitate targeting to sites of cutaneous inflammation, and endothelial cells expressing adhesion molecules, thus enabling activated lymphocytes to move from the blood into the skin. The cytokine profile of the T cells largely determines the type of immune response generated and its efficacy (Norval 2000).

CHS (which is frequently used to assess immune responses in the skin) is considered as a measure of T cell function in which simple chemicals are applied to the skin, and most studies indicate that UV exposure of some human subjects leads to its suppression (Tie et al. 1995). CHS can be divided into two phases, the first is induction/sensitisation (afferent) and the second is elicitation (efferent). During sensitisation, small and structurally simple haptens are placed on the skin which alone is incapable of generating an immune response. However, they react with proteins locally in the skin to create immunologically relevant hapten-derivatised proteins. These are taken up by LCs in the epidermis, carried to the draining lymph nodes and presented there to specific T cells. In the elicitation phase, rechallenge with the same contact sensitiser occurs. Antigen-specific T cells are recruited or activated in situ, leading to the release of particular cytokines, infiltration of macrophages and neutrophils and a measurable inflammation, either by a colour change or by swelling.

When we are exposed to UV radiation, a multistep process is initiated in the skin. The initiator (or photoreceptor in the skin that converts the physical energy contained with UV radiation into a biologically recognizable signal) located in the outer skin layers is likely to absorb photons, change their structure as a result and trigger the cascade. Experiments implicated DNA damage (Hurks et al. 1995), the formation of cis(Z)-urocanic acid (UCA) from trans(E)-UCA (Moodycliffe et al. 1993), cytoplasmic transcription factors and membrane changes (Pourzand et al. 1999), leading to clustering of cell surface receptors, as initiating events. These include both pro-inflammatory and anti-inflammatory cytokines, as well as histamine and prostanoids (PGE). Some of the major factors can be found in Duthie et al. (1999). Most recently a range of neuropeptides and neurohormones have been recognised in the skin which can act to control immunity and inflammation. For example, within 24-72 h of UV-B irradiation, calcitonin gene-related peptide (CGRP) is released from cutaneous sensory C fibres adjacent to epidermal LCs (Benrath et al. 1995) - CGRP is immunosuppressive by altering adhesion molecule expression and antigen presenting cell function. It is also vasodilatory, thus contributing to UV-induced oedema and erythema. Scholzen et al. reported the role of the sensory nervous system in controlling cutaneous immune responses following UV exposure (Scholzen et al. 1999).

Since the production of the range of mediators, changes in the function and phenotype of the antigen presenting cells appear within 24 h of acute UV irradiation. One of the most dramatic effects is the loss of LCs from the epidermis. For example, Yoshikawa et al. (1990) reported that irradiation of a small area of human skin with 1440 J / m^2 on each of 4 consecutive days led to a reduction in LC numbers from 565 to 17 per mm. The interdigitating network, which is composed of the dendritic processes of the LCs, is lost and the remaining cells round up. A proportion of the LCs migrates to the draining lymph node, while others are trapped in the skin or undergo apoptosis. One major cytokine involved in the abnormal migration is tumor necrosis factor (TNF)-a (Moodycliffe et al. 1994) and another described more recently is interleukin (IL)-1b (Duthie et al. 1999). It is thought

that the LCs which arrive in the lymph node following UV exposure cluster abnormally with the T cells. There might be changes in the expression of adhesion and co-stimulatory molecules on their cell surface, although these have been difficult to demonstrate experimentally, and perhaps alterations in antigen internalisation and processing occur in addition. Whatever the mechanism, it has been suggested that the activity of T cells producing T helper 2 (Th2) cytokines, such as IL-4 and IL-10, is promoted, with a concomitant abrogation in the production of the Th1 cytokines, such as IL-2 and interferon (IFN)-g (Ullrich 1996). This process indicates that the Th2 cytokines generally downregulate cell-mediated responses by a variety of mechanisms. However, it has only been demonstrated in a limited number of systems and several recent publications indicate a more complex outcome. The properties of both subsets of T cells might be altered by the UV exposure and the antigen driving the response is likely to influence the mode of the modulation (Garssen et al. 1999).

Animal experiments show that antigen-specific CD4 T cells can be found in the spleen and lymph nodes of irradiated mice (Meunier et al. 1995; Moodycliffe et al. 2000; Schwarz et al. 2000). Moodycliffe et al. (2000) reported that natural killer T (NKT) cells were demonstrated as being critically important in UV-induced suppression of tumour immunity and delayed type hypersensitivity (DTH). NKT cells represent only 2-3% of the T cell population in spleen and lymph nodes but are very potent regulatory cells, perhaps acting in the UV-irradiated animals through the production of IL-4. Schwarz et al. (2000) found that a subset of T cells expressing CTLA-4, a regulatory molecule found on activated T cells which ligates to co-stimulatory molecules on antigen presenting cells, was shown to mediate UV-induced tolerance to a contact sensitiser. In this case the production of IL-10 from the CTLA-4 T cells was involved. These diverse mechanisms might reflect the different types of antigens used, and how, and where they are first encountered and presented to the immune system. Within 2-3 days of UV exposure, particularly following erythemal doses, a new population of antigen presenting cells enters the dermis. These were discovered by immuno-cytochemistry of skin sections and by flow cytometry of epidermal and dermal cell suspensions. The reported changes in the expression of adhesion molecules (molecules which allow circulating immune cells to bind to the endothelial cells lining the vessels before they extravasate into the dermis and epidermis) on the endothelial cells might be important in allowing entry of these cells. In human skin, they are found to be macrophages according to their phenotype and properties, and can be distinguished from LCs as they are CD1a -CD11b+ while LCs are CD1a CD11b (Meunier et al. 1995). They were able to produce high levels of IL-10 and low levels of IL-12, and express different co-stimulatory molecules from LCs, thereby promoting suppressed immune responses in the skin.

Initiators of UV-Induced Immune Suppression

Research shows that the initiator in the skin that converts the physical energy contained with UV radiation into a biologically recognizable signal is a critically important area of research in photoimmunology. Three photoreceptors have been identified that absorb UV energy and initiate immune suppression: epidermal DNA, trans-urocanic acid (UCA) and membrane lipids (Ullrich et al. 2005).

DNA as an initiator of UV-induced immunosuppression

UV absorption by cellular DNA results in various types of damage such as the formation of cyclobutane pyrimidine dimers (CPDs). CPDs have been located in keratinocytes and LCs following UV-B exposure, and also in DCs in lymph nodes draining the irradiated sites (Sontag et al. 1995). The first evidence that DNA damage is an important initiator of immunosuppression came from experiments in the marsupial *Monodelphus domestica* in which CPD repair is carried out by an endogenous photolyase. Photolyase binds to the CPDs and can make them revert to pyrimidines on absorption of UV-A-visible light (Ley et al. 1991).

The suppression of CHS, induced by UV irradiation, was prevented if the photolyase was activated by exposure to visible light following the UV exposure (Applegate et al. 1989). A series of experiments were then conducted in which mice were UV-B irradiated on their shaved backs and sensitised with fluorescein isothiocyanate (FITC) 3 days later on the same site, a procedure which leads to significant local suppression of CHS on challenge (Vink et al. 1996, 1997). First, the CPDs in mouse skin were repaired in vivo by treatment with liposomes containing T4 endonuclease V immediately after the irradiation (Vink et al. 1996). Second, the CPDs in DCs from lymph nodes draining the irradiated skin sites were repaired in vitro using exogenous photolyase plus photoreactivating light, and then the cells were inoculated into naive animals (Vink et al. 1997).

DNA damage can act as a trigger for the production of specific cytokines from keratinocytes cultured in-vitro. The synthesis of IL-6 in human keratinocytes is a result of UV exposure (Petit-Frere et al. 1998). The wavelength dependence of the IL-6 release was found to be similar to that of DNA absorption or the induction of CPDs, with a maximum effect at 250 nm and only minor effects above 313 nm. The reliance of the IL-6 production on CPD formation was shown by treating the keratinocytes with photolyase plus photoreactivating light and this procedure led to a reduction in IL-6 release and the specific repair of the CPDs. Another study used a line of murine keratinocytes, which were exposed to UV-B irradiation, produced factors able to suppress delayed type hypersensitivity (DTH) (Nishigori et al. 1990). One of the factors was identified as IL-10 which is an important suppressor of both T cell and antigen presenting cell effector functions. The situation with human keratinocytes might be different from murine as several groups have failed to find up-regulation of IL-10 expression as a result of UV-B irradiation of freshly isolated or cultured keratinocytes, and the major source of IL-10 in this case might be from melanocytes (Teunissen et al. 1997). UV-B could induce the expression of TNF-a in murine keratinocytes by damage to DNA (Kitibel et al. 1998).

Recently, the mechanism for the production of these immunomodulatory molecules appeared to involve DNA-dependent protein kinases (Yarosh et al. 2000). A link between UV, DNA damage, the expression of specific cytokines and immunosuppression has been suggested (Garssen et al. 2000). Ahrens et al. (1997) examined two groups of patients with different defects in DNA excision repair, one leading to a greatly increased risk of developing skin cancer (xeroderma pigmentation complementation group D, XP-D) while the second had the same risk as normal healthy people (trichothiodystrophy, TTD). On UV-B irradiation of cultured cells from the former group, there was an increased susceptibility to the inhibition of expression of intercellular adhesion molecules, of key importance in immune cell interactions, compared with the latter group.

UCA as an initiator of UV-induced immunosuppression

Urocanic acid (UCA) has been demonstrated as another initiator in the epidermis to be involved in UV-induced immunosuppression (Norval et al. 1995). UCA is a metabolic product of the essential amino acid histidine. UCA accumulates in the epidermis because keratinocytes lack the enzymes required for catabolisation of UCA. Of the two tautomeric forms of UCA trans-UCA and cis-UCA the latter predominates in the epidermis. UV converts trans- into cis-UCA. Removal of UCA by tape stripping of the epidermis prevents UV-induced suppression of the induction of CHS, indicating that cis-UCA is involved in photoimmunosuppression (Fabo et al. 1983). Further, injection of cis-UCA partially mimics the immunoinhibitory activity of UV radiation (Kondo et al. 1995). In turn, antibodies directed against cis-UCA restore particular immune responses after UV exposure (Moodycliffe et al. 1996). cis-UCA also inhibits the presentation of tumour antigens by Langerhans cells (Beissert et al. 1997). This effect can be reversed by IL-12. In addition, injection of cis-UCA antibodies reduces the incidence of UV-induced skin tumours in a photocarcinogenesis model, suggesting a role of cis-UCA in the generation of UV-induced skin cancer (Beissert et al. 2001).

UCA plays a role as an initiator in UV-induced immunosuppression. A murine model of CHS in which 2,4-dinitrofluorobenzene (DNFB) was applied to the abdomen 5 days after irradiating the shaved back with various doses of narrow bandwidths (3 nm) UV at 10 wavelengths between 250 and 320 nm, and then challenging by ear painting with DNFB several days later and measuring the ear swelling response. Each wavelength caused a dose-dependent suppression of CHS but with differing effectiveness. It fitted closely the absorption spectrum of UCA and no other major epidermal component such as DNA had the same spectrum. In addition if the stratum corneum, in which the UCA is located, was removed by tape stripping, then the suppression in CHS did not occur (De Fabo et al. 1983).

Some experiments focused on modulation of the DTH response in a mouse model of infection with herpes simplex virus (HSV) (Howie et al. 1986). Here the animals were UV-B irradiated with a dose that represented about 0.9 MED (Minimal Erythemal Dose), followed 3 days later by subcutaneous inoculation with the virus, and subsequent challenge with inactivated virus injected into the ear to measure the swelling response. The UV-exposed group demonstrated a 54-94% reduction of DTH compared with the unirradiated group. If the UV was replaced by treating the mice with cis-UCA, a dose-dependent reduction in the DTH occurred-10, 1, 0.1 and 0.01 mg per mouse induced 61, 76, 23 and 5% suppression, respectively, compared with untreated animals (Norval et al. 1989). Furthermore, if the mice were pretreated with a monoclonal antibody which had specificity for cis-UCA before the UV irradiation, the suppression in the DTH response was no longer significant (DTH after UV-B was 55% suppressed and after cis-UCA antibody plus UV-B was only 12% suppressed, compared with unirradiated animals) (El-Ghorr et al. 1995).

Membrane lipid peroxidation and free radical formation as initiators of UV-induced immunosuppression

UV radiation interferes with the function of a variety of molecules in the skin cell. UV-induced DNA damage and isomerization of urocanic acid are two prime examples. UV radiation is also well known for its ability to alter cellular redox equilibrium leading to free radical formation and membrane lipid peroxidation. This molecular response to stress might also contribute

to UV induced immune suppression. Antioxidant treatment blocks the UV-induced impairment of antigen presentation, abrogates the UV-induced suppression of CHS (Caceres-Dittmar et al. 1995; van den Broeke et al. 1995), and interferes with the induction of tolerance (Nakamura et al. 1997).

Cytokine production is involved in the procedure of UV-induced free radical formation which may contribute to immune suppression (Tobin et al. 1998). Within minutes of UV exposure, the Src tyrosine kinase, which is normally found at the inner surface of the plasma membrane, is activated. This leads to a cascade of events that result in the activation of downstream mediators including H-Ras, Raf-1, c-jun amino-terminal protein kinase (JNK) and ultimately phosphorylation of positive regulatory sites in the activation domain of c-jun leading to the activation of activator protein-1(AP-1) and nuclear factor-kappaB (NF-kB). Activation of these transcription factors is a critical step in the formation of many of the immune regulatory cytokines secreted by UV-irradiated keratinocytes, one of the first steps leading to immune suppression. The addition of free radical scavengers (N-acetylcysteine) blocks intracellular signalling and interferes with the activation of AP-1 (Adler et al. 1995; Devary et al. 1997). Because UV-induced signal transduction was blocked, when cells were treated with compounds, such as vanadate and low concentrations of Triton X-100, which are known to interfere with membrane organization, it was assumed that one target of UV was the cell membrane. To rule out a role for UV-induced DNA damage in this system, HeLa cells were enucleated and then exposed to UV radiation. Both AP-1 and NF-kB were activated in UV-irradiated enucleated HeLa cells (Devary et al., 1993).

NF-kB activation induced by UV radiation usually involves a cell membrane component (Simon et al. 1994). Murine fibrosarcoma cells were genetically engineered to overexpress heat shock protein 70. Heat shock proteins are normally used by cells to increase their resistance to environmental insults, particularly UV radiation. Over expression of heat shock protein 70 significantly blocked cells killing by UVB and UVA radiation and by agents that induce oxidative stress, such as hydrogen peroxide. In addition, the production of immune regulatory cytokines by cells exposed to UV radiation was significantly suppressed by over expressing heat shock protein 70 (Simon et al. 1995). These findings suggest that UV-induced alteration of membrane redox potential can activate transcription factors in epidermal cells and drive cytokine production, ultimately leading to UV-induced immune suppression.

UV Immunosuppression and Related Human Diseases

The majority of studies about UV immunosuppression were conducted in animals, mostly in mice. Although many studies have been done with human cells in vitro, the question is obviously whether the findings obtained in the animal models can be extrapolated to the human system. In fact, UV radiation appears to suppress the induction of CHS in men. Tolerance can be induced in about 10% of the individuals (Yoshikawa et al. 1990). Other studies reported that a higher proportion of subjects developed tolerance when the hapten was applied onto skin areas exposed to erythemogenic UV doses (Cooper et al. 1992). Nevertheless, a certain proportion of human individuals might exist whose immune response will be compromised by UV radiation. This suggests in analogy to the murine system the existence of UV-susceptible and UV-resistant individuals. Thus, sensitivity to sunburn appears to be associated with susceptibility to UV radiation-induced

suppression of cutaneous cell-mediated immunity in humans (Kelly et al. 2000).

The potential effect of UV radiation on infections has long been recognised. In 1901 Finsen demonstrated that 'light' could be used successfully in healing of skin tuberculosis (*lupus vulgaris*); it had the opposite effect on smallpox lesions and on lung tuberculosis. Leprosy has been called the 'sunshine' disease because lesions occur most frequently on areas of the body exposed to sunlight. In addition three viral infections (*herpes simplex* virus (HSV), human papilloma virus (HPV) and human immunodeficiency virus (HIV)) are influenced by natural exposure to sunlight (Patki et al. 1991).

HSV type I causes vesicular 'cold sores' typically in the orofacial region of the body. At the primary infection, latency is established in the ganglia for life. The virus can be reactivated at intervals, reappear in an infectious form in the skin and replicate there, inducing recrudescent lesions at the same site as the initial infection (Perna et al. 1987). UV irradiation of this area is one common triggering factor for reactivation, recognised both by the subjects themselves and also shown experimentally (Rooney et al. 1991). The dose of UVR required to cause such effects is usually quite high (e.g., erythemal dose). It is known that T cells are critical in curtailing the viral replication and spread, as indicated by the severe HSV infections suffered by subjects with T cell immunodeficiencies, and that IFN-g is a key cytokine in immune control (Smith et al. 1995). UV exposure might suppress local immunity sufficiently to allow the virus to replicate in the epidermis and to cause the clinically apparent lesions. The presentation of HSV by epidermal cells is known to be affected by UVR (Gilmour et al. 1993). Perhaps T cell function is also affected by UVR (Miura et al. 1994), but this has not been confirmed (Gilmour et al. 1993; Neill et al. 1998).

The interaction of HPV with UVR might contribute to the development of squamous cell carcinomas in immunosuppressed individuals. The tumours are found almost totally on areas of the body exposed naturally to the sun and the prevalence is highest in sunny climates. The UV irradiation might induce damage to DNA in epidermal cells with such mutations being perpetuated and amplified by the proliferative activity of the virus, and then downregulate immune responses locally to allow the survival of such cells (Hartevelt et al. 1990).

Although animal studies suggest that UV-irradiating cultured cells or transgenic mice which contain parts of the HIV genome, can activate the virus from latency (Patki et al. 1991), in almost all studies involving patients with HIV, no effects of sunlight exposure or the phototherapy on disease progression or on immunological parameters have been observed (Akaraphanth et al. 1999). However, Cruz et al. (2000) show an increase in viral RNA (indicating HIV activation) in the skin of HIV-positive patients with psoriasis following exposure to a single dose of UV-B. An epidemiological study shows that there was a small but statistically significant reduction in CD4-positive T cell numbers and in the ratio of CD4:CD8-positive cells in a cohort of HIV-infected homosexuals during the summer months in comparison with other times of the year (Maas et al. 2002).

There are also other diseases which might be influenced by UV exposure. For example Gallerani and Manfredini (Gallerani et al. 2000) reveal a seasonal variation in the incidence of shingles which is caused by the reactivation of *herpes zoster* virus from latency in the ganglia: the frequency of disease was higher in the late spring /summer months than in the winter months, perhaps due to the longer length of daylight and more sunshine in summer, resulting in modulation of the immune

response to the virus and consequent reactivation and viral replication.

However, the immune system does not only protect humans from infectious agents but also from malignant mutations. Transformed cells in particular in the early stage can be recognized as 'foreign' and attacked by the immune system (tumour immunology). This might apply in particular for both non-melanoma skin cancer and malignant melanoma. Evidence exists for a strong correlation between the risk for developing skin cancer and immunosuppression. For example, individuals chronically immunosuppressed, like transplant patients exhibit a significantly increased risk for skin cancer, and this risk increases with the cumulative UV load (Euvrard et al. 1997). Some epidemiological studies found that exposure to UV radiation is a risk factor for all three forms of skin cancer: i. squamous cell carcinoma (SCC), ii. basal cell carcinoma (BCC) and iii. cutaneous malignant melanoma (CMM), especially for light-skinned people (Evans et al. 1988; Holman et al. 1986; Longstreth et al. 1998). Because UV-B level rise with declining ozone, skin cancer rates are expected to increase worldwide. There is a special concern for an increase in the rate of malignant melanoma in regions close to Antarctica (Longstreth et al. 2000; Mackie et al. 1988). A significant increase of UV-B was observed under ozone hole conditions, especially around 300nm. For the 14-year period, 173 cases of skin cancer were diagnosed, 65 during the first 7 years, 108 during the second, an increase of 66%. Cutaneous malignant melanoma (CMM), 19% of the cases, increased by 56%, raising the rate from 1.22 to 1.91 per 100 000. Non-melanoma skin cancer (NMSC), 81% of the total, increased the rate from 5.43 to 7.94 per 100 000 ($p<0.05$). Fifty nine percent of CMM patients and 54% of NMSC cases had skin phototypes I-II (Jaime et al. 2002). All this clearly supports the notion that the immunosuppressive nature of UV radiation might be relevant to carcinogenesis.

Conclusion

People are often exposed to UV radiation which influences the immune system. Although in theory, photoimmunosuppression might support the exacerbation of infectious diseases, severe infections even after excessive sun exposure are rarely observed. In contrast, low and constant suppression of the immune system might have important implications for the induction of some diseases (e.g., skin cancer) (Schwarz 2002).

Human immune systems are so sophisticated that, if one parameter is downregulated, another might well compensate and no overall change will occur. This is also supported by the rodent models where a UV-induced suppression of immune systems (such as DTH) can be demonstrated, but it is not necessarily correlated with loss of immunity and increased microbial load or severity of symptoms. In addition, the type of cytokine response which is important in controlling an infection might be related to UV effects (Norval 2001).

UV radiation can cause immunosuppression by inducing a number of cellular changes. The initiators for these effects include DNA damage of cells, membrane lipid peroxidation, or photoisomerisation of trans to cis-UCA and its subsequent interaction with cells in the skin (Ullrich 2005).

The reason why UV radiation can cause immunosuppression in humans remains unclear. It is likely that either insufficient or too much exposure to UV can damage human health. In order to best use this important natural exposure for optimal health, further epidemiological and biomolecular research is required to study the mechanisms of both beneficial and adverse UV effects on population health.

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The Pollution of the Surface Waters and its Impact on the Quality of the Vegetables Cultivated and Consumed in the City of Lubumbashi

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Currently, the rivers in the city of Lubumbashi are subject to mineral and organic pollution. The main sources of this pollution are the effluent from metallurgic industries, domestic water and all sorts of garbage, as well as the waste produced by the enrichment of the ores of copper and cobalt by artisan processes. Indeed, the mineral pollution that the rivers of Lubumbashi experience is due to muddy and mineralised water produced by the washing of ores in the rivers in order to rid them of the impurities and to concentrate the useful minerals of copper and cobalt they can contain. Thus, loaded with these impurities, the water from the rivers cannot be used for domestic needs and especially for watering vegetables cultivated and consumed by the population. The use of polluted water as well as the consumption of vegetables watered with polluted water constitutes contamination of the population who do not have easy access to drinking wateri and to healthy food.

Key words: *Effluents; Pathogenic Bacteria; Vegetables; Mineral Pollutants*

For the past five years, the population has denounced the pollution which affects the rivers in the city of Lubumbashi (Gazette de Lubumbashi 2007). The main sources of this pollution are the waste water from the mining industry and those used in the processing of copper and cobalt ores (Kalenga et al. 2006; Kachaka 2005; Réseau Ressources Naturelles 2007; SNC-Lavalin International 2003; Vanden Weghe et al. 2005). The population plays a significant part in this pollution. Indeed, in the city of Lubumbashi the population pollutes the environment from the artisan enrichment of ores by washing them in the rivers (SNC-Lavalin International 2003). The same population needs water for lucrative activities such as rearing fish in the ponds dug along the rivers and for cultivating vegetables. Facing the difficulties of access to drinking water, people use the polluted water coming from the rivers for domestic activities. About 55% of the urban Congolese population has no access to drinking water of good quality (Document Intérimaire de Stratégies de Réduction de la Pauvreté [DISRP] 2002). Thus, Kakoma (2004) declared, as far as the problem of water is concerned in the city of Lubumbashi, that "the present situation is dramatic when one compares it to the one that prevailed in Elizabethville [during colonization] and during the first ten years after the independence of the country in 1960". Indeed, it is not only difficult to gain access to water of quality and in sufficient quantity; but also even the reserves of natural waters are threatened by pollution (DISRP 2002). Thus, for many years the rivers in the city of Lubumbashi have been subject to pollution of mineral origin due to the mining industry that

uses them as spillways (Vanden Whege et al. 2005). The same rivers are also the object of organic pollution due to the mismanagement of garbage in the city. Thus the rivers receive all sorts of garbage and contaminated water coming from hospitals and constitute pathways for the vectors of tropical illnesses (Kakoma 2004; Kiyombo 2003).

Material and Methods

This research was on the pollution of the rivers in the city of Lubumbashi. Its methodological approach aimed to assess the contamination of the surface waters and their impact on the quality of vegetables cultivated and watered with them (SNC-Lavalin International 2003; Vanden Weghe et al. 2005). We searched for the contaminants (mineral and organic) in the water of the Rivers Kampemba and Kalaviundu, as well as in the vegetables cultivated along them. To carry out this survey successfully, five points of sampling water and vegetables were chosen (Figure 1).

This research has been carried out in the city of Lubumbashi (Kampemba). Water has been sampled from the rivers of interest, as well as from the drain where waste is discharged from an ores processing factory[1]. The vegetables (*Ipomoea Batata*) analysed produce the leaves, and tubers of sweet potato, often consumed by our population. These vegetables are called "*Matembele bange*"[2] in the vernacular language (Swahili[3]) of the DRC. The sampling of water and vegetables has been achieved in five places described as follows:

i) the point of tipping of the waste waters by the CHEMAF factory (Avenue of the Cemeteries);

ii) in the drain for the discharges from the factory (on Savonnier Avenue);

iii) in the Kampemba River and in the near neighborhood of the bus station named the '*Terminus Kaleja*' (before the confluence of waters from the Rivers Kampemba and Kalaviundu).

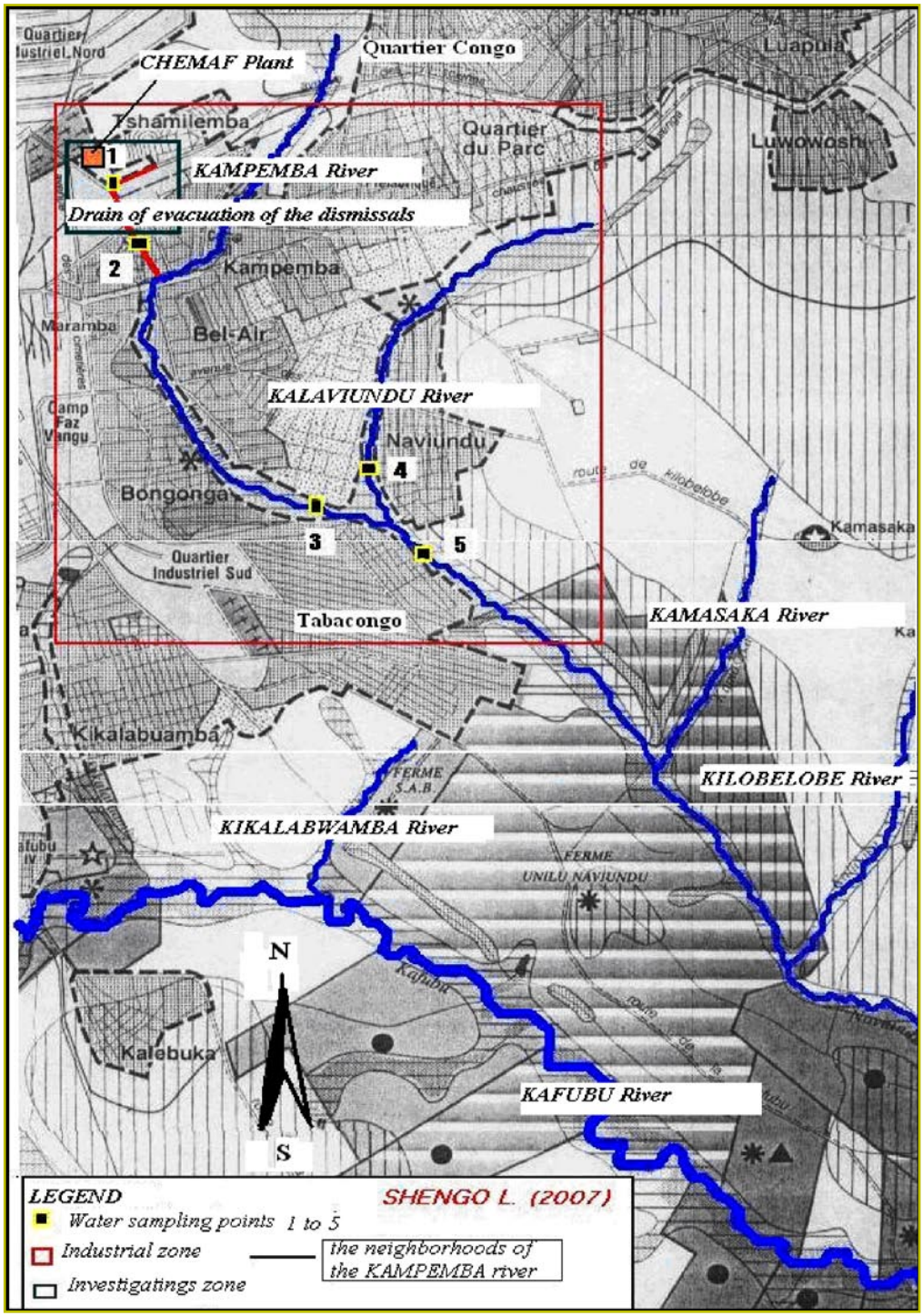
iv) in the Kampemba River, before the point where it mixes with water of the Kalaviundu River, which is in the Naviundu district.

v) in the Kalaviundu River and far from the point where it mixes with the River Kampemba.

Water sampling procedure

We used a simple method for sampling the water. It consisted of withdrawing water from each of the places chosen (see above) with the help of small 250ml polyethylene bottles. Thus, the withdrawal of water from the rivers was done by immersing the small bottle attached to a bamboo cane in the water until the wanted depth was reached. Concerning the waste coming from the CHEMAF factory, a manual withdrawal was achieved from the drain where the waste was discharged. For their preservation, the samples were acidified with concentrated nitric acid until at a pH below 2 for the analysis of the mineral contaminants. A timetable of collection of samples was drawn up for precise hours in the morning for every 7 days or 4 times per month from the beginning of the month of February until the end of the month of March 2007. For the samples of vegetables, 100g of fresh plants were collected from where they were cultivated along the rivers. After drying the vegetable samples at 50°C in a MEMMERT steam room until a constant weight, the analysis of minerals was performed on 5g of the dried vegetable matter.

Figure 1: The test locations (sites) on the Rivers Kampemba and Kalaviundu in the City of Lubumbashi



Physicochemical analyses of the samples

These analyses on one hand consisted of the determination of the electric conductivity and the pH of the samples with the help of two devices: A sensor provided with a probe of Condi340i mark and a HASCH pH-meter, respectively. On the other hand, these analyses consisted of the determination of the concentrations of copper (Cu), cobalt (Co), iron (Fe), manganese (Mn), nickel (Ni), arsenic (As), lead (Pb) and zinc (Zn) in the samples with the help of a PERKIN ELMER 300 spectrophotometer. Different standard solutions of the minerals of interest have been used at required absorption wavelength (or energy) of the light emitted by the multi-element cathode lamp for the spectrophotometer calibration and the mineral analysis. For the vegetables, their mineral compositions have been determined by x-rays fluorescency spectroscopy method. Thus, a dry and finely ground sample of the vegetable matter was placed in a cylindrical capsule whose capacity equals 5g and irradiated by a primary beam of x-rays. Agitation of matter allowed a secondary emission (fluorescency emission) of proper x-rays involved in the analyses of the mineral content of the vegetables.

Microbiological analysis of water

For counting the organisms in the water samples, we used the vacuum filtration method of a membrane made with esters of cellulose (0.45µm) and the biologic amplification technique in cultures contained in Petri dishes. These analyses have been done by making a 5mL withdrawal of water to analyse with a sterile pipette before pouring it aseptically on the membrane for the vacuum filtering. Then, we placed the membrane in a Petri dish and submitted it to incubation (44°C) during 24 hours in a MEMMERT steam room. After incubation, we counted the number of yellow colonies developed on each of the membrane filters and we calculated the average of the numberings of the colonies (Ayres & Duncan Mara 1996). Since the bacterial count has been achieved for 5 ml of water (the volume of sample submitted to filtration), we multiplied the number counted by 0.2 to get the number of organisms per 1 ml.

Results and Discussion

The results found from the analyses of the pollutants (mineral elements and pathogenic bacteria) contained in the samples of water from the rivers and the effluent from the CHEMAF factory, as well as from the vegetables watered with them, are presented.

Concentrations in mineral elements

Table 1 presents the results of the mineral analyses of effluent from the CHEMAF factory and the samples of water taken from the Rivers Kampemba and Kalaviundu during our investigation.

First, the analysis of the results contained in Table 1 indicates that the pollution in this survey is mainly due to the water coming from the ores processing factories, mainly from CHEMAF (Alberta Environment 1999; Canada Gazette 2002; Journal Officiel de la RDC 2003; Kalenga et al. 2006). This contamination spreads from the point of tipping of the effluent into the River Kalaviundu because the waters leaving the factory and the water of the Rivers Kampemba and Kalaviundu presented at different points of sampling show elevated electric conductivities (20940-27030µS/cm). The electric conductivity of water decreases as one moves further away from the source of contamination. This means that the aquatic environment undergoes a sort of natural purification. However, it is important to mention that the elevated electric conductivities

Table 1: Results of the physicochemical analyses of samples

	A	B	C	D	E	Sample N°1	Sample N°2	Sample N°3	Sample N°4	Sample N°5
pH			6.0-9.5			6.87	7.00	7.70	6.69	8.08
EC[1] (µS/cm)		750-1500				27030	21690	20940	3500	1780
Cu (mg/L)	0.30	1.5	<1	0.2-1	2.10^{-3} -4.10^{-3}	2.47	0.34	0.13	0.27	0.74
As (mg/L)	-	0.40	<0.05	0.1	0.005	0.05	0.04	0.03	0.05	0.01
Co (mg/L)	-	-	<1	0.05	-	10.33	4.02	2.41	4.28	5.23
Fe (mg/L)	0.10	6.0	<0.2	5.0	3	3.78	0.20	1.02	0.75	1.10
Mn (mg/L)	1.00	0.05	-	0.2	-	4.66	3.40	1.67	0.02	1.62
Ni (mg/L)	-	1	-	0.2	15.10^{-3}-25.10^{-3}	0.20	0.11	0.05	0.00	0.02
Zn (mg/L)	0.50	10	<5	1-5	0.03	10.63	8.44	4.89	3.09	1.56

Notes:

EC[1] Electric conductivity

A Regulations on the liquid effluent of the mines of metals (RLSMM) (Canada Gazette 2002)

B Mining regulation of the RDC (Journal Officiel de la RDC 2003)

C European norms (Kalenga et al. 2006)

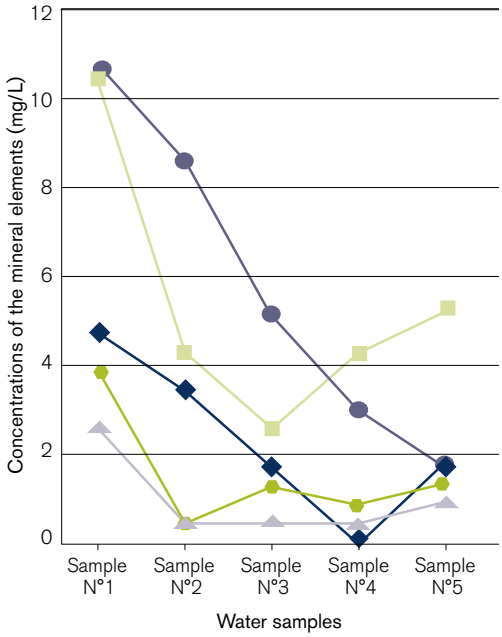
D Water quality guidelines for agricultural uses (Alberta Environment 1999)

E Water quality guidelines for the protection of freshwater aquatic life (Alberta Environment 1999)

observed in the water indicate the strong mineralisation known to the River Kampemba because it serves as a spillway for the discharges from the CHEMAF factory (Sample No. 1). These observations remain correct although we did not take into account the contribution to water pollution due to the other factories (LUKI Mining and Katanga Metal Processing, and so on) situated in its neighborhood. Indeed, while considering the toxicity benchmarks fixed by the norms that we used for the analysis of the results collected at the start of the research, clearly, it appears that the effluent from the CHEMAF factory has a mineral load that predisposes it to contamination of the environment (Cu, Co, Fe, Mn and Zn). Under Congolese mining regulations, only the manganese in the rivers can be described as the pollution of water. In fact, for the other mineral pollutants, either there is not a benchmark of toxicity defined by the DRC environmental laws, or their concentrations in water are below the benchmark of toxicity which has been fixed high enough for them to not be defined as polluting compared to those fixed by the other norms we have used. These norms are the ones applied in Canada and in the European Union that we have chosen as a reference (Canada Gazette 2002; Journal Officiel de la RDC 2003; Kalenga et al. 2006). After the analysis of Figure 2, it is also important to note that some mineral elements (Cu and Co) found in the water of the rivers are sometimes at concentrations higher than those of the issuing source of pollution (mainly the CHEMAF factory).

These changes to the mineral concentrations along the rivers reveal upstream of the point of tipping of the effluent from the CHEMAF factory, the

Figure 2: Concentrations of the mineral elements in water



existence of other sources of water pollutants along the Rivers Kampemba and Kalaviundu. Among these new sources of mineral pollutants, we can mention the enrichment of the ores of copper and cobalt by washing them in the rivers as a mean to eliminate the mineral impurities (Gazette de Lubumbashi 2006; Réseau Ressources Naturelles 2007; SNC-Lavalin International 2003; Vanden Weghe et al. 2005). Thus, when relying on different water quality guidelines that we used, it is clearly established that the rivers are contaminated and their waters are unfit to be used for agriculture (Alberta Environment 1999).

Microbiological analyses of water

Concerning pollution of organic origin, it is usually in connection with the presence of pathogenic organisms in water. Thus, we tested for pathogenic organisms in water. These analyses have been achieved in water sampled in three places that we have chosen with regard to the number of vegetable gardens and human activities we found along the rivers (laundry, bathing, and so on). The results of these analyses are presented in Table 2.

The results presented in Table 2 show that water sampled in the drain for the evacuation of discharges from the CHEMAF factory, as well as those collected from the Rivers Kampemba and Kalaviundu, are polluted because they contained organisms of fecal contamination (OMS 1986). So, these results also indicate that these waters have a mineral and organic pollution. The mineral nature of this pollution is due mainly to factory effluent whereas garbage and domestic waste are responsible for its organic nature. It is important to note that it is in the drain for evacuation of the discharges from the factory that the pollution of water is most evident, whereas for the rest of the sampling points, it appears to be less. Besides, if one considers the results arrived at at the start of our investigation, it is clearly established that the population uses water that is polluted. This water is dangerous for health because it not only contains mineral elements, but also pathogenic organisms. Therefore, the vegetables cultivated along the Rivers Kampemba and Kalaviundu are watered with contaminated water and

Table 2: Microbiological analyses of water

Germs	faecal coliforms	Total coliforms	Flora aerobe mesophile	Clostridium perfringens	Escherichia Coli
Sample (pH)					
N°2 (pH=7,00)	45/mL	75/mL	1920/mL	1/mL	10/mL
N°3 (pH=7,70)	10/mL	-	1460/mL	-	15/mL
N°4 (pH=6,69)	15/mL	-	1440/mL	-	10/mL

Note : *- Not detectable*

Table 3: Concentrations of the mineral elements in the vegetables

Parameters	Sample N°1	Sample N°2	Sample N°3	Sample N°4	Sample N°5
As (mg/g)	0,0582	0,0388	0,0204	0,0304	0,0000
Co (mg/g)	0,0166	0,0052	0,0002	0,0100	0,0318
Cu (mg/g)	0,0948	0,0538	0,0312	0,0100	0,0780
Fe (mg/g)	0,2166	0,2002	0,1578	0,2250	0,4580
Mn (mg/g)	0,0000	0,0000	0,0000	0,0000	0,0000
Ni (mg/g)	0,4904	0,4784	0,4104	0,3388	0,0000
Pb (mg/g)	0,0016	0,0004	0,0002	0,0002	0,0000
Zn (mg/g)	0,0000	0,0000	0,0080	0,0120	0,1000

present a danger for the population which consumes them. The results of the mineral and microbiological analyses indicate together that in our city the surface waters experience a complex pollution problem.

Mineral analyses of vegetables watered with the polluted waters

During our investigation, we also had the opportunity to achieve mineral analyses of the vegetables cultivated in five places and watered with the polluted water. The results presented in Table 3 have been arrived at at the end of the chemical analyses of the vegetables that we sampled along the drain for evacuation of the discharges from the CHEMAF factory and along the Rivers Kampemba and Kalaviundu.

Although manganese was the most common mineral contaminant in the water we analysed during our investigations, the results reported in Table 3, allow us to note its absence in the samples of vegetables (*Ipomoea batata*) that we submitted to the mineral analysis. The other mineral elements have been found in the vegetables in concentrations that vary with the sampling places. It is in the samples of vegetables cultivated in the neighborhood of the drain for evacuation of the discharges from the CHEMAF factory that the majority of the heavy metals have been found to be in the highest concentrations (Cu, Ni, Pb and As). For the rest of the heavy metals of interest (Fe, Zn and Co), a marked presence has been observed in the vegetables cultivated along the River Kalaviundu (Sample No 5) downstream from the confluence point with the River Kampemba. These results confirm those arrived at previously and indicate that pollution of the water spread from the point of tipping of the liquid effluents from the factory to as far as the River Kalaviundu. Thus, some heavy metals initially found in the wastewaters from the industrial area (Figure 1) have been found in the water of the rivers, as well as in the vegetables submitted for mineral analyses. On one hand, their concentrations are superior to the Australian Food Standards maximum level equal to 0.01mg/Kg of fresh vegetables. This means they are severely contaminated by heavy metals (Anthony & Balwant 2006).

On the other hand, one can note for sample No 3 that the vegetables contain nearly all the heavy metals we analysed but in smaller concentrations if they are compared to those found in the vegetables sampled elsewhere so that the hypothesis about the self purification of water seems plausible. Indeed, as revealed by the results of the analyses of the mineral pollutants in water, one can note a decrease of the concentrations in heavy metals (Fe, Cu, Ni, Co, Pb and As) in the vegetables while going from Sample 1 to Sample 3, although, thereafter, a rise of concentration has been observed. This fact especially confirms the existence of the new sources of water

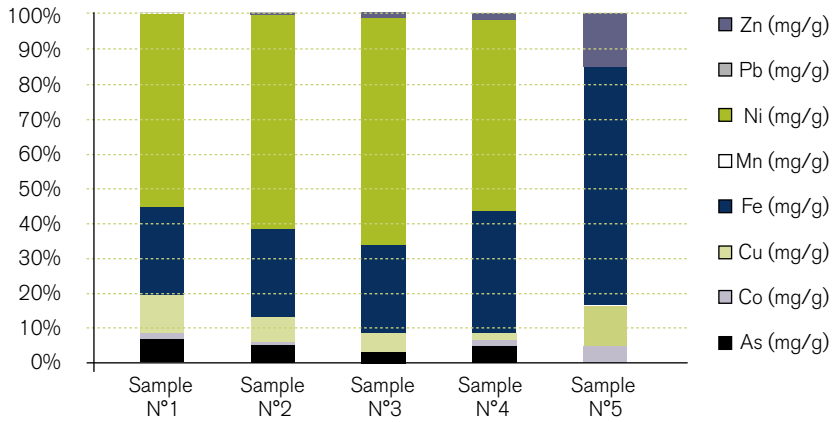
pollutants (Cu, Fe, Zn and Co) along the River Kalaviundu.

Thus, as one can see in Figure 3, the mineral elements, nickel, iron, copper and arsenic, are more frequent in the vegetables (*Ipomoea Batata*) cultivated and watered with the contaminated water. Concerning zinc and cobalt, they have not been found in all the vegetables we analysed. In fact, zinc (10,64mg/L) found initially in the waste waters from the CHEMAF factory has only been found in the vegetables cultivated far from the issuing source of the mineral pollutants, contrary to cobalt whose origins seem to be more numerous (from the artisan enrichment of ores). Besides, it is difficult to know where the nickel goes as it is not found in the vegetables from the last sample (Sample No 5) we submitted for analyses. These results indicate that the water of the Rivers Kampemba and Kalaviundu are polluted and that watering vegetables with water taken from them constitutes a means of transmitting their pollutants to the vegetables that the population consumes (De Zeeuw 2000; Martin 2001).

Health implications

It is clear when relaying the results arrived at from our investigations that the samples of water that we analysed are of poor quality from a physicochemical and microbiological viewpoint. These waters present a health danger for the users (De Zeeuw 2000; OMS 1985, 1994). So, the population uses polluted water with high concentrations of heavy metals, strongly mineralised, and containing various pathogenic organisms. The population also consumes vegetables cultivated in a contaminated environment (Alberta Environment 1999; De Zeeuw 2000). So without wanting to be considered alarmist, we support the assumptions of Konen (2002) that although water from the rivers is not used in the city of Lubumbashi to drink, it is, however, true that the population uses it nevertheless for other domestic needs such as washing up and laundry, bodily care (bathing) as well as the market cultivation of vegetables such as Ipomoea batata. So, the possibilities for ingesting the contaminants contained in the water and vegetables (the heavy metals and the bacteria and organisms from fecal contamination) are numerous (De Zeeuw 2000; Nabulo 2004). Besides, as the same population eats fish coming from the rivers, it is, therefore, at the mercy of all sorts of illnesses linked to the quality of the water or food it consumes daily (De Zeeuw 2000; Martin 2001).

Figure 3: Concentrations in mineral elements in the plants



Conclusion

The results from this research indicate clearly that the water of the Rivers Kampemba and Kalaviundu experience pollution of a complex nature. This pollution is due mainly to the waste waters from the copper and cobalt ores processing factory. The other sources of pollution of the rivers are from domestic effluent and garbage, as well as from waters greatly mineralised produced by the enrichment of the ores of copper and cobalt by artisan processes.

As the physicochemical and microbiological analyses reveal, the industrial waste poured into the aforementioned rivers makes their waters unfit to be used for any domestic needs. Thus, their use for any domestic purpose or for the watering of vegetables must be avoided. Besides, the vegetables cultivated along the two rivers are contaminated by heavy metals and are therefore unfit for human consumption because they put the health of the population in danger.

We suggest that in future environmental studies of this kind also search for the means of reducing the effects of the pollution and contribute to the protection of our aquatic ecosystems and waters resources.

Acknowledgments

The authors thank wish to thank Mrs Lwangu N of Regideso/Katanga and Mbayo M. of the mineral analysis laboratory of the Observatory of Mineral Resources of the University of Lubumbashi for their contribution to the completion and the success of this research.

Endnotes

1. The Chemical of Africa (CHEMAF).
2. "*Kalembula*" in "*Bemba*". The "Bemba" is a vernacular language more spoken in the Southeastern region of the Katanga province and in the Zambian province of Copper Belt.
3. A vernacular language used in the Katanga province as well as in the Eastern regions of the DRC.

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The Importance of Environmental Health in Improving the Life Expectancy of Indigenous Peoples

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There is a pressing need to ensure the full participation of Indigenous peoples in policy making processes. Much of the failure of service delivery to Indigenous people and communities, and the lack of sustainable outcomes, is a result of the failure to engage with Indigenous people and of the failure to support and build the capacity of Indigenous communities. It is the result of a failure to develop priorities and programs in full participation with Indigenous communities. Effective participation in decision making processes that affect Indigenous Australians has been confirmed as essential to ensuring non-discriminatory treatment and equality before the law. There is a challenge to build into policy a longer term vision for the wellbeing of Indigenous communities. One of the major problems with Indigenous policy making in Australia is that it is not sufficiently targeted to overcome the existing level of inequality and discrimination experienced by Indigenous peoples. Ambitious targets should be set. Indigenous policy should not be allowed to simply drift along without targets. It is not good enough to rely on 'record levels of expenditure' as the measure of progress. Once goals and targets have been set, government processes must be reformed to ensure that they are capable of meeting these challenges. Indigenous policy making should be based on a commitment to human rights. Fundamental to good policy development is that all legislation, policies and programs developed and implemented by governments should be consistent with international human rights standards.

Key words: *Indigenous People; Policy; Human Rights; Participation*

As the Social Justice Commissioner my functions are to monitor the enjoyment and exercise of human rights for Indigenous Australians including human rights as they relate to native title. Under the HREOC Act and the Native Title Act, I am required to produce annual Social Justice and Native Title Reports. These reports are tabled in the federal parliament each year. The most recent Social Justice Report, tabled in parliament on 20 March 2008, focuses on issues relating to family violence and child abuse in Indigenous communities. My Social Justice Report 2005 to the federal parliament made findings in relation to Indigenous health. This has manifested in the Close the Gap Campaign. In recent months I have put a series of challenges to government for addressing Indigenous issues.

In general terms, I have outlined a series of challenges for Indigenous policy making generally, and for the past two years I have lead the Close the Gap Coalition on health specific activities. Let me start by outlining some of the key issues and principles for addressing Indigenous policy generally.

First, there is a pressing need to ensure the full participation of Indigenous peoples in policy making processes. Much of the

failure of service delivery to Indigenous people and communities, and the lack of sustainable outcomes, is a direct result of the failure to engage appropriately with Indigenous people and of the failure to support and build the capacity of Indigenous communities. It is the result of a failure to develop priorities and programs in full participation with Indigenous communities. Effective participation in decision making processes that affect Indigenous Australians has been confirmed as essential to ensuring non-discriminatory treatment and equality before the law. It is also central to the human rights based approach to development which is now widely accepted and operational across the United Nations and the international development cooperation system.

Second, there is a challenge to build into policy a longer term vision for the wellbeing of Indigenous communities. One of the major problems with Indigenous policy making in Australia is that it is not sufficiently targeted to overcome the existing level of inequality and discrimination experienced by Indigenous peoples. For example, government health funding must be needs-based so that programs are capable of overcoming existing inequalities and are also cognisant of the future needs of particular groups. For Indigenous peoples this is going to be a major issue with a rapidly expanding youth population over the next decade creating a further pressure on what are already inadequate levels of funding and service. Also, policy development and program implementation can benefit from understanding community development principles.

Creating change in communities is a long term process that will ultimately only be achieved by empowering and supporting communities, often small steps at a time, so that they are capable of taking control of their circumstances. This takes time and consistency of effort. Of particular importance in the context of policy design and implementation that relates to Aboriginal peoples and Torres Strait Islanders, are the following guidelines:

- Indigenous peoples have the right to full and effective participation in decisions which directly or indirectly affect their lives;
- Their participation should be based on the principle of free, prior and informed consent, and
- Governments and the private sector (amongst others) need to support efforts to build the capacity of Indigenous communities ... so that they can participate equally and meaningfully in the planning, design, negotiation, implementation, monitoring and evaluation of policies, programs and projects that affect them.

Third, ambitious targets should be set. Indigenous policy should not be allowed to simply drift along without ambition and without targets. It is not good enough to rely on 'record levels of expenditure' as the measure of progress. Such targets and goals should receive bipartisan support and form the basis of inter-governmental cooperation. We need long term commitments to make real progress in Indigenous affairs. Much can be achieved if the federal government ensures that the targets agreed are matched with teeth for accountability and implementation.

Fourth, once goals and targets have been set, government processes must be reformed and re-engineered to ensure that they are capable of meeting these challenges.

And fifth, Indigenous policy making should be based on a commitment to human rights. Fundamental to good policy development is that all legislation,

policies and programs developed and implemented by governments should be consistent with international human rights standards. A human rights based approach encourages the adoption of proactive measures to create an enabling framework for active participation and engagement of all citizens, and particularly for those who are disadvantaged or powerless. Ultimately, human rights are about implementing a sound policy framework. And remember, human rights are for everyone, everywhere, everyday. Following some rapid developments with the new government, we are moving towards implementing a human rights based approach to Indigenous health. So let me talk about what it is, and how to implement, a human rights based approach to Indigenous health.

Under international human rights standards, the right to health is the right for all people to have opportunities to be as healthy as possible as provided to you by the state. What this means, in practice, is that the state provides two things:

- The first is the foundation for good health provided by safe drinking water, hygienic conditions, healthy housing and a supply of healthy food. I refer to this as 'health infrastructure'.

- Health goods and services make up the second. That is, hospitals and medicines for when people are ill and primary health care services that aim to prevent ill health or detect it at an early stage so that ill health is nipped in the bud.

The right to health obliges a state to ensure that everyone, regardless of race, has an equal opportunity to be healthy. This is where the right to health is of direct relevance to Indigenous people in Australia. It means that from a health perspective, communities across Australia (whether Indigenous or non-Indigenous) should enjoy a similarly healthy standard of drinking water, can access roughly the same standard of fresh vegetables, fruits and meat, and have their sewage and garbage removed. It also means that they enjoy, from a health perspective, the same standard of housing that is in good repair with functioning sanitation and is not overcrowded.

Indigenous peoples in Australia do not enjoy the same opportunities to be as healthy as the non-Indigenous population in relation to primary health care, medicines and health infrastructure. 'Health hardware' as it is sometimes referred to, along with food supplies have been identified as the key determinants of Indigenous ill health in the *National Environmental Health Strategy* (DHAC 1999). There are also many other environmental health factors that influence health such as air quality, noise pollution, occupational health, food quality and pest control.

Despite some areas where real improvements have occurred, particularly the water supplies in many communities, Indigenous people do not have equal access to health information. Poor infrastructure in Indigenous communities results in many health risks and includes skin infections such as scabies mite, infectious diseases, trachoma and rheumatic fever. Overcrowding and poor environments encourage and lead to many vectors such as the scabies mite, which according to a report prepared for the Department of Health and Ageing in 2002, have been endemic in many remote communities and the statistics have not improved. A clean, sufficient and reliable water source is vital as it is required for drinking, hygienic food preparation and washing of people, clothes and bedding. Access to clean water and functional sewerage requires a combination of both functioning community infrastructure as well as functioning household hardware.

Indigenous people experience higher hospitalisation rates than non-Indigenous people for all diseases associated with poor environmental health.

Indigenous Environmental Health: Challenges and Opportunities

Poor environmental health in many remote Indigenous Australian communities is one of the main factors responsible for the poor public health outcomes frequently associated with these communities. As I have mentioned previously without environmental health conditions conducive to good health, such as access to safe food, clean water and adequate sanitation, all other public health programs and clinical interventions will continue to be seriously undermined. Improving and maintaining basic environmental health conditions in Indigenous Australian communities is central to securing better health outcomes. In order for there to be improvements in environmental health infrastructure and living standards, real collaboration must occur with all those working across the different areas of health and social and physical environments.

The 'environmental health workforce' plays an integral part in promoting healthy living practices and maintaining infrastructure to ensure long-term, effective use. In order to sustain a healthy environment for Indigenous Australian communities there needs to be adequate support and development of the workforce which manages this infrastructure. Environmental Health Workers play a central role in Indigenous Australian communities and issues which have been identified as important by this workforce include: support through on-the-job training, creating career paths, providing effective means for concerns to be heard, and promoting partnerships.

An initiative that is aiming to address the need of Indigenous environmental health is the NSW Health Aboriginal Trainee Environmental Health Officer Program which has been running since 1997. This now fully funded program identifies that in order to help reduce the impacts of environmental health on Indigenous communities there needs to be a commitment from government to help educate, train and place Indigenous Australians in the positions of environmental health workers. As there are very few Aboriginal people working in the profession of environmental health this is an important program to ensure workers can help communities create environments supportive of good health especially in remote communities.

As mentioned above, I have made a series of recommendations for achieving Aboriginal and Torres Strait Islander health equality within a generation. Over the past two years I have worked with a broad coalition of more than 40 peak bodies across the health, Indigenous health, NGO, reconciliation and human rights sectors to promote the findings of my 2005 Social Justice Report. The first stage of this work culminated in mid-March when the Prime Minister, the Ministers for Health and Indigenous Affairs, the Opposition leader, Ian Thorpe, Catherine Freeman, and every major Indigenous and non-Indigenous health peak body signed a Statement of Intent for a new partnership to Close the Gap in Indigenous health inequality.

The Statement of Intent commits the Government of Australia, Indigenous Australians, supported by non-Indigenous Australians and Indigenous and non-Indigenous health organisations to work together to achieve equality in health status and life expectancy between Indigenous and non-Indigenous Australians by the year 2030. The Statement of Intent also outlines that specific measures are needed to improve Aboriginal and Torres Strait Islanders' access to health services. And crucial to this is ensuring that for Indigenous

Australians to have equal access to health services they need to be actively involved in the design, delivery and control of these services. There has been a commitment by those that have signed to:

- Develop a comprehensive long-term plan of action that is targeted to need, evidence-based and capable of addressing the existing inequalities in health services in order to achieve equality of health status and life expectancy between Indigenous and non-Indigenous Australians by 2030.
- To ensuring primary health care services and health infrastructure for Aboriginal and Torres Strait Islander peoples which are capable of bridging the gap in health standards by 2018.
- To ensuring the full participation of Aboriginal and Torres Strait Islander peoples and their representative bodies in all aspects of addressing their health needs.
- To working collectively to systematically address the social determinants that impact on achieving health equality for Aboriginal and Torres Strait Islander peoples.
- To building on the evidence base and supporting what works in Aboriginal and Torres Strait Islander health, and relevant international experience.
- To supporting and developing Aboriginal and Torres Strait Islander community-controlled health services in urban, rural and remote areas in order to achieve lasting improvements in Aboriginal and Torres Strait Islander health and wellbeing.
- To achieving improved access to, and outcomes from, mainstream services for Aboriginal and Torres Strait Islander peoples.
- To respect and promote the rights of Aboriginal and Torres Strait Islander peoples, including by ensuring that health services are available, appropriate, accessible, affordable and of good quality, and
- To measure, monitor, and report on our joint efforts, in accordance with benchmarks and targets, to ensure that we are progressively realising our shared ambitions.

Copies of the Statement of Intent are available on the HREOC website. In addition to the Statement of Intent there were important targets resulting from the Indigenous Health Equality Summit with one area focusing on improving the environmental health of Indigenous Australians.

Some of the targets that will be put in place following on from the Health Summit include:

- Ensuring the development of a set of community level health service facility standards that are nationally agreed.
- Ensuring that all community level facilities meet the health service facility standards - both of these within two years.
- Ensuring that all community facilities have access to the appropriate equipment and technology necessary to deliver comprehensive primary health care to Aboriginal communities in a timely manner, i.e. within five years.
- Use a majority of local Indigenous teams for house assessment and maintenance.

- To ensure that 90% of Aboriginal families can access a standard healthy food basket (or supply) for a cost less than 30% of their available income.

These are just some of the targets resulting from the Health Summit and the completed document outlining all of the Health Summit findings and targets will be made available at a later date.

An important message that we should all reflect on when we work with Indigenous people, or with any of our stakeholders for that matter: from self respect comes dignity, and from dignity comes hope.

Endnote:

1. Keynote address delivered on behalf of Commissioner Tom Calma to the International Federation of Environmental Health 10th World Congress on Environmental Health, Brisbane, 12-16 May 2008

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Challenges and Opportunities for Environmental Health in the Western Pacific Region

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The pursuit of economic development has brought about the overall economic improvement in the Western Pacific Region, although its magnitude and pace vary from country to country. It has also resulted in rapid urbanisation and industrialisation, and changed the physical and social environments in which people live. These changes have in turn affected their health and wellbeing. According to recent estimates of the World Health Organization (WHO), environmental health risks, such as unsafe water, poor sanitation and hygiene, indoor and outdoor air pollution, toxic chemicals, hazardous wastes, noise, radiation, housing and community risks, traffic, unsafe occupational and recreational environments, inadequate water resource management and land use, man-made environmental emergencies, climate and ecosystem changes, attribute 2.9 million deaths, or 24% of the total deaths, and 58.8 million disability-adjusted life years lost (DALYs), or 22% of the total DALYs, annually in the Region. Over 90% of such deaths and disease burdens occur in developing countries of the Region. The most significant environmental health risks in the Region are indoor air pollution from burning solid fuels, urban air pollution and unsafe water supply and poor sanitation, which contribute 30% of the total deaths attributable to environmental risks. Environmental risk factors are particularly important for vulnerable population groups, such as children and the elderly. In order to respond to these environmental health challenges in the Region, WHO has developed a regional strategy for environmental health with the following objectives: i. to strengthen national capacity in environmental health risks assessment and management; ii. to enhance cooperation between health and environment sectors, and their cooperation with other socio-economic development sectors in solving problems; and iii. to promote inter-country cooperation in solving common and transboundary environmental health problems. WHO has developed effective partnerships with various regional organisations to implement the regional strategy for environmental health. Climate change is an emerging challenge in the Region, and WHO has recently formulated a regional framework for action to address the health implications of climate change. These regional and national policies and strategies need to be supported by local actions. WHO has promoted healthy cities and settings in the Region to provide frameworks for developing and implementing local actions for health protection and promotion. The Alliance for Healthy Cities was established with the support of WHO to facilitate the exchange of good practices among cities and other stakeholders.

Key words: *Western Pacific; Environmental Health; Climate Change; Health Risk Assessment; Burden of Disease*

The World Health Organization (WHO) Western Pacific Region covers 37 countries and areas[1], ranging from Mongolia in the north and New Zealand in the south (Figure 1). It consists of the world's most populous country (China) as well as small island nations and territories in the Pacific. The Region is one of the rapidly developing economic zones in the world.

Over the last 50 years, the countries and areas in the Western Pacific Region have undergone considerable economic development although its magnitude and pace vary from country to country. Such economic development has brought about rapid urbanisation, industrialisation and technological advances, leading to improved standards of living for many people who are now living longer lives. However, economic development has also caused the changes in physical and social environments which have often adversely affected the health and safety of various population groups.

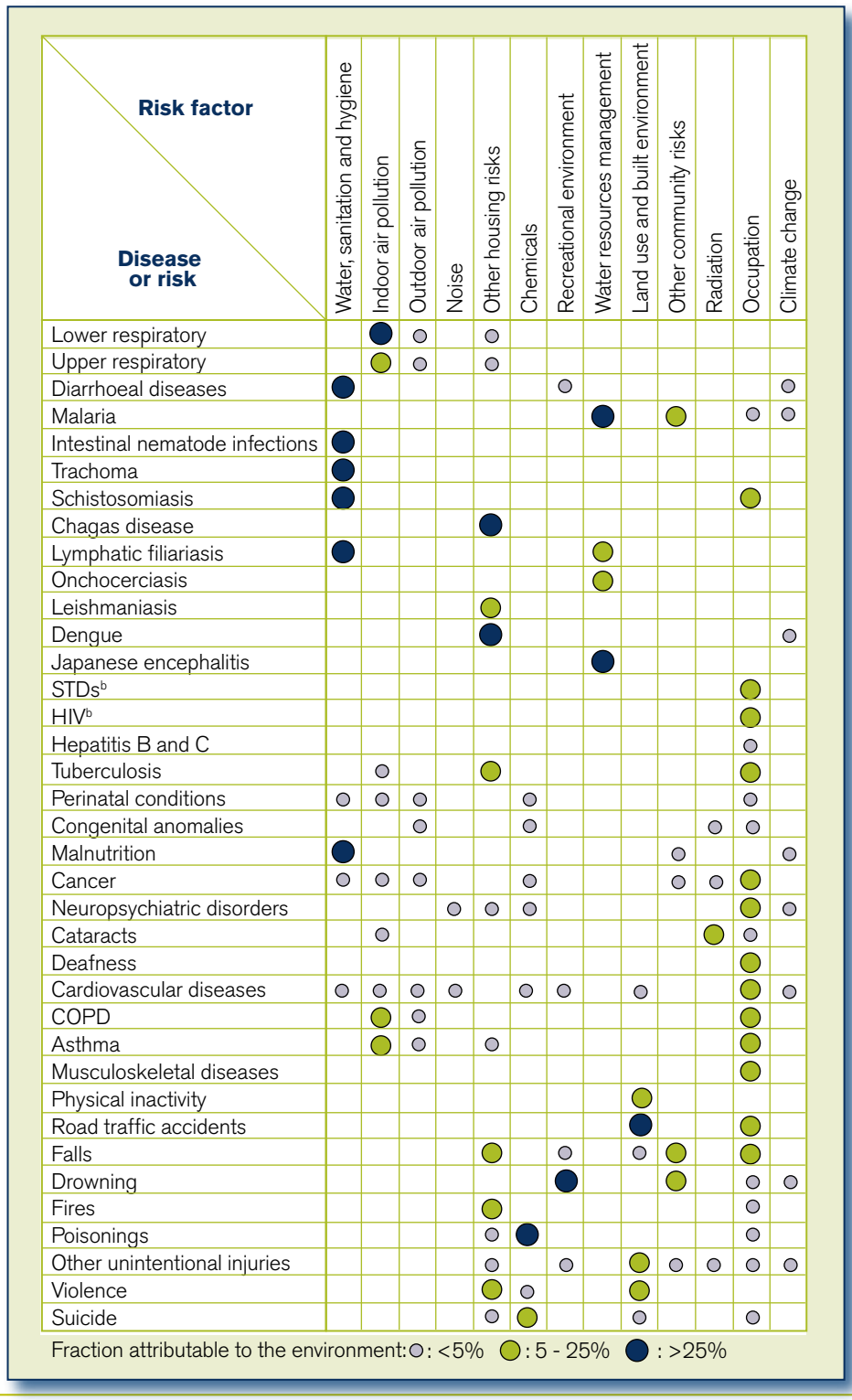
Regional Environmental Health Challenges

The countries and areas of the Western Pacific Region face a variety of environmental health hazards. In low-income countries, people still suffer from traditional environmental risks such as unsafe water, inadequate sanitation and poor hygiene, and indoor smoke from domestic cooking and heating. People in rapidly developing countries are exposed to additional, more modern environmental risks such as exposure to urban, industrial and agrochemical pollution, as well as industrial emergencies. More recently, the health impact of changes in climate and ecosystems has become a concern in many countries in the Region.

Recently, WHO has made estimates of the environmental burden of disease[2]. According to the estimates, environmental health risks, such as unsafe water, poor sanitation and hygiene, indoor and outdoor air pollution, toxic chemicals, hazardous wastes, noise, radiation, housing and

Figure 1: WHO Western Pacific Region

Figure 2: Disease and related environmental risk factors with indicative values for environmentally attributable fractions

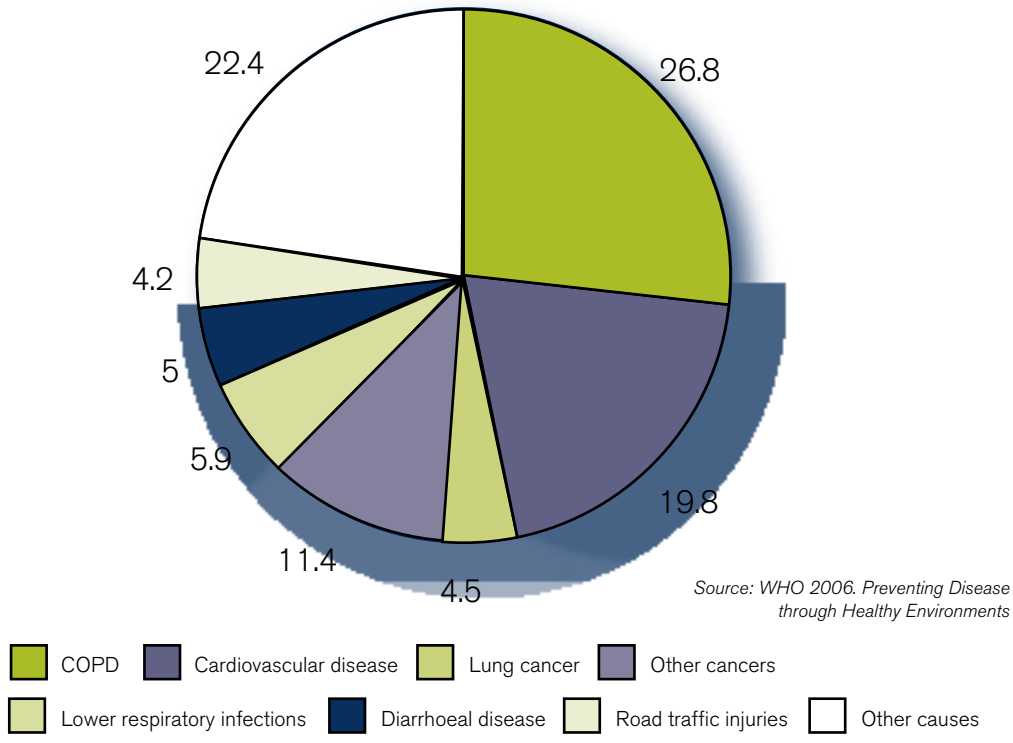


community risks, traffic, unsafe occupational and recreational environments, inadequate water resource management and land use, man-made environmental emergencies, climate and ecosystem changes, attribute an estimated 2.9 million deaths, or 24% of the total deaths, and 58.8 million disability-adjusted life years lost (DALYs), or 22% of the total DALYs, annually in the Region. Over 90% of such deaths and disease burdens occur in developing countries of the Region. Reducing these different burdens of environmental risks to health is a major challenge to the countries and areas in the Region.

Different environmental risks are related to different health outcomes (Figure 2). For example, contaminated water is strongly linked to the occurrence of diarrhoeal disease, but drinking water which contains carcinogens would cause cancer. Indoor and outdoor air pollution is associated with respiratory infections, particularly in children, but it also results in cardiovascular disease, lung cancer and chronic obstructive pulmonary disease (COPD).

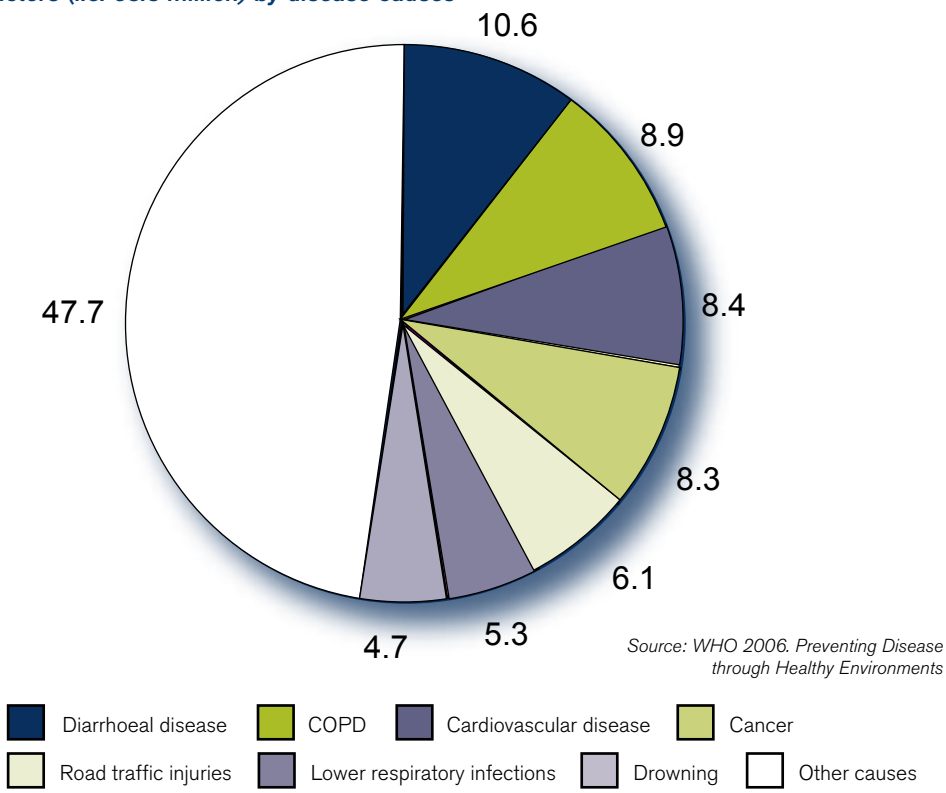
Of the 2.9 million deaths that occur due to various environmental risks in the Region, 26.8% results from COPD, 19.8% from cardiovascular disease, 15.9% from cancer (4.5% from lung cancer), 5.9% from lower respiratory infections, and 5% from diarrhoeal disease (Figure 3). In terms of disease burden, 10.6% of 58.8 million DALYs lost in the Region results from diarrhoeal disease, 8.9% from COPD, 8.4% from cardiovascular disease, 8.3% cancer, 6.1% from road traffic injuries, and 5.3% from lower respiratory infections (Figure 4). These estimates indicate that air pollution and unsafe water are major environmental risks to health in the Region. Figure 5 shows that an estimated

Figure 3: Percentage of total deaths attributable to environmental risk factors (i.e. 2.9 million) by disease causes



Source: WHO 2006. Preventing Disease through Healthy Environments

Figure 4: Percentage of total disability-adjusted life years lost attributable to environmental risk factors (i.e. 58.8 million) by disease causes

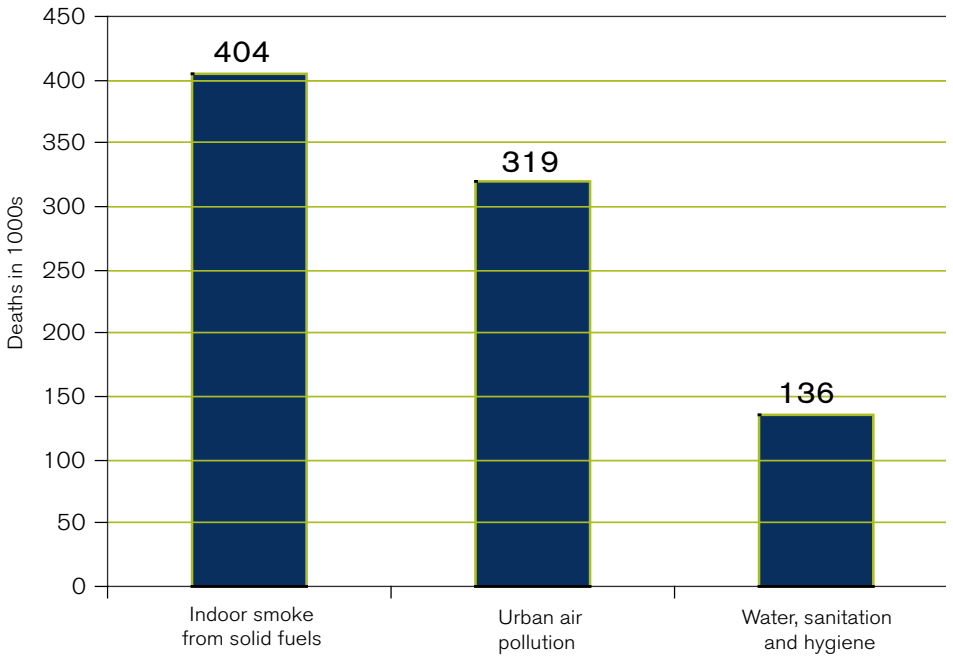


Source: WHO 2006. Preventing Disease through Healthy Environments

404,000 deaths are attributable to indoor air pollution from burning solid fuels, 319,000 deaths are due to urban air pollution and 136,000 deaths are due to unsafe water, and poor sanitation and hygiene in the Region. These three environmental health risks contribute 30% of the total deaths attributable to all environmental risks.

In 2007, WHO produced preliminary estimates of the environmental burden of disease for countries. An example for Australia is depicted in Figure 6. These country profiles of environmental burden of disease are available at the WHO website[3]. The country profiles contain the estimates of the environmental burden of disease for three major environmental risks, namely indoor air pollution from burning solid fuels, urban air pollution and unsafe water and poor sanitation and hygiene, and country-specific mortality rate estimates due to these environmental risks are shown in Figures 7 to 9. The proportion of population using solid fuels is high in many developing countries, and the mortality rate due to indoor air pollution from solid fuels is particularly high in countries like Lao People's Democratic Republic, China and Papua New Guinea. Urban air pollution is a problem in both developed and developing countries. The mortality rate due to urban air pollution is high in China, Lao People's Democratic Republic and Viet Nam, compared to other countries in the Region. Some developing countries in the Region have low population coverage for adequate water supply and sanitation. The mortality rate due to diarrhoeal disease from unsafe water and poor sanitation and hygiene is high in developing countries, such as the Federated States of Micronesia, Lao People's Democratic Republic and Cambodia.

Figure 5: Mortality attributable to major environmental risk factors



Source: WHO 2007. Country Profiles of Environmental Burden of Disease

Young children and the elderly are vulnerable to environmental risks. About one million children under 5 years old die every year in the Region. Of these deaths, 14.2% is from respiratory infections, 13.5% is from diarrhoeal disease, 7.1% from injuries and 35.4% from perinatal conditions, including the effects of toxic chemicals (Figure 10). The main environmental risks to children's health include unsafe water supply, poor sanitation and hygiene, indoor and outdoor air pollution, chemical hazards, road traffic injuries and drowning.

For older people, non-communicable diseases, such as cancer, cardiovascular disease and COPD, are the main causes of deaths. Over 80% of mortality among people older than 60 years of age in the Region every year is from these causes (Figure 11). Long-term exposure to toxic chemicals and other pollutants is a risk factor contributing to the development of non-communicable diseases and chronic health problems. Ageing lowers the strength of people's physical functions and immunity. Older people are more susceptible to various injuries, and less able to cope with heat and cold. They are also more vulnerable to infectious disease. The wellbeing of older people also depends on their social environment. The on-going demographic changes, such as the ageing of the population, rural to urban migration and more nuclear families, coupled with the breakdown of community structure cannot sustain the family and community support needed for older people. The main environmental determinants of older people's health include not only physical environmental factors, such as drinking water, indoor and outdoor air quality, noise, food safety, extreme high and low temperatures, national and man-made disasters and emergencies, and age-unfriendly built environments (e.g. houses, parks, community environment, transportation), but also supportive social environments.

Figure 6: Example of country profile of environmental burden of disease – Australia

Country profiles of Environmental Burden of Disease

Australia

Population	20.2 mio
GNI/capita	30 610 US$
% urbanization	88%
% people living in cities greater than 100 000 inhabitants	72%
Population below the poverty line (national)	NA
Population below the poverty line (international, <$1/day)	NA
Under age 5 mortality rate	5/1000 live births
Life expectancy	81 years

Environmental burden of disease for selected risk factors, per year

Risk factor	Exposure		Deaths /year	DALYs/ 1000 cap /year
Water, sanitation and hygiene (diarrhoea only)	Improved water: 100% Improved sanitation: 100%		-	0.2
Indoor air	SFU% households:	<5%	-	-
Outdoor air	Mean urban PM10: 18 ug/m3		700	0.2
Main malaria vectors	No transmission			
Main other vectors	None			

Environmental burden of disease (preliminary), per year

Estimate based on regional exposure and national health statistics 2004		
DALYs/1000 cap	(World - lowest: 14, highest: 316)	16
Deaths		22 000
% of total burden		14%

Environmental burden by disease category [DALYs/1000 capita], per year

Disease group	World's lowest country rate	Country rate	World's highest country rate
Diarrhoea	0.2	0.2	114
Respiratory infections	0.1	0.1	56
Malaria	0.0	0.0	32
Other vector-borne diseases	0.0	0.0	4.2
Lung cancer	0.0	0.8	2.5
Other cancers	0.5	2.1	4.1
Neuropsychiatric disorders	1.4	2.0	4.4
Cardiovascular disease	1.3	2.4	13
COPD	0.0	1.5	4.7
Asthma	0.3	1.3	2.4
Musculoskeletal diseases	0.5	0.9	1.5
Road traffic injuries	0.3	0.4	10
Other unintentional injuries	0.9	2.0	19
Intentional injuries	0.1	0.6	7

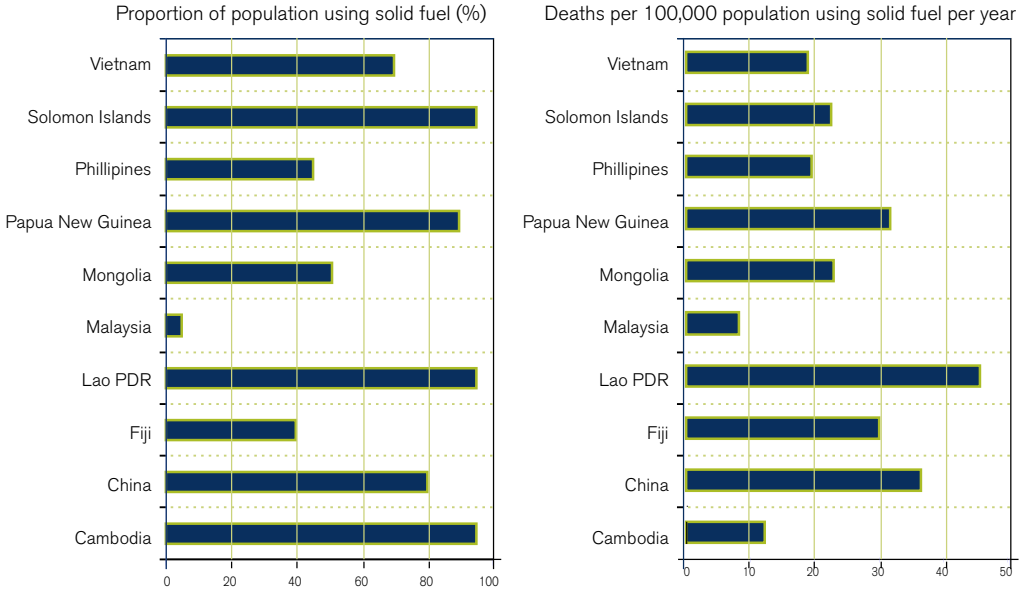
Other indicators

Use of leaded gasoline (2004)	No	
Overcrowding	1%	(2001)
Malnutrition (% stunting)	NA	

World Health Organization

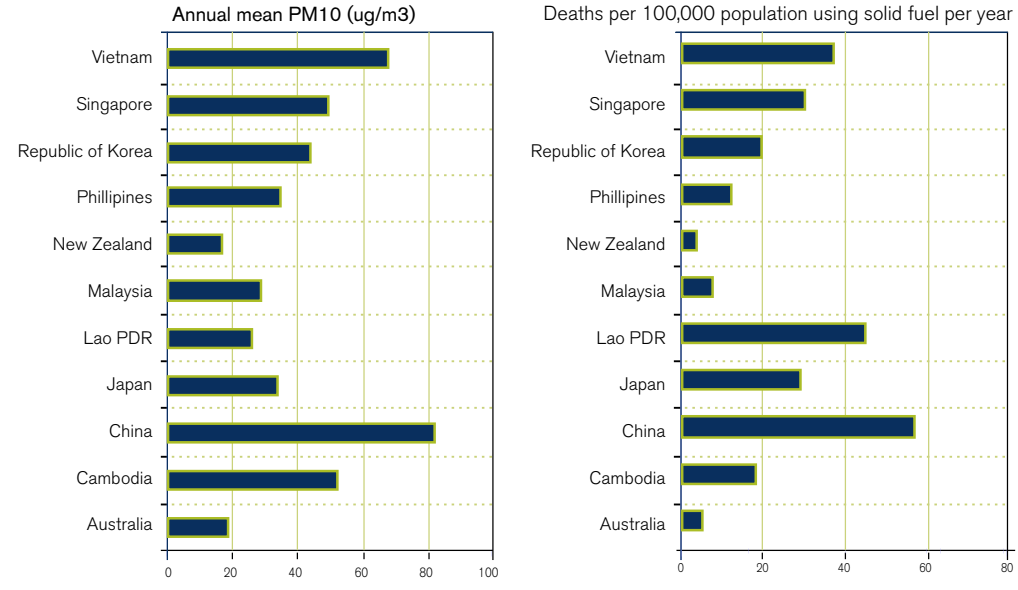
Public Health and the Environment
Geneva 2007

Figure 7: Indoor air pollution from solid fuel use and its health impacts in different countries



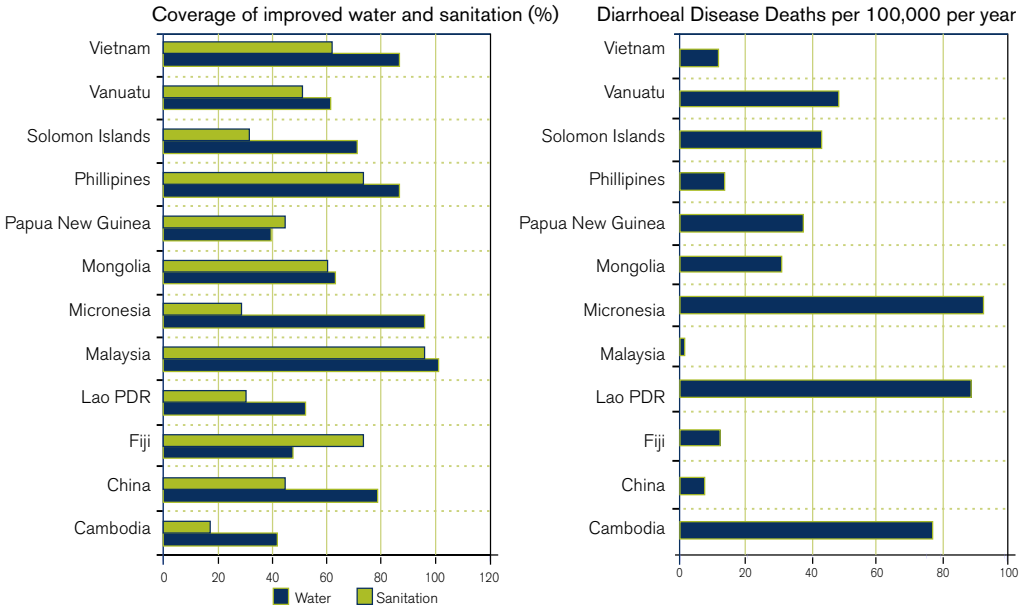
From WHO 2007: Country Profiles of Environmental Burden of Disease

Figure 8: Urban air pollution and its health impacts in different countries



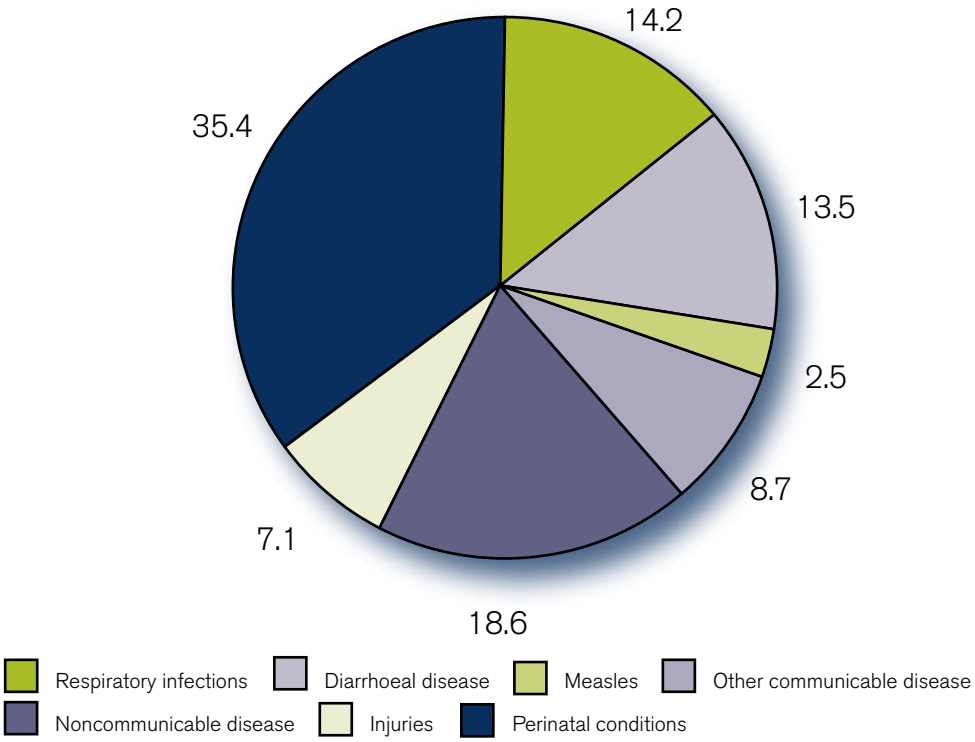
From WHO 2007: Country Profiles of Environmental Burden of Disease

Figure 9: Coverage of improved water supply and sanitation and impacts on diarrhoeal disease in different countries



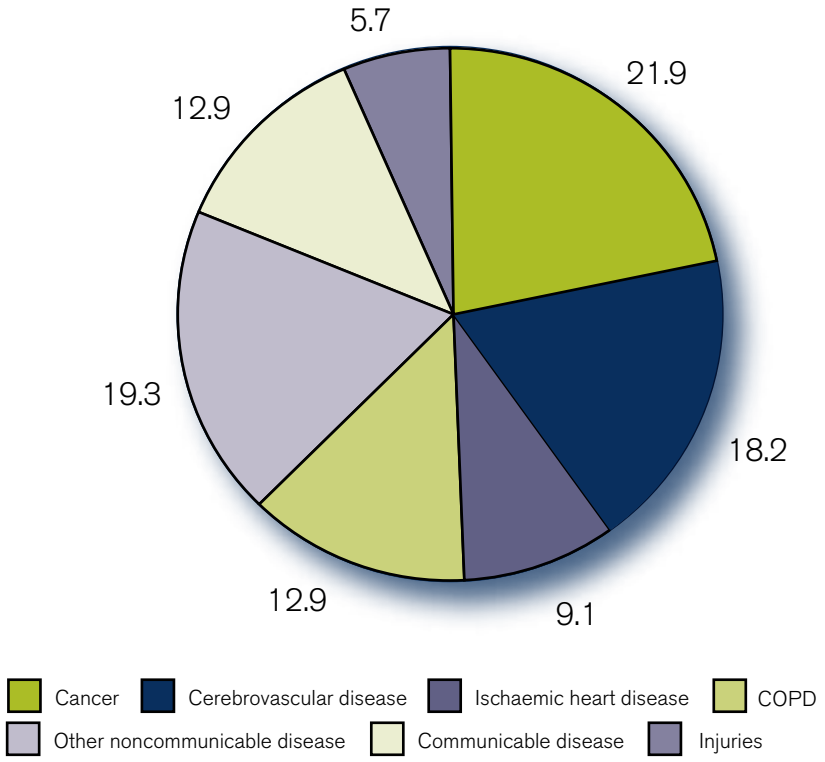
From WHO 2007: Country Profiles of Environmental Burden of Disease

Figure 10: Percentage of total deaths of children under 5 years old by disease causes



WHO 2002 Global Burden of Disease Estimates for WPRO

Figure 11: Percentage of total deaths of people above 60 years old by disease causes



WHO 2002 Global Burden of Disease Estimates for WPRO

Regional Partnerships and Opportunities

In response to these regional environmental health challenges, WHO has developed a regional strategy for environmental health with the following objectives:

1. To strengthen national capacity in environmental health risk assessment and management;

2. To enhance cooperation between health and environment sectors, and their cooperation with other socio-economic development sectors in solving problems; and

3. To promote inter-country co-operation in solving common and transboundary environmental health problems.

The frameworks to implement the regional strategy include:

i. country capacity building through developing and implementing national environmental health action plans (NEHAPs) for priority environmental health issues;

ii. development and implementation of the Regional Forum on Environment and Health for Asian countries in the Region in cooperation with the United Nations Environment Programme (UNEP); and

iii. development and implementation of the Framework for Action on Drinking Water Quality and Health in the Pacific with the Pacific Islands Applied Geoscience

Commission (SOPAC) and the Regional Strategy for Solid Waste Management in the Pacific with the Secretariat of the Pacific Regional Environment Programme (SPREP). The regional strategy was approved by the Regional Committee, which is the governing body of WHO for the Western Pacific, in September 2005.

Since November 2004 when the First High-Level Meeting on Environment and Health in South-east and East Asian Countries was held in Manila, Philippines, WHO has collaborated with UNEP Regional Office for Asia and the Pacific in developing a regular regional forum on environmental health in Asia. Director or Director-General level officials from Ministries of Health and Environment from 14 countries (Brunei Darussalam, Cambodia, China, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Republic of Korea, Philippines, Singapore, Thailand, and Viet Nam) participated in the Meeting. After the Second High-Level Meeting in December 2005 and two scientific conferences on environmental health, the First Ministerial Regional Forum was held in August 2007 in Bangkok, Thailand. The Charter of the Regional Forum, which was approved by the participating ministers for health and environment, requires the participating countries to develop and implement NEHAPs or equivalent plans. It lists six regional priorities. They are the health implications of the following environmental hazards:

i. air quality;

ii. water supply, hygiene and sanitation;

iii. solid and hazardous waste;

iv. toxic chemicals and hazardous substances;

v. climate change, ozone layer depletion and ecosystem changes; and

vi. contingency planning preparedness and response in environmental health emergencies.

For each of these priorities, a regional Thematic Working Group was established. WHO and UNEP serve as the joint secretariat to the Regional Forum[4] and support the activities at country and regional levels.

In the Pacific, WHO partners with SOPAC, the governments of Australia and New Zealand, and the Institute of Advanced Studies (IAS) of the University of the South Pacific (USP) to improve water quality. This initiative has three components:

i. development and implementation of water safety plans;

ii. establishment of systems for the monitoring of drinking water quality; and

iii. strengthening of national capacity for microbial analysis of drinking water supply. WHO also collaborates with SPREP and the Japan International Cooperation Agency (JICA) to conduct a regional training course on solid waste management in the Pacific.

Emerging Challenge: Climate Change

During the last 100 years, human activities, related to the burning of fossil fuels, deforestation and agriculture, have led to a 35% increase in the CO_2 levels in the atmosphere, causing increased trapping of heat and warming of the earth's atmosphere. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that most of the observed increase in globally averaged temperatures since the mid-

20th century was very likely due to the increase in anthropogenic greenhouse gas concentrations. Eleven of the last 12 years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature. IPCC also reports that the global average sea level rose at an average rate of 1.8 mm per year from 1961 to 2003. The total rise in the sea level during the 20th century was estimated to be 0.17 m.

The globally averaged surface warming projected for the end of the 21st century (2090-2099) will vary between 1.1–6.4°C. Global mean sea level is projected to rise by 30–60 cm by the year 2100, mainly due to the thermal expansion of the ocean. It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent. It is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and heavier precipitation, causing loss of life and increased injuries. These climatic changes will cause the disruption of ecosystem services to support human health and livelihood, and will impact on health systems. IPCC projects an increase in malnutrition and consequent disorders, with implications for child growth and development. The disruption in rainfall patterns can be expected to lead to the increased burden of diarrhoeal disease and to the altered spatial distribution of some infectious-disease vectors.

The current and emerging climate change-related health risks in the Region include heat stress and water- and food-borne diseases (e.g. cholera and other diarrhoeal diseases) associated with extreme weather events (e.g. heat waves, storms, floods, and droughts); vector-borne disease (e.g. dengue and malaria); respiratory diseases due to air pollution; aeroallergens, food and water security issues; malnutrition; and psychosocial concerns from displacement. These risks and diseases are not new, and the health sector already is tackling these problems. However, the capacity to cope with potentially increasing levels of these risks and diseases is limited, particularly in developing countries.

There is growing, but still limited, political commitment to integrate health considerations in efforts to mitigate and adapt to climate change at national and international levels in the Region. There is also insufficient awareness among the general public about climate change and its impact on health.

In 2007, the WHO Regional Offices for South-East Asia and the Western Pacific convened two consultations with Member States on climate change and health (one in Kuala Lumpur, Malaysia in July; and the other in Bali, Indonesia in December). Through these consultations, a Regional Framework for Action to Protect Human Health from the Effects of Climate Change in the Asia-Pacific Region (hereinafter, the Regional Framework) has been prepared. The objectives of the Regional Framework are:

i. to increase awareness of health consequences of climate change;

ii. to strengthen health systems capacity to provide protection from climate-related risks and substantially reduce health systems greenhouse gas emissions; and

iii. to ensure that health concerns are addressed in decisions to reduce risks from climate change in other key sectors. It contains a number of recommended actions to be taken by governments as well as by WHO for each of these objectives.

In the Region, cases of a likely linkage between climate change and health outcomes have been observed, but they

are not very strong and the number is small. There is a need for WHO to provide technical guidelines, training of relevant personnel and technical assistance to countries to undertake the assessment of the health impacts of climate change. Examples of effective interventions to reduce the health impacts of climate change by the health sector are limited. WHO will support efforts to compile good practices of climate change adaptation and mitigation in the health sector and cases where the decisions of other development sectors (e.g. transport, energy, agriculture) on their mitigation and adaptation to climate change incorporate measures to protect and promote health. These good practices and cases and the information on the health impacts of climate change need to be shared among health professionals. WHO will consider establishing, or strengthening existing, regional information sharing mechanisms for this purpose. WHO will also support health professionals to be able to participate more actively in national and global processes (e.g. the United Nations Framework Convention on Climate Change) of promoting and negotiating climate change mitigation and adaptation actions.

These future WHO actions on climate change were discussed at the 122nd WHO Executive Board session in January and the 61st World Health Assembly session in May 2008. These global governing bodies of WHO agreed that the health sector needs to take more proactive actions to adapt to a changing climate and to mitigate global warming. The WHO regional governing body, the Regional Committee for the Western Pacific, will discuss the issue of climate change and health at its 59th session in September 2008 and is expected to endorse the Regional Framework.

Promotion of Local Actions: Healthy Cities and Settings

Environmental health issues require national, regional and global policies. They also require local actions. The healthy settings approach has been promoted for cities, marketplaces, workplaces, schools, hospitals and communities in the Region to: i. provide a framework for developing and implementing local actions for health protection and health promotion; ii. address determinants of health through multi-sectoral actions; iii. encourage all stakeholders to participate in planning and implementing activities associated with health problems; and iv. share good practices through networking.

With the support of WHO, the Alliance for Healthy Cities[5] which is a network of cities and other stakeholders, including non-government organisations and national coordinating organisations, was established in 2003, and its inaugural general assembly, with an international conference on healthy cities, was convened in October 2004 in Kuching, Malaysia. The Alliance for Healthy Cities aims to facilitate more effective communication and mutual support among cities and to provide cities and other stakeholders with recognition of good practices and innovative projects. The second general assembly and conference of the Alliance for Health Cities were held in Suzhou, China in October 2006, and the third general assembly and conference will be held in Ichikawa City, Japan in October 2008. The Alliance for Healthy Cities has currently almost 100 members from Australia, Cambodia, China, including Hong Kong and Macao, Japan, Republic of Korea, Malaysia, Mongolia, Philippines and Viet Nam.

National and sub-national chapters of the Alliance have also been established in Japan and China in 2005, Republic of Korea in 2006, and Hong Kong and Australia in 2007. These chapters promote

the Healthy Cities approach in their own languages and cultures. To recognise and facilitate good practices and innovations, WHO has provided awards since 2004. The Alliance itself has started providing its own awards since 2006. In addition, a number of exchange visits and international conference on Healthy Cities have been organised by members of the Alliance.

Conclusion

WHO estimates that a significant proportion (almost one quarter) of the total burden of disease in the Western Pacific Region is attributable to various environmental risk factors. Special attention should be given to vulnerable population groups, such as children and the elderly.

WHO collaborates with a number of regional partners for the development of national capacity in assessing and managing environmental health risks, particularly in developing countries of the Region. WHO also facilitates inter-country cooperation in addressing transboundary environmental health issues and those issues common in multiple countries.

Climate change is an emerging challenge in the Region. WHO has developed a regional framework for action to protect human health from the effects of climate change in consultation with countries, and will move to implement it in the years to come.

Healthy cities and settings are an effective approach to creating local action for health protection and health promotion. The networking of healthy cities and settings can facilitate the sharing of good practices in the Region[6].

Endnotes

1. American Samoa, Australia, Cambodia, China, Cook Islands, Fiji, French Polynesia, Guam, Hong Kong (China), Japan, Kiribati, Lao People's Democratic Republic, Macao (China), Malaysia, Marshall Islands, Federated States of Micronesia, Mongolia, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Pitcairn Islands, Republic of Korea, Samoa, Singapore, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu , Viet Nam, and Wallis and Futuna
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3. http://www.who.int/quantifying_ehimpacts/countryprofiles/en/index.html
4. For further information on the Regional Forum, see the website: http://www.environment-health.asia/.
5. For further information on the Alliance for Healthy Cities, see the website: http://www.alliance-healthycities.com/
6. An earlier version of this paper was presented to the International Federation of Environmental Health 10th World Congress on Environmental Health, Brisbane, 12-16 May 2008.

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Compendium of Sustainable Development Indicator Initiatives: A Global Directory of Comprehensive Indicator Systems

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The need for changing the way we measure progress by adopting sustainable development monitoring and indicator systems has been acknowledged. In response to calls by the Brundtland Commission 20 years ago and later Agenda 21, among others, many indicator systems have been developed. The landscape of sustainable development indicator systems is full of stories of success, but also of continuing challenges. Indicator systems are key policy tools to operationalise the general concept of sustainable development based on shared but differentiated responsibilities. Indicator systems that help articulate and track progress in fulfilling these responsibilities are fundamental as planning, implementation and evaluation instruments, and also as instruments of communication and coordination across different scales, up to and including the global scale. A dilemma is that contextualising indicators creates a fragmented approach, while it is essential to ensure indicators are relevant to local audiences. Indicator sets are compiled based on geographic regions with natural or jurisdictional boundaries, economic sectors and institutions, in many countries. There is no consensus on a more systematic approach to measuring progress and on how to use these measures in policymaking more effectively. Even where there is consensus on indicators, due to the different priorities or unsystematic design of monitoring efforts, availability and quality of time series data is a major problem. The Compendium on Sustainability Indicators: A Global Directory for Indicator Initiatives can be seen as an attempt to bring together experience in one place on best practice for measurement from the global to the local level. While the Compendium offers no synthesis and does not by itself offer solutions, it lays bare the facts on parallel indicator systems with the explicit intention of facilitating cross-scale and cross-jurisdictional dialogue and cooperation.

Key words: *Sustainable Development Indicators; Directory for Indicator Initiatives; Measurement*

The need for changing the way we measure progress by adopting sustainable development monitoring and indicator systems has been acknowledged for decades now. In response to calls by the Brundtland Commission 20 years ago and later *Agenda 21*, among others, many indicator systems have been developed by international organisations, national governments, local authorities and others, while probably even more of them are being planned (United Nations 1992; WCED 1987).

The landscape of sustainable development indicator systems that evolved is full of stories of success, but also of continuing

major challenges. Indicator systems are key policy tools to operationalise the general concept of sustainable development based on shared but differentiated responsibilities. Indicator systems that help articulate and track progress in fulfilling these responsibilities are fundamental as planning, implementation and evaluation instruments, and also as instruments of communication and coordination across different scales, up to and including the global scale. However, the landscape of indicator efforts is fragmented in terms of types of indicator systems and ways of indicator development and use. It is also fragmented in terms of developed versus developing countries and national versus local or sectoral initiatives. The major risks associated with excessive dominance of economic measurement tools that characterised the post-WWII decades are increasingly recognised, but the resulting cross-scale mosaic of indicator systems has not consolidated as a coherent picture and as part of a global program of transformation and transition to sustainability.

A key dilemma is that contextualising indicators creates a fragmented landscape of approaches, while it is essential if one is to ensure indicators are relevant to local audiences. Indicator sets are compiled based on geographic regions with natural or jurisdictional boundaries, economic sectors and institutions, in many countries of the world. Over the years many coordination initiatives were started that aimed at building coherence. Some of these focused on identifying common principles, such as the Bellagio Principles (IISD 2007), while others on common frameworks and core indicator sets for countries, groups of countries or sectors (e.g. Eurostat 2007; Montréal Process Liaison Office 2007; OECD 2007; UN-DESA 2007; United Nations 2007). Some of the coordination efforts are aimed only at providing common methodology, while others, such as the indicators for the Millennium Development Goals are strongly associated with policy processes and implementation mechanisms.

Despite these and other coordination efforts there is no general consensus on a more systematic approach to measuring progress and on how to use these measures in policymaking more effectively. Even in cases where there is consensus on the indicators, due to the different priorities or unsystematic design of monitoring efforts in the past, availability and quality of time series data is a major problem. So much remains to be done. In this light you could see the *Compendium on Sustainability Indicators: A Global Directory for Indicator Initiatives* as an attempt to bring together experience in one place on best practice for measurement from the global to the local level. While the Compendium offers no synthesis and does not by itself offer solutions, it lays bare the facts on parallel indicator systems with the explicit intention of facilitating cross-scale and cross-jurisdictional dialogue and cooperation. As we view the development of sustainable development indicators as part of a long-term social learning process, the Compendium itself is intended to be a long-term, ongoing initiative.

Comprehensive Indicator Systems

A key issue regarding indicators' systems is that the systems should be *comprehensive*. What do we mean by 'comprehensive'? The interpretation is broad, and covers not only the content and structure of indicator sets, but also the way indicators are communicated, used and integrated into decision making. This broad interpretation of comprehensiveness is aligned with sustainable development. In this sense, comprehensiveness can be considered as a collection of indicator systems criteria that are used as a filter when deciding what initiatives are

suitable to include in the Compendium. Comprehensive indicator systems are necessary to navigate the 'path of sustainability'. Without tools like these the direction of the human enterprise, on whatever scale, risks drifting and being based only on ad-hoc policy measures.

This statement could be rephrased as follows: If you do not know where you are located and where you are coming from, you will not be able to define where you are heading and you will not be able to decide whether you are moving in the right direction. Navigating change is possible only through the use of a comprehensive indicator system.

The starting point for a comprehensive indicator system is a *conceptual framework* that cuts across key domains of sustainable development, including but not limited to ecological, social, and economic domains, and, depending on the framework, institutional domains. Initiatives listed in the Compendium represent many different types of frameworks, such as those based on pressure-state-response, capital accounting, or other categories. In general, we did not encourage listing indicator efforts that focused only on a specific topic, as we think that to integrate an indicator system often cuts across a diverse set of policy areas, which is at the heart of the sustainability challenge. While thematically different, many of the initiatives reflect the application of common principles such as the Bellagio Principles for measuring and assessing progress towards sustainable development.

Related to the question of conceptual framework, comprehensiveness can also be defined in terms of *relevance* of the indicators for key policy issues. At the highest level a subset of comprehensive indicator systems might be identified as *headline indicators*, which is a good practice in terms of focusing attention on policy priority areas that require close attention.

Recognition of *cross-scale* issues in both the temporal and spatial sense is a key challenge. Most initiatives listed report retrospective time series trends and an increasing number are developing forward looking projections, outlooks, or scenarios. With regard to the spatial scale, trans-boundary and cross-scale issues are increasingly important, for example, by taking into account the implications of global processes in community level indicator systems.

The *target audience* of indicator systems varies, but it is crucial to make an explicit effort to have indicators that cover public interest issues available to the widest range of social groups, ranging from top decision makers to the general public in a way that is understandable and transparent. Also, it is vital to include public participation in the process of selecting headline issues as well as the specific indicators. This reflects the perspective represented by the Aarhus Convention (the United Nations Economic Commission for Europe Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters at Aarhus, Denmark, 25 June 1998) on the importance of:

- involvement of all key stakeholders and the general public in matters related to the environment and sustainable development;
- public access to information and supporting data; and
- making information regularly available.

In addition to the above attributes related to indicator initiatives overall, the following indicator criteria are seen to be central:

- from the reading of the indicator values over time one should be

able to definitively and objectively conclude whether the changes describe a positive or negative development;

- the indicator should be based upon objective data measurements, where the specific data leave no room for interpretation besides the monitoring inaccuracy;

- the indicator must be easy to comprehend and there has to be a recognised causal link between the data the indicator is based upon and the development one wishes to describe; and

- the indicator is closely linked to planned targets.

Clearly, the extent to which initiatives listed in the Compendium comply with the rather broad range of attributes listed in this section varies, but they represent an effort to bring attention to attempts that approach sustainability issues in a systemic way.

About the Compendium

Over the more than a decade of its existence, the Compendium evolved from a printed report of IISD (Pintér, Hardi & McRorie-Harvey 1995) into a web database with over 800 indicator projects listed (International Institute for Sustainable Development (IISD) 2008, *Compendium of Sustainable Development Indicator Initiatives*, http://www.iisd.org/measure/compendium), making it one of the world's leading information sources on the design and use of comprehensive indicator systems. The intended audience includes primarily indicator practitioners around the world in the public sector, business and in civil society. Based on our experience the Compendium is also of considerable interest to the policy research community and the academic sector. Besides IISD's contribution, in kind and financial support for the work came from Environment Canada, the World Bank, the UN Commission for Sustainable Development, Redefining Progress, and more recently IFEH.

The goals of the Compendium can be summarised as to:

- improve communication among the various stakeholders in sustainable development to promote the sharing of experiences, methods and approaches on indicator development and use for mutual benefit;

- facilitate the harmonisation of indicator development approaches and indicator sets;

- help avoid duplication of efforts and facilitate the integration of monitoring, data analysis and reporting activities;

- provide governments, NGOs, the private sector and the public with access to a pool of experts working on indicator development;

- help identify areas of future research where indicator work is required; and

- provide information on a wide range of publications related to developing indicators and indices for sustainable development.

The Compendium is not targeting any specific indicator system but rather it can be seen as a meta database. Entries listed are not restricted to initiatives adopting the term 'sustainable development indicators', but also include those that operate with other, comparably holistic concepts whether measuring quality of

life, ecosystem/human system wellbeing, ecosystem health, genuine wealth or others. By adopting a flexible approach, we sought to demonstrate alternatives to a whole system perspective on environment/development interactions, and assuming that the conceptual and methodological challenges were sufficiently similar to offer useful lessons, irrespective of the terminology used.

Access to the information is free and can be queried through a powerful search engine. In order to streamline database maintenance and reduce costs, entries are submitted by indicator initiative owners who can also manage their information in order to keep it up to date. Consistency of the information and quality control is ensured through a part-time administrator at IISD. Although stronger in some regions and sectors than in others, the Compendium provides information on initiatives carried out at international, national, provincial, territorial, state, regional, sectoral, ecosystem and local/community levels worldwide.

Information on indicator initiatives is requested and presented in entries that cover a wide range of indicator system design parameters. These parameters were developed over years through a consultative process among the partner organisations and practitioners involved. The choice of design parameters represents a compromise between the wide range of factors that could be used to characterise indicator efforts and the need to keep the database simple to manage and update. Even with this, there are 36 fields to enter information in, including free text and a selection of predetermined criteria. The Compendium does not include indicators themselves, but provides direct links to printed and electronic resources where such information is easily available. More detailed information on base format can be found in Appendix 1 of this paper and on the Compendium website itself.

Submission of entries is open to the public through a web interface. In order to complement voluntary submissions, from time to time a special effort was made by IISD to search actively for and request relevant entries to make sure information on key initiatives is not missed. In order to help maintain entries and cut the cost of updates, the Compendium sends automatic periodic requests for update to the email address listed under a given entry with a direct link to the entry's update page.

Review of the 2007 Updates to the Compendium

Since its emergence as a field of practice in the early 1990s, alternative indicators of progress are being developed by an increasing number of organisations. In sharp contrast with earlier years, the number and type of initiatives is now at a point now where providing a comprehensive picture of what is happening in the field may no longer be practically possible. Our impression is that the recognition that a fundamental rethinking of the way we measure progress is necessary is starting to reach the mainstream, and as a result the number of initiatives has started to proliferate.

As part of the effort to keep information on key initiatives in the Compendium as current as possible, a campaign was initiated in early 2007 to identify key recent initiatives not sufficiently represented. The campaign was undertaken by IISD in cooperation with IFEH based on a cooperation agreement signed in 2005 by the two organisations. Since 2000, the IFEH has been running projects on sustainability indicators initiatives, including the compiling of best practices as well as methodologies. The focus of IFEH's initiative has also been on collecting information

on local/regional level indicators from around the world through 37 national environmental health member organisations. The International Institute for Sustainable Development (IISD) and IFEH formed a joint working group. At IFEH the initiative has been named *The IFEH Sustainability Initiative* (IFEH SII). At IISD the work is run through the Measurement and Assessment Program, which in 1995 initiated the work on the Compendium.

In terms of the agreement (the MoU between IFEH and IISD and IFEH on Policy on the Use of Sustainability Indicators) the Compendium was introduced to IFEH's global network of 37 national member organisations covering over 60,000 professionals with a request to consider registering their relevant indicator initiatives. In addition, IISD engaged five part-time researchers based in different parts of the world to identify and compile entries on key indicator efforts not currently represented in the Compendium (Appendix 4; Appendices 2 & 3 provide information on the organisations). Both the IFEH request and the work of the researchers were to ensure there is more even representation of indicator initiatives from around the world, including developing countries. The focus of this update was on initiatives in Asia, Africa, Latin America and the Caribbean, United States, and sectoral nodes related to Forestry and Environmental Health. Besides collecting new and updated information, participants also reviewed and amended the structure of the Compendium to better reflect SD indicator initiative design issues. This included adding new selections in pre-existing menus, better explanation of some of the Compendium fields, and fine-tuning the database for ease of use.

A Sampling of Comprehensive Indicator Initiatives in the Compendium

As of early May 2007 the campaign to update the Compendium resulted in 153 largely new, and some updated entries on recent indicator initiatives from around the world. The following is a brief sampling of initiatives recently added that illustrate the spectrum of ongoing work that covers a cross-section of sustainability issues across the environmental and socio-economic domains.

Not only was there the diversity of indicators and frameworks, but also the diversity of processes used in selecting and linking them to policy processes. Some of the initiatives here are also noted for their attempt to link to indicator efforts across scale either by adopting a higher level framework (e.g. Example 1) or by trying to influence indicator and assessment work in their wider region (e.g. Example 3). Attempts like this illustrate that the need for harmonising the way we measure progress is well recognised and attempts at cross-scale coordination might be having a gradually positive effect.

Example 1: The Changing California - Forest and Range Assessment 2003

This initiative used indicators that have been developed from the Montreal Process suite in conjunction with public and stakeholder consultation on values and priorities within the state. The assessment includes not only the monitoring for each indicator, but also an evaluation of the natural-socioeconomic system. This exercise includes identifying challenges in monitoring, setting new goals, implementing new tools to address emerging issues, and continuing to consult with public and stakeholders. They have depicted the whole integrated system to create a 'management landscape' with GIS. In this landscape map, the conservation, urban, agricultural, and economic values for the whole state are represented and form

Table 1: The Changing California, Forest and Range 2003 Assessment Initiative

Title of Initiative	The Changing California, Forest and Range 2003 Assessment
Lead Organisation(s)	Fire and Resource Assessment Program, California Department of Forestry and Fire Protection
Description of Goal	To provide the California State Board of Forestry and Fire Protection, the public, and other policy makers information on environmental, economic, and social conditions that support forest and rangeland resource sustainability.
Geographic Scope	State/Provincial
Municipality, Province/State	California
Framework for Indicator Set	The FRAP framework is a systematic overview of the status, trends and challenges to California's Forests and Rangelands. It is based on the sustainability indicators and criteria developed by the Montreal Process. These criteria include conservation of biological diversity, maintenance of productive forest functions, maintenance of forest health and vitality, conservation of soil and water, forest contribution to global carbon cycles, maintenance of socioeconomic benefits, and the policy framework needed to foster forest conservation and sustainable forest management.
Progress to date/future areas of work	The Forest and Range 2003 Assessment is the fourth FRAP assessment. The first two assessments (1979 and 1988) were organised by demand, supply, limits, and opportunities in the use of forests and rangelands. In 1995, CDF, under the Board of Forestry's leadership, experimented with framing the Assessment on the most limiting natural factor on forest and rangelands - wildfire. It contained a fiscal, planning, and policy framework and was widely published as the California Fire Plan (1996). The 2003 Assessment goes beyond the California Fire Plan methodology and uses criteria and indicators for sustainable forest management. This project is ongoing and further assessments are forth-coming.
Timeframe	Ongoing
Presentation of the information and indicators	An assessment summary and a series of online technical reports are available on the website. The technical reports are broken down according to criteria and reporting for each indicator is available.
Publications	The assessment is web-based. Please see http://www.frap.cdf.ca.gov/assessment2003/
Initiative Locations	United States
Contact Person	
Address	
Email	
Website	http://frap.cdf.ca.gov/
Initiative Types	Other, criteria and indicators of sustainable forest management
Intended Use Of Initiative	Policy Development, Performance Measurement, Indicator Development, Adaptive Management
Geographic Units	Natural Areas
Issue Areas	Forestry, Other, see 'Description of the Framework'
Organization Types	provincial/territorial/state
Mandate Requirement	Legislative
Public Involvement	consultation, evaluation process, public membership on committee
Other Public Involvement	In developing the Assessment, the legislative mandate requires that CDF solicit the cooperation of, and information collected by, public and private organizations, federal forest and rangeland resources
Report Frequency	Periodic
Public Access to Supporting Data	Yes

the basis of the assessment's conceptual framework. It is interesting to note that for a forest and range assessment, the three major categories of this landscape map were land-use, ownership, and housing density, suggesting that managers are looking at the entire landscape, and not parceling the forest areas into impervious units and managing them like closed systems.

Example 2: Indicators in South Africa's State of the Environment Report

The National State of Environment (SoE) Report for South Africa provides a comprehensive analysis and report on resource management and environmental issues at a national scale. The initiative is focused on the improvement of the quality of life of all South Africans: by promoting sustainable development; by utilisation and protection of their natural and cultural resources; by empowering the South African public, communities and organisations through participation, environmental education, capacity building, research and information services; and, by establishing responsible tourism. Indicators are grouped according to the main issues related to climatic and atmospheric change, sustainability of terrestrial ecosystems, sustainability of water resources, sustainability of coastal and marine systems, the social dimension, the economic dimension, and the political dimension. While this does not cover all sectors, it does cover those that rely heavily and directly on the state and trends of the natural environment.

The report which is prepared through public involvement consultation and public membership on committee is intended for decision makers, planners, environmental managers, and interest groups from different backgrounds, and for different purposes. In order to make this report useful to as wide an audience as possible, it is also available in Afrikaans, iXhosa, isiZulu, and Tswana.

As part of the State of Environment Reporting Programme initiated by the Department of Environmental Affairs & Tourism, municipal state of the environment reports have been developed for the Cape Metropolitan Area, Durban, Johannesburg, Pretoria Metropolitan Area, North West, Gauteng, Mpumalanga, and KwaZulu-Natal. These provide information on local environmental issues specific to each city, and outline what can be done to enhance sustainable development and use of natural resources at a local level. The reports are available on the internet, indeed, this report is the first national State of the Environment Report on the internet for South Africa. The initiative provides public access to supporting data.

Table 2: National State of the Environment Report for South Africa

Title of Initiative	National State of the Environment Report for South Africa
Lead Organization(s)	Department of Environmental Affairs and Tourism
Description of Goal	The National State of Environment (SoE) report is the major mechanism through which resource management and environmental issues are comprehensively reported and analysed on scales that transcend local authority and provincial boundaries. This initiative and its reports are focused on the improvement of the quality of life of all South Africans, by: promoting sustainable development, utilisation and protection of their natural and cultural resources; empowering the South African public, communities and organisations through participation, environmental education, capacity building, research and information services; and, establishing responsible tourism. This initiative was designed for ministers, decision makers, environmental managers, and planners, who need to know what the state of South Africa's environment is and what the consequences will be from certain policies, projects or actions.

Geographic Scope	National
Partners	CSIR, United Nations Environment Programme (UNEP), Norwegian Research and Development Agency (NORAD), Global Resource Information Database Arendal (GRID), and Ugland Publikit
Progress to date/future areas of work	The first attempt to produce a National SoE for South Africa was made in 1992, when a report was submitted to the United Nations Environment Programme at UNCED in Rio de Janeiro, describing the South African environment and resource base (although South Africa could not participate fully in UNCED, but only had observer status). A prototype electronic NSoE report was then compiled by the Department of Environmental Affairs &Tourism (DEAT) in 1995, but was not published. This report is therefore the first National State of the Environment Report on the Internet for South Africa. The Internet was chosen as the preferred medium for this report (although an overview is also available in printed format), as it is widely and freely accessible to a broad spectrum of users, it can be easily updated, modified, and added to, and it gives greater flexibility in accessing the information. In this way, the report is useful to decision makers, environmental managers, and interest groups from different backgrounds, and for different purposes. In order to make this report useful to as wide an audience as possible, it is also available in Afrikaans, iXhosa, isiZulu, and Tswana. City state of the environment reports are being developed in parallel with the national report for the Cape Metropolitan area, Durban, Johannesburg Metropolitan area and Pretoria Metropolitan area. These will provide information on local environmental issues specific to each city, and outline what can be done to enhance sustainable development and use of natural resources at a local level. As part of the State of Environment Reporting Programme initiated by the Department of Environmental Affairs & Tourism, four provinces, namely North West, Gauteng, Mpumalanga, and KwaZulu-Natal, have recently completed preliminary State of the Environment Reports. These may also be available on the Internet in the near future.
Timeframe	Although reporting on the state of the environment is not mandatory at this point in time, the department has decided to commission a comprehensive assessment of, and report on the state of the environment in South Africa. This will be the first comprehensive report since 1999. The main report that will reflect on the state of the environment, human vulnerability to environmental change and the future state of our environment will be known as the South African Environment Outlook 2005. The project started towards the end of September 2004, and a report was released in 2005.
Presentation of the information and indicators	The SoE Report on the Internet is constructed as follows: The first page is divided into three main sections. On the left are links to global and cities state of the environment reports. On the right are links to resources such as global indicators, maps and on line documentation. The centre part of the page contains links to the different sections of the national state of the environment report. The cooperating partners are shown as hyper links at the bottom of the page. Choosing a topic or issue (chapter) related to the national state of the environment report, links to a page giving a brief overview of the topic. Further links provide access to information on driving forces, pressures, state, impact, response, outcomes, linkages, data issues, and references used in compiling the contents of the chapter. Additional links are provided at the top of each page, and where appropriate, links to city state of the environment reports are provided at the bottom of pages. Further links are provided in the text. The National State of the environment report uses several indicators that are presented as graphs or in some cases, in tabular or map format. The indicators are grouped according to main issues in: Climatic and Atmospheric change, Sustainability of Terrestrial Ecosystems, Sustainability of Water Resources, Sustainability of Coastal and Marine Systems, Social dimension, Economic dimension, and Political dimension.
Publications	National State of the Environment Report 1999 National State of the Environment Report 2005

Initiative Locations	Southern Africa
Contact Person	
Title	Director State of the Environment
Address	Department of Environmental Affairs and Tourism; Environmental Information and Reporting, Fedsure Forum Building, 315 Pretorius Street, Pretoria, 0002, South Africa
Fax Number	
Telephone Number	
Email	
Website	http://www.ngo.grida.no/soesa/nsoer/index.htm http://www.ngo.grida.no/soesa/
Initiative Types	Sustainable Development Initiative, Methodology / Guideline, Local Agenda 21
Intended Use Of Initiative	Education / Awareness, Performance Measurement, Strategy Development
Geographic Units	Both
Framework	PSR-Pressure-state-response
Issue Areas	Agriculture, Atmosphere, Nature and Biodiversity, Climate Change, Economic Performance, Education, Employment, Energy, Freshwater, Governance, Human Health, Housing, Natural Resources, Oceans and Seas and Coasts, Population, Poverty, Public Safety, Social, Harmful Substances and Chemicals, Waste, Wetlands, Other, Marine, Antarctica and other external territories
Organisation Types	national/federal
Mandate Requirement	Legislative
Steering Committee	http://www.ngo.grida.no/soesa/nsoer/general/whois2.htm
Public Involvement	consultation, public membership on committee
Funding Source	Norwegian Research and Development Agency (NORAD), and Department of Environmental Affairs and Tourism
Report Frequency	no fixed time
Public Access to Supporting Data	Yes

Example 3: Indicator System for Hungary's Lake Balaton Region

Indicators are typically developed with a focus on retrospective analysis of ecological and socio-economic trends and considered comprehensive from this point of view. However, comprehensiveness can also be thought of as a criterion whether indicators cover not only past but also expected future trends. This initiative is interesting not only because of its broad coverage of sustainability issues in a regional context, but because of the attempt to make use of some of the same indicators in both past and future assessment.

Another notable aspect is to establish a link between indicators across scale. Besides developing and analysing indicators at the regional level, some of the applicable indicators are also developed with community scale data for some of the key towns in the Balaton region. Both regional and municipal scale data are to be presented through a single web portal that also integrates past and future trends and analyses.

Table 3: Integrated Vulnerability Assessment and Adaptation Strategies for Hungary's Lake Balaton Region

Initiative Title:	Integrated Vulnerability Assessment and Adaptation Strategies for Hungary's Lake Balaton Region
Lead Organization:	Lake Balaton Development Coordination Agency (LBDCA)
Your organization:	IISD
Contact:	Gábor Molnár

Contact Organization:	LBDCA
Title:	Executive Director and Project Manager
Address:	
Fax:	
Telephone:	
Email:	
Web Site:	http://www.chrome.hu/bft/public/menu.php?m=177
Scope:	Sub-national
Goals of Initiative:	The overall purpose of the project is to contribute to a better understanding of the Lake Balaton ecological and socio-economic system's vulnerability and resilience arising from multiple forces of global and local change, including land use, demographic, economic and climate change and build capacity for more effective policy-making and adaptation measures in response. The project is complementing ongoing policy initiatives and scientific research, and has a clear niche by focusing on better understanding the vulnerability of the Lake and its watershed from an integrated perspective. Climate change is seen as one of the emerging important determinants of vulnerability, but its impacts are considered in the broader context of sustainable development. Through its training component the project will lead to measurable improvements in vulnerability assessment and adaptation capacity, and on-the-ground results will be achieved through initiatives financed by a small grants program using innovative financing mechanisms, such as public-private partnerships. Longer-term impact will be ensured by integrating criteria related to adaptation to global change into the regular grant-making activities of the Lake Balaton Development Council. Due to Lake Balaton's high profile and a focused engagement and influencing strategy, the project will significantly increase awareness of climate change impact, vulnerability and adaptation issues locally, nationally and internationally.
Framework:	The framework for indicators includes three categories: economic, ecological and social. The project also uses an analytic framework to study vulnerability based on internal and external pressures to the region, adaptation capacities and an enabling external policy environment.
Partnerships:	International Institute for Sustainable Development (IISD), UNEP/GRID-Geneva United Nations Development Programme (UNDP) Global Environment Facility (GEF) LEAD International
Progress:	The project uses indicators to provide a baseline analysis of vulnerability and to analyze future scenario trajectories. To date ca. 40 indicators have been developed, data collection and analysis is ongoing. Interaction among indicators is being analysed using a cross-impact matrix as an interim methodological step before the construction of a meta-model.
Timeframe:	Project is due to end in December 2008. LDBCA is to take over maintenance of indicator system thereafter.
Presentation:	IISD as a project partner is developing a multi-functional and multi-scale tool called BalatonTrend that will integrate the web-based presentation of time series past trends and maps with the projection of future scenario and associated indicator trajectories. It will also provide access to raw indicator data and multimedia content related to selected trends.
Publications:	Project proposal, project brochure, indicator report being prepared.
Country or Continent or Worldwide:	Central and Eastern Europe
Date Established:	2006
Date of Last Report:	2007
Initiative Types:	Analytical Report, Indicators Initiatives, State of Environment Initiative,

Other Initiative Type:	Sustainable Development Initiative, Other - describe
Intended Use Of Initiative:	Integrated vulnerability and adaptation
Geographic Units:	Adaptive Management, Education / Awareness, Indicator Development, Policy Development, Public Access to Information, Strategy Development
Municipality, Province/State:	Both
Initiative Framework:	Lake Balaton region
Issue Areas:	Capital based approach, Issue based
Other Issue Area:	Agriculture, Air Quality, Atmosphere, Climate Change, Economic Performance, Education, Employment, Fisheries, Freshwater, Governance, Groundwater, Human Health, Land Use, Natural Resources, Nature and Biodiversity, Population, Poverty, Public Safety, Social, Transportation, Waste, Wastewater, Wetlands
Type of Organization:	hydrogeological conditions, condition of lake shoreline, environmental infrastructure, material consumption, economic diversity, tourism, real estate, awareness,
Other Organization Type:	international government organization, international NGO, other - describe
Mandate Requirement:	Regional development council
Other Mandate Requirement:	other - describe
Steering Committee Present:	Project is tied to mandate of LBDCA by the Government of Hungary to support sustainable development in the Lake Balaton region.
Public Involvement:	Project Management Board comprised of representatives of LBDCA, IISD and UNEP / GRID-Geneva.
Other Public Involvement:	consultation, other - describe
Funding Source:	Multi-stage stakeholder involvement in indicator selection, scenario building and the identification and implementation of adaptation options.
Report Frequency:	LBDCA, GEF, UNDP, UNEP, IISD
Public Access To Supporting Data:	no fixed time
	Yes

Example 4: Katrina Index

In contrast to the Lake Balaton initiative, where emphasis is on early warning and emerging vulnerability, the Katrina Index is focused on issues that arise in the context of post-disaster reconstruction. The Index, which is actually a collection of non-aggregated indicators, basically monitors the state of New Orleans' rebound to its pre-Katrina condition, which it uses as a benchmark. Hurricane Katrina's effects were felt across the entire spectrum of sustainability issues in New Orleans and reconstruction has to be equally broadly focused. Therefore, indicators are focused on those priorities where rebuilding is most intensively focused. One could further extend these measures to capture changes in some of those conditions, particularly in the environmental infrastructure domain that contributed to the disaster. Emphasis on immediate priorities that often emerge in the aftermath of major crises such as Katrina can be balanced with perspectives on root causes, as another criterion for comprehensiveness.

Table 4: The Katrina Index

Title of Initiative	The Katrina Index
Lead Organization(s)	Brookings Institution Metropolitan Policy Program, Greater New Orleans Community Data Center
Description of Goal	Beginning in December 2005, the Katrina Index began monitoring the social and economic recovery of the Gulf Coast region, especially the New Orleans area, from the storm's impact in August 2005. Relying on nearly

	40 indicators, the Index has aimed to provide members of the media, key decision makers, nonprofit and private sector groups, and researchers with an independent, fact-based, one-stop resource to monitor and evaluate the progress of on-the-ground recovery. Starting in 2007, The Katrina Index is being released as a joint collaboration between the Greater New Orleans Community Data Center and the Brookings Institution Metropolitan Policy Program. The goal of this collaboration is to bring an even better, more tailored assessment of recovery to this Index's many users.
Geographic Scope	Metropolitan Region
Municipality, Province/State	New Orleans, Louisiana
Partners	Blue Moon Fund, Living Cities, Inc.
Progress to date/future areas of work	The Brookings Institution and the New Orleans Data Center will continue to release and update the Katrina Index on a monthly basis, likely on the second Wednesday of every month.
Initiative Locations	North America, UNITED STATES
Contact Person	
Email	info@gnocdc.org
Website	http://www.gnocdc.org/KI/KatrinaIndex.pdf
Initiative Types	Quality of Life
Intended Use Of Initiative	Education / Awareness, Performance Measurement, Public Access to Information
Geographic Units	Political / Administrative
Framework	Issue based
Issue Areas	Economic Performance, Education, Employment, Human Health, Housing, Population, Poverty, Social, Transportation, Other, Infrastructure, Emergency Response
Organization Types	NGO
Report Frequency	Periodic
Public Access to Supporting Data	Yes
Notes/Comments	To contact the Katrina Index, please leave comments or questions through the "Ask Allison" link at www.gnocdc.org.

Example 5: Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible (ILAC)

The initiative is notable not only for the comprehensiveness of the indicator approach promoted, but for the broad political consensus that such approach is required in order to better understand and tackle environmental problems in the Latin American and Caribbean region.

Table 5: Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible (ILAC)

Title of Initiative	Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible (ILAC)
Lead Organization(s)	Ministerio del Ambiente y Energía (MINAE) / Programa de las Naciones Unidas para el Medio Ambiente (PNUMA) / Observatorio del Desarrollo - Universidad de Costa Rica
Description of Goal	The following the are key goals of this initiative: a) Consolidate and continue existing efforts in LAC in order to implement programs and projects of interest for the region so that the recommendations in Program 21 will develop with an emphasis on participatory mechanisms. b) Develop actions to encourage the participation of civil society and the private sector in order to promote sustainable productive activities and stimulate sustainable lifestyles. At the same time, allow for conservation and the sustainable use of environmental goods and services which are essential for life.

	c) Promote the instrumentation of sustainable development models d) Contribute, as a political framework, in the identification and prioritisation of financial, institutional and technical mechanisms for an effective implementation of Programme 21, the Barbados Action Plan, and the results of the 22nd Special Session of the UN General Assembly.
Geographic Scope	National, Multinational, International
Publications	Document with goals and mandate for initiative: www.eclac.cl/dmaah/noticias/discursos/9/11769/ILAC%20ESPANOL.pdf Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible (ILAC): Indicadores de Seguimiento http://www.odd.ucr.ac.cr/documentos/espanol/ILAC_2004_FINAL_ESN.PDF Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible (ILAC). Costa Rica 2005 http://www.odd.ucr.ac.cr/ilac/
Initiative Locations	South America, Central America, Caribbean
Website	http://www.odd.ucr.ac.cr/ilac/
Initiative Types	Indicators Initiatives, Sustainable Development Initiative, Inventory
Intended Use of Initiative	Policy Development, Performance Measurement, Strategy Development
Geographic Units	Both
Framework	Environmental media, Issue based
Issue Areas	Nature and Biodiversity, Education, Employment, Energy, Forestry, Governance, Human Health, Land Use, Oceans and Seas and Coasts, Poverty, Social, Waste, Other, vulnerability
Organization Types	national / federal, academic / research, international government organization
Mandate Requirement	other, LAC Ministries of the Environment Forum
Public Involvement	Unknown
Report Frequency	no fixed time
Public Access to Supporting Data	Yes

Example 6: Environmental Indicators for Metropolitan Melbourne

The use of indicators at the local level is vital for the involvement of citizens and for local governments to address the most important threats on a local, but also on the global scale. This initiative is an outstanding example on how this can be done.

It is outstanding in the sense of how to make complex information on the environment and health available to a broader audience. Also, the Melbourne initiative is outstanding in the sense that the information is understandable by non-specialists, while experts can dig deeper and easily access more specific details. And finally, it is also outstanding in the sense that it creates opportunities for citizens and stakeholders to take part in envisioning and taking action in the interest of sustainable development.

The Melbourne initiative is based upon PCR (Pressure - Condition - Response) framework which is similar to the PSR framework (Pressure - State - Response), and its indicators are presented in 11 categories applicable to Melbourne. While these headline items have been found relevant for Metropolitan Melbourne and not all items are necessarily relevant for other cities around the Globe, the way the information is structured has broader relevance.

Table 6: Environmental Indicators for Metropolitan Melbourne

Title of Initiative	Environmental Indicators for Metropolitan Melbourne
Lead Organization(s)	Melbourne City Council/Australian Institute of Urban Studies
Description of Goal	To identify, collect and analyse data concerning Metropolitan Melbourne's environmental state and compile in a central document which can be used by Local Government officers to compare and analyse there own environmental impacts and initiatives.
Geographic Scope	Metropolitan Region, Local/Community
Municipality, Province/State	Metropolitan Melbourne
Framework for Indicator Set	Data is collated from various government, regulatory agencies and other sources and compiled into one document and reported on at a local government municipal level to try to assist local councils assess, analyse & compare their own environmental initiatives and the impacts of them. Indicators are reported via the pressure - state - response model.
Partners	The Steering Committee for the project is chaired by the Australian Institute of Urban Studies (Victorian Division) and coordinated by Melbourne City Council. Membership comprises 13 local councils from metro Melbourne (the number is increasing), the Municipal Association of Victoria (local government peak body) and several State Government agencies including the Environmental Protection Authority, Department of Sustainability & Environment, Sustainability Victoria and Parks Victoria.
Progress to date/future areas of work	Annual Bulletins #1 to 8 have been published with indicators on: waste (litter), water (waterways & beaches), air & greenhouse gas emissions, open space, transport, biodiversity, built environment. The reports are presented in a pressure - condition - response format. There is a summary of each group indicators assessing the Metropolitan Melbourne's progress on each indicator.
Timeframe	Annually published bulletin. Alternate indicators are reported on every two years.
Presentation of the information and indicators	Published as a paper document and on the internet via: City of Melbourne website: http://www.melbourne.vic.gov.au/research AIUS website: http://www.aius.org.au/indicators/ Consists of tables, charts and text. All source data is referenced.
Publications	Environmental Indicators for Metropolitan Melbourne Bulletins #1, August 1998, Bulletin #8, October 2005 Downloadable (PDF) from City of Melbourne web site as well as: www.aius.org.au/indicators/ www.melbourne.vic.gov.au/research
Initiative Locations	Australia, New Zealand and Pacific Islands
Contact Person	
Title	Senior Research Analyst
Addreass	City of Melbourne GPO Box 1603M Melbourne Victoria Australia 3001
Fax Number	
Telephone Number	
Email	
Website	http://www.aius.org.au/indicators/
Initiative Types	Indicators Initiatives, State of Environment Initiative, Performance Report, Analytical Report
Intended Use of Initiative	Education / Awareness, Policy Development, Performance Measurement, Indicator Development, Strategy Development
Geographic Units	Political / Administrative
Framework	PSR-Pressure-state-response, Capital based approach
Issue Areas	Air Quality, Atmosphere, Nature and Biodiversity, Climate Change, Energy, Freshwater, Governance, Land Use, Oceans and Seas and Coasts, Recreation, Harmful Substances and Chemicals, Transportation, Waste, Wetlands
Organization Types	municipal, academic / research

Mandate Requirement	not mandated
Public Involvement	public membership on committee
Funding Source	Contributions from Local councils and AIUS, as well as occasional sponsorship from state government agencies
Report Frequency	1 year
Public Access to Supporting Data	Yes
Notes/Comments	a summary of the report is also listed on the City of Melbourne Research website: www.melbourne.vic.gov.au/research

Conclusion

As the brief sampling of selected initiatives from the Compendium illustrate, efforts to strengthen the evidence base of planning, policy implementation and evaluation can and do yield rather different answers depending on who is asking the question, where, how and when. The indicators citizens of New Orleans would have selected before Hurricane Katrina would have been rather different from those on the indicator list in the Katrina Index. Indicators proposed by ILAC would be applied differently in Costa Rica from Argentina. And measures that talk about watershed processes for the Lake Balaton region in Hungary would need to be adjusted for applicability to Lake Chad or Lake Winnipeg.

Ideally, local indicator systems could be smoothly nested under regional or national sets, and national sets could be derived from or be closely linked with globally agreed measures. As these and other entries in the Compendium illustrate, however, there are many ways to be comprehensive when it comes to developing indicator systems. Despite many efforts to develop common indicator sets, whether for countries (e.g. by ILAC, the UN Commission for Sustainable Development and others), for a sector (e.g. by the OECD for the environmental aspects of agriculture, by signatories of the Montreal Process), or for a particular scale (e.g. by ICLEI for cities), experience to date tells us common sets have no universal applicability. Whether there is explicit awareness of it or not, 'comprehensiveness' is typically rooted in a particular worldview or rationality, which is not necessarily shared. For instance, comprehensive indicator systems developed under the Montreal Process might not be automatically adopted by aboriginal forestry associations that rely on traditional knowledge in their forest management practices. In the interest of making indicator sets relevant and in order to build ownership, there is a need for a technical/political/scientific process to determine what measures work best for a particular context.

While it would probably be unrealistic to expect universal cross-scale is possible, harmonisation related to issues that cut across scales and the interests of a wide range of political actors and stakeholders is essential. As the example of the indicators related to the Millennium Development Goals (MDGIs) illustrate, if there is sufficient consensus on certain global issues, it is possible to come up with core indicators.

The following conclusions arise not only from work on the Compendium, but also from over a decade practical experience working on indicator systems in various contexts:

1. In the interest of further harmonisation to evolve, it is necessary to keep track of and periodically summarise the experience with sustainable development indicators. This has been done by organisations such as the UN-CSD, OECD, SCOPE and others, and in a small way also complemented by the

Compendium. We invite national, regional and local authorities, the private sector, the academic community, civil society, aboriginal groups and others to share their indicator experience through the Compendium, as a simple and cost effective way of making connections between ongoing indicator efforts.

2. We see the continuing need for international efforts to harmonise indicator systems similar to those lead by the UN-CSD. Emphasis on selected headline indicators related to common policy issues rather than, or as well as, comprehensive sets should be considered.

3. We see a particular need to both strengthen and learn from comprehensive indicator efforts at the local level. There is a multitude of ongoing efforts around the world and we also see through the few specific local initiatives that our organisations are leading, or involved in, that perhaps because of the closer proximity of local government to stakeholders and sustainability issues on the ground there is clearer understanding of the need for and uses of indicators in planning, decision-making and evaluation. We believe the energy and creativity generated through local initiatives could, when added together, catalyse higher level policy change and offer useful lessons for sustainable development governance.

4. We see the need for elaborating guidelines to be used by local/regional authorities in order to build up local reporting systems in order to monitor the performance of the community, in order to communicate this information to the community/public, in order to involve the public, and finally with the backup of the public to adopt the most adequate local policies.

5. The work on indicators and indicator systems should be coordinated with efforts to improve the system of national accounts, particularly its environmental satellite accounts, using where possible a capital based framework.

6. In order to facilitate harmonisation among indicator systems, further efforts could be made to harmonise indicator frameworks and the methodologies of developing indicator sets and generating the underlying raw data. Efforts such as the Bellagio Principles developed over a decade ago by a group of prominent international experts can provide a starting point for creating a set of principles that take the experience gained in indicator development into account.

7. Although it is not formalised around a central institution and policy process, there is in fact a global policy agenda emerging around the development of alternative ways of measuring progress. In order to make sufficient progress, the discourse on indicators must have strong technical foundations, but it also must have a much stronger foundation in policy. We see a need both for a high level policy dialogue on the institutional dimensions of this issue, including the role of existing organisations, and the question of capacity and resources required to arrive at a robust new measurement system that takes sustainable development priorities into account.

Acknowledgments

The authors would like to acknowledge contributions by Angeline Gough, University of British Columbia, Canada, Diego Martino, Uruguay, Amy Miller, Rutgers University, United States, Shilpa Nischal, TERI, India M. Sulema Pioli, Brazil, Randall Solomon, Rutgers University, United States, David Wakumuru, Egerton University, Kenya, Carissa Wieler, IISD, Canada.

Endnote

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Appendix 1: Information base format

The Compendium is designed to facilitate remote data insertion and extraction, and to allow for the search and retrieval of entries through eight search tool fields. Each initiative has a unique entry in the Compendium and includes information as shown in below.

Compendium Form - Search the Compendium

Title of initiative	The full title of the initiative.
Lead organization(s) for this initiative	Include the full organization name(s) before any acronyms.
Your name	The name of the person entering the information.
Your e-mail	The e-mail of the person entering the information. This e-mail will enable access to the initiative at a later date for editing.
Your organization	The name of the organizations with which the person entering the information is affiliated.
Date initiative established	Select a year between 1960 and 2020.
Date of latest report or proposed release	Select a year between 1960 and 2020.
Type of initiative	A program, project or report using social, environmental and economical indicators, including those that measure the progress towards a common vision or goal. Includes: ▪ Analytical Report: A technical or scientific document that examines an issue through the use of concrete data and/or professional methodology and then recommends an action. ▪ Certification Program: Indicators developed in order to meet standards of a certification program, often in the natural resources sector (i.e., forestry). ▪ Indicator Initiatives: A written record of the current state and use of the indicators that a specific initiative is using. Includes graphic and/or tabular displays of the indicators. ▪ Inventory: An itemized list of indicator initiatives with traits, indicators and categories specific to those initiatives. ▪ Local Agenda 21: An initiative that is focused on the long-term strategic action for sustainability in municipal administration, reflective of the Local Agenda 21 Program. ▪ Methodology/Guideline: A report, statement or booklet that describes a methodology for developing specific indicators or procedure for an indicator initiative. ▪ Performance Report: A written record or project portraying the progress toward an initiatives goals or initial statement of intent(s). It provides an account of the work that has been done, the circumstances under which the initiative was performed and the extent to which the work done achieved the desired goals. ▪ Quality of Life: An initiative that is focused on a set of issues responsible for determining quality of life for people. ▪ State of Environment Initiative: Generally describes the current condition of the environmental issues of concern and may specify areas requiring further work or research and how these will be addressed. ▪ Sustainable Development Initiative: An indicator report that focuses on economic, social and environmental issues for a particular geographic area and addresses or attempts to address the interconnections of the issues. ▪ Other: Describe.
Intended use of initiative	The primary purpose(s) towards which the initiative is directed and that one intends to follow. Includes: Adaptive Management, Advocacy, Education/Awareness, Indicator Development, Performance Measurement, Policy Development, Access to Information, Research and Strategy Development

Title of initiative	The full title of the initiative.
Description of intended use	Brief description of the intended use of the indicator initiative. Refers to the goal of the initiative itself, rather than broader societal intended outcomes.
Geographic scope of initiative	Geographic area covered by the report. Includes: Global, International, Local/Community, Metropolitan Region, Multinational, National, Other, State/Provincial, Sub-national
Geographic units used	Geographic units used in the report. Includes: Political/Administrative, Natural Areas or Both
Country or continent or international	The geographic location (national and above), in which the initiative and its indicators are intended to perform. If the indicators are intended for a sub-national location, choose the country in the field. Choose most relevant one.
Municipality, Province/State	Name of municipality or state in which initiative applies, if applicable
Framework for initiative	A structure for organizing, grouping or classifying the indicators used by an initiative or the overarching world view on which the initiative is based. Clarification of which conceptual model or framework is used in the identification and organization of indicators. Includes: Capital-based Approach (natural, social, economic, cultural), DPSIR-Driver-Pressure-State-Impact-Response, Environmental Media (air, freshwater, marine, wildlife, ecosystem, etc.), Issue-based (climate change, acid rain, air quality, etc.), PSR-Pressure-state-response, and Resource Sectors (agriculture, forestry, mining, etc.).
Issue areas	The particular areas or issues that the initiative is addressing and will attempt to perform upon. Includes: Acid Rain, Agriculture, Air Quality, Arts and Culture, Atmosphere, Climate Change, Drinking Water, Economic Performance, Education, Employment, Energy, Fisheries, Forestry, Food Safety, Freshwater, Governance, Groundwater, Harmful Substances and Chemicals, Housing, Human Health, Land Use, Manufacturing, Mining, Natural Resources, Nature and Biodiversity, Noise, Oceans, Seas and Coasts, Population, Poverty, Public Safety, Recreation, Social, Stratospheric Ozone Depletion, Transportation, Waste, Wetlands, Other. This list may be expanded
Lead organization(s)	Name(s) of organization(s) leading the initiative or producing the report
Type of organization(s)	Select the category that best describes the lead agency
Partners	Group or organizations notably involved in the initiative. List the complete names of all major partners.
Mandate requirement	An official or authoritative goal or requirement that is responsible for the onset of the initiative.
Steering committee present	Describe structure of steering committee, if present. This field attempts to assess how indicator initiatives and SOE reports are governed.
Public involvement	The manner in which the public is involved in the initiative process or in evaluation of the initiative. Includes: Consultation, Evaluation Process, Public Membership on Committee, Unknown and Other.
Funding source	The organization or sponsor responsible for complete or partial assistance in the initiative program. Name of funding organization(s) or sponsor(s).
Frequency of reports	The time period and the rate at which the reports are created and/or released. Select the category that best describes the report frequency or reporting plans for the initiative.
Public access to supporting data	Are the data for this initiative available for viewing and/or downloading by Compendium users? Will users be able to look at and/or download data that are used in initiative or report?
Web site address for initiative or report	Web address specific to initiative or report.

Title of initiative	The full title of the initiative.
Notes/comments	Any additional information, unique features.
Contact person	Name of person most closely associated with initiative or report.
Title	Contact person's title or position.
Organization	Organization with which that contact person is affiliated.
Telephone	Telephone number of contact person.
Mailing address	Enter complete mailing address.
E-mail address	E-mail address for contact person.
Progress to date/future areas of work	The status of the indicator initiative, including whether the project is in early, mature and completion stages.
Presentation of the information and indicators	Type of presentation including databases, graphics, models and other visualization tools.
Publications	Publications related to the indicator initiative, including year of publication, format (online, hard copy) and publisher.

Appendix 2

About The International Institute of Sustainable Development

The International Institute for Sustainable Development contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change, measurement and assessment, and sustainable natural resources management. Through the Internet, we report on international negotiations and share knowledge gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries and better dialogue between North and South.

IISD's vision is better living for all - sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organisation in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC) and Environment Canada; and from the Province of Manitoba. The institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.

IISD's Measurement and Assessment (former Measurement and Indicators) Program was established in 1994. Our work is focused on improving decision-making through the development and use of information tools and processes compatible with sustainability requirements. We play a key role in integrated, forward looking environmental assessment and reporting processes from the local to the global level, including the design and delivery of training and capacity building programs for clients in the public sector. Our team brings a solid understanding of conceptual issues, scientific perspectives and thorough consideration of the policy process to bear on the analysis of complex sustainability issues and produces information that is understandable for decision-makers and the non-expert public.

Appendix 3

About The International Federation of Environmental Health

The International Federation of Environmental Health is a non-governmental organisation of national organisations representing some 60,000 environmental health professionals in 37 member countries worldwide. Since its incorporation in 1986 it has actively promoted care for the environment in the interest of human health through a variety of means, including, among other things, the holding of nine world congresses and publication of the proceedings; the adoption, publication and dissemination of global position papers (see http://www.ifeh.org/about.policies.html), the establishment of a comprehensive webpage - www.ifeh.org , and the wide circulation of its publication, *Environment and Health International*.

The Federation, in addition, is active in the field through its members, and benefits from the accumulated knowledge, experience and expertise of Environmental Health Professionals working around the world. The Federation promotes an holistic approach to environmental sustainability and encourages inter-sectoral collaboration, multidisciplinary and community-participative activities, and the utilisation of meaningful sustainability indicators to inform good EH management practices at local, regional and international levels.

As a result of the collaborating agreement with the IISD, the IFEH has formed a working group to disseminate information and to encourage all IFEH member organisations to participate in the collection of examples on sustainability indicator initiatives to the Compendium. Inside the IFEH this initiative has been named: The IFEH Sustainability Initiative (IFEH SII).

The IFEH SII Working group comprises:

- Henning Hansen, Coordinator of the initiative, ENVINA Denmark
- Fred O' Brien, Vice president IFEH, CIPHI Canada
- Steen Fogde, ENVINA Denmark
- Domenic Losito, CIPHI, Canada
- Raymond Ellard, Hon. IFEH Secretary, and EHOA Ireland

IFEH is still expanding and its current member organizations are divided into 5 regional groups:

- **Africa regional IFEH group**: Botswana, Kenya, Liberia, Malawi, Mauritius, Nigeria, Rwandese Republic, South Africa, Tanzania, Uganda, Zambia, Zimbabwe
- **Americas regional IFEH group**: USA, Canada and Jamaica
- **Asia & Pacific Regional IFEH Group**: Australia, Hong Kong, Malaysia, New Zealand, Singapore, Sri Lanka
- **European Regional IFEH group (EFEH)**: Austria, Cyprus, Denmark, England, Wales and Northern Ireland, Finland, France, Germany, Ireland, Latvia, Lithuania, Malta, Netherlands, Norway, Scotland, Sweden
- Middle East IFEH Regional Group: Saudi Arabia.

Besides its full organisational members, IFEH also houses associate member organisations and many university faculties as academic associate members. Altogether, through IFEH's global network there is access to an estimated 60.000+ professionals in the area of environmental health as well as environmental protection.

Appendix 4

List and focal area of work of researchers involved in the current Compendium update:

- Diego Martino, CLAES (Centro Latino Americano de Ecología Social), Argentina
  Focus area: Latin America and the Caribbean - Spanish

- Angeline Gough, IISD Intern, Lake Balaton Development Coordination Agency, Hungary
  Focus area: Forestry

- Amy Miller, Rutgers University, New Jersey, United States
  Focus area: USA

- Shilpa Nischal, TERI, New Delhi, India
  Focus area: Asia

- Sulema Pioli, University of Sao Paulo, Brazil
  Focus area: Latin America and the Caribbean - Portuguese

- David Wamukuru, Egerton University, Kenya
  Focus area: Africa

The IFEH 10th World Congress on Environmental Health
Brisbane, Australia 11 - 16 May 2008

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National and International Perspectives on Disaster Management

Tony Pearce

Emergency Management Australia

Available data show that over the past 30 years some 3 million people have died as a result of natural disasters worldwide, and whilst there are no clear figures available to show the numbers of injured and those made homeless over the same period we can imagine that they would be massive. The work conducted by Emergency Management Australia during its involvement in the International Decade for Natural Disaster Reduction (IDNDR) program revealed that the economic impact of natural disasters occurring in Australia annually is in the vicinity of AU$1 billion. Today's emergency manager needs to have a broad understanding of community need, and an ability to anticipate the likely results of their decision making on communities. In order to be confident and competent in practice, emergency managers require training and education that encompasses the concepts of response management, recovery management, the sociological and psychological aspects of emergencies, the legal implications of decision making during emergencies and the political dimension to managing emergencies both in the short and longer term. Recent world events are creating real issues for emergency managers, and that the attention being focused on terrorism is as a result of political and bureaucratic changes in priorities. The fear is that this change in priorities could result in the available slices of the emergency management budget pie becoming smaller. The funding of what might be considered traditional emergency management programs is at risk of becoming subsumed by the increasing allocation of budget to intelligence and security agencies.

Key words: *Natural Disasters; Emergency Management; International Decade for Natural Disaster Reduction*

What does the future hold for the Australian emergency management community and are we prepared to meet the challenges that will inevitably present? The threat that climate change poses, the increasing severity and frequency of natural disasters, the increased occurrence and savagery of terrorist induced emergencies, and the ever looming threat of the next pandemic suggest that the practices of the past may not be enough to meet the challenges of the future. Historically, the very concept of a catastrophe has been difficult for many in the Western world to grasp and providing a definition for what it is that classifies any particular emergency as having attained this unenviable status has also been difficult.

Significant events in recent years have started to galvanise our thinking and have rightly caused us to consider just how well prepared we actually are for emergencies of the magnitude of the 2004 Indian Ocean tsunami, Hurricane Katrina, and the Pakistan earthquake in 2005. Australia has fortunately been actively considering the possible impacts of large scale emergencies for some time. Initially, this was through Australia's participation in the International Decade for Natural

Disaster Reduction (IDNDR), the aim of which was to identify ways to reduce the huge numbers of lives lost and property damaged as a result of natural disasters, and to negate the large scale economic impact and social disruption that arises as a result of them. While Australia recognised that in itself it is not immune to such risks and the need exists to consider the possible impact of such events on this country, our involvement in the IDNDR program along with 137 other countries, would be focused not only on reducing the impact of natural disasters on the Australian community, but also to assist other South Pacific nations to reduce the impacts on theirs.

While Australia's participation in the IDNDR was not specifically focused on catastrophic events, clearly natural hazards that threaten areas of Australia such as tropical cyclones, bushfires, floods, heatwave, severe weather behaviour, earthquake and landslide, all have the potential to reach catastrophic proportions if they are large enough or prolonged enough in duration and if they impact upon vulnerable or unprepared communities.

Available data show that over the past 30 years some 3 million people have died as a result of natural disasters worldwide, and whilst there are no clear figures available to show the numbers of injured and those made homeless over the same period we can imagine that they would be massive. The work conducted by Emergency Management Australia during its involvement in the IDNDR program revealed that the economic impact of natural disasters occurring in Australia annually is in the vicinity of AU$1 billion.

This paper has so far focused predominantly on the impacts of natural disaster, however, there are many other issues facing emergency managers into the future. The remainder of the paper considers some of those issues that are not specific to any one country but that should have some relevance to most.

The Emergency Management Profession

The first issue concerns the lack of recognition that emergency management is a profession and should be viewed as such. There is no doubt that one of the ways in which we will build public confidence in the ability of governments and those charged with providing prevention, response and recovery services in times of emergency is for the business of emergency management to be seen as a profession.

Professionalism needs to be seen both in the context of the provision of education and the attaining of qualifications by individuals, and in the way that organisations view practitioners and resource them to be able to carry out their roles. Failing to educate and resource those expected to carry out formal emergency management roles is akin to choosing not to have insurance, and it is only when the disaster strikes that the implications of such decisions are realised.

Recent overseas examples of response to large scale emergencies have clearly shown that trained emergency responders who are well equipped and resourced are of little value if those who are expected to coordinate their utilisation in times of major emergency have little experience and limited education. Today's emergency managers need to have a broad understanding of community need, and an ability to anticipate the likely results of their decision making on communities. In order to be confident and competent in practice, emergency managers require training and education that encompasses the concepts of response management, recovery management, the sociological and psychological aspects of emergencies,

the legal implications of decision making during emergencies, and the political dimension to managing emergencies both in the short and longer term.

How often are there situations where a person charged with facilitating the emergency management functions of their organisation both in government and in the private sector has said that they wish they could get the training that they need to carry out that function with confidence? Such comment is not isolated and this is both disappointing, and an indicator that we are not recognising the significance and importance of the role that emergency managers play. An associated and almost as frequent occurrence is that where emergency managers with significant responsibilities in their organisations explain to me that the emergency management role is 'tacked on' to other responsibilities that invariably take priority. Unfortunately, there are few who have the luxury of saying that emergency management is their core business, and that they are trained and resourced to carry out that function. This is a situation that has to change. You would not go to a doctor who practiced medicine part time as a secondary function to having a primary role as a plumber, so why should we accept that those upon whom we might depend for our survival in times of emergency are placed in such a situation?

Emergency Management Leadership

Leadership in emergency management is also an issue for the future. There are a number of things that contribute to good emergency management leadership including education and experience. Other significant elements include an ability to appreciate the environment, good interpersonal skills, and an ability to communicate a vision in such a way that others can both appreciate the rationale behind it and feel confident in their own ability to achieve that vision.

It is being stated widely in the US that the issues arising from the management of Hurricane Katrina are clearly attributable to a lack of leadership. I have analysed the impacts of the relocation of the Federal Emergency Management Agency (FEMA) into the Department of Homeland Security, the subsequent loss of many of those who had for many years managed the recovery and relief operations of the old FEMA, and the absorption of FEMA's funding into the new, massive, amorphous Department and there is little doubt that these things occurred in some part as a result of poor leadership.

While personal traits, natural behaviour and general demeanour are a significant part of the full picture in a good leader, life experiences and exposure to an array of situations is necessary to ensure that an individual actually has a base upon which to apply their personal attributes. Similarly, I am not sure that leadership is something that can be taught, but it can be learnt. We can teach people to be good managers as this is in many ways a mechanistic process for which there are countless models, texts and theories, however, the development of leadership in the context that I have already alluded to requires time, exposure to experiences and the recognition and development of an individual's inherent personal attributes. Developing leadership is about knowledge of others, situations and capacities, it is about having the skill to communicate and engage, and it is about a desire for self development and an awareness and understanding of situational context.

Leadership in emergency management is not about position or status, we are all familiar with poor leaders who have occupied formal powerful positions in organisations, and in the obverse of those who do not actually have designated formal power or status but emerge over a

period of time as the informal leaders in organisations. A good leader will engage both individuals and the team by creating an environment of understanding and direction while building or enhancing solid two way communication lines. Leadership in emergency management involves behavioural flexibility and steadfast determination, being able to keep your cool amid chaos while heightening activity and increasing focus as appropriate to situational need.

What is important in relation to the world of emergency management - regardless of the cause of the crisis or whether it is a natural disaster or man-made - is that a great many people will look to us for leadership. They will look to us to take charge, and to direct outcomes not activities. The emergency manager's role in any crisis is to maintain calm and guide others so that they sense someone is in control. The ability to make quick decisions is required, and that can take a degree of courage on occasions. Emergency managers must believe in themselves, believe in their training, believe in their colleagues and 'back' themselves to make the 'hard call'.

Community Expectation

Community expectations are greater today than ever before and it is likely that this trend will continue into the future. In recent years we have seen the concept emerge that 'a more aware community is a better prepared community'. We need to better understand the context in which such awareness is gained in order to appreciate when this awareness will result in positive outcomes and when it will not. Greater awareness is being facilitated in many ways today. The number of significant emergencies occurring worldwide, both of natural and man-made origins is increasing annually. The frequency of occurrence combined with blanket electronic and print media coverage has ensured that unaffected members of the community virtually live through each emergency with the victims themselves. While this situation will definitely result in a more aware community, it is not necessarily commensurate with a real understanding of the potential impact of an equivalent emergency should the unaffected community observer ever experience it.

Awareness needs to be coupled to a realistic understanding of the actual risk that specific communities face which will often be different from the environment in which the observed emergencies have occurred. Further, our communities need to be educated as to how government and non-government organisations will respond to those emergencies from which they are at risk. The days of working to the community and providing to them what we decide they need are long gone. Today, we must work with the community to ensure that they have ownership of their own safety outcomes, better to be able to provide a facilitation role, and better to understand exactly what level of support will be required come that fateful day that we have to assist them deal with an emergency. Now while I am neither inferring that we are not recognising this need, nor suggesting that we are not developing processes to address it, the frequency and exposure to overseas events is progressing at such a rate that we might be struggling to keep up. In some ways the education process is being developed slightly faster in the counter terrorism environment than in the natural disaster environment. Exposure leads to perception, and perception is reality that leads to expectation. One of the challenges for emergency management into the future is to manage community expectation in such a way that it becomes realistic.

Emergencies as Political Events

A significant issue for emergency managers now and into the future is the need to recognise that man-made and natural disasters are now not just simply emergencies to be managed in a technical response and recovery context. It is imperative that we recognise that we are also managing a political emergency whereby the actions taken by emergency managers could have long lasting implications for the government of the day. Evidence of this is provided by the reaction of the community. Both those affected and unaffected were observers to the response to Hurricane Katrina in the US and the Beslan school hostage siege in Russia.

Clearly, Australian politicians have recognised the significance to their governments of community reaction to the management of emergencies. This recognition manifests itself in many ways, one of which is an increased expectation of timely, accurate information to be used in government provided public information announcements. Another way in which the political aspect of emergencies has manifested itself is the frequency in which politicians will now attend incident sites. It is no longer unusual to see the leaders of the day attend emergencies within hours of them occurring, and while the tenet of our responsibility is still to focus efforts on the immediate needs of the affected community, it is an unwise emergency manager who chooses not to recognise the political aspect of the event and ensure that those needs are met to the best of their ability.

Emergency Management Policy Development and Advice

The area of emergency management policy development and public administration are necessarily linked. Emergency management in the modern era is more than simply providing acute emergency response and recovery services in times of emergency. It also involves the development and analysis of sound emergency management and public policy by experienced public administrators, policy developers and analysts. Emergency management policy advice and analysis is provided for three reasons, first, to ensure that the government of the day is able to provide services that meet community needs, second, to ensure the consideration of future policy initiatives that align with the strategic policy direction of the current government, and third, to conduct analysis and review of the effects and outcomes of existing government policy.

The development and provision of emergency management policy advice at local, state and national government levels plays a critical part in the development of a public safety culture and if developed and analysed effectively should lead to improvements in emergency management practice and community safety outcomes.

The policy developed should focus on three areas to ensure that the desired improvements can be realised. First, it should consider the analysis, review and re-design of existing emergency services response and recovery strategies, and where the need is identified develop new policy that supports response and recovery agencies to achieve this. Second, analysis and review of the whole of government emergency management arrangements existing at local, state and national government level and identification of gaps where the development of additional policy would assist to make the arrangements more effective. Finally, it should focus on analysis of the level of community awareness and preparedness to be able to respond appropriately and recover from emergencies with the ultimate aim of providing opportunities to enhance community resilience.

The very nature of emergency management means that policy development and the advice provided in the three areas mentioned previously can be both pro-active and reactive depending on whether the policy or advice is being developed as a planned part of day to day emergency management strategy enhancement, or in response to the occurrence of an acute emergency, where the need for development of an urgent piece of policy advice has been identified. The way in which emergency management policy is developed and advice is provided in each of the three areas can be slightly different, however, the aim is the same, that is, to ensure that it fits within the government of the day's overall policy framework, to ensure that it does actually address the issue for which it is developed and to ensure that it contributes positively to public safety outcomes.

Policy advisors need to be cognisant of the risks associated with the provision of poor policy advice from the perspectives both of public safety and the political implications. Good policy development and advice can only be provided from an informed and authoritative position, and where the problem for which it is being designed has been well defined. Poorly defined problems lead to poor policy advice, which in the case of emergency management can lead to negative public safety impacts. As such, the development of good policy advice should be based upon rigorous analysis and research of the available information from as many different perspectives as possible, and be provided from a value free position independent of the analyst's personal viewpoint.

One of the challenges for the future is to ensure that emergency management policy is developed collaboratively, that is, the policy developer does not presume to develop policy or provide advice on matters of emergency management independently where other agencies, groups or individuals have some responsibility for service delivery, or where the policy or advice will impact upon others' capacity to provide their service.

The second challenge for the future, and possibly the more difficult in a policy sense, is the ability to implement and evaluate emergency management policy. Many a good piece of policy work has been brought undone through poor implementation and inappropriate or non-existent evaluation following implementation. An appropriate implementation strategy needs to be developed to ensure the timeliness of the introduction of the policy and the acceptance and understanding of its introduction by those who are to be affected by it. The implementation strategy should also consider possible unintended outcomes, ensure an understanding of what might arise that could prevent the desired outcome from being achieved, and what further information the recipients of the policy advice might require. One of the critical aspects of good emergency management policy development is being able to assure oneself that the implementation of the policy has in fact delivered the desired outcome. An appropriate evaluation process that considers general outcomes, community impacts, and political exposure should be conducted. Any issues arising out of the evaluation should be addressed immediately.

Inter-Government Relations

One area in which significant advances have been made in recent years is the area of inter-governmental relationships. Clearly, if we are to have an effective national emergency management capability this can only be achieved if governments continue to work together on the development of community safety strategies. Examples of how this

has played out since 2001 in Australia include changes to existing emergency management structures at the national level resulting in the creation of the National Counter Terrorism Committee, the Australian Emergency Management Committee, and a raft of other forums that focus on critical infrastructure protection and other areas of importance. All of these forums combine membership of the Australian government and all states and territories.

There have been significant increases in funding at the Australian Government and state and territory levels for policing and intelligence gathering purposes and response and recovery operations. An example of this would be the hundreds of millions of dollars spent by all governments on counter terrorism initiatives, many of which have much broader application across a range of natural hazards as well. Importantly, there has been a principle of cost sharing initiatives introduced where the Australian and state and territory governments have jointly invested in the development of capability enhancements.

Another very important initiative has been the jointly developed National Emergency Protocol, a protocol that facilitates immediate communication between the Prime Minister and the Premiers or Chief Ministers of affected jurisdictions during emergencies of national significance. Decisions about national assistance and support would be made through the protocol being invoked ensuring that the fullest extent of national capability can be brought to bear during a large scale disaster or emergency.

Management of the Crisis-Consequence Interface

A particular area of future risk is that of the ability to manage the interface between crisis and consequence management. Prior to 9/11 in New York and the numerous subsequent terrorist attacks that have occurred around the world, most developed countries including Australia historically worked within some version of a Prevention, Preparedness, Response and Recovery paradigm, designed to deal with all hazards including those for which we have had little or no experience in the past. However, since starting to invest significant amounts of money and effort into the intelligence gathering and security aspects of counter terrorism, there has been a subtle shift in some parts of the world toward working more within a crisis/consequence management paradigm when considering these issues.

The attention being focused on terrorism creates the possibility that political and bureaucratic priorities might change, possibly resulting in the available slices of the emergency management budget pie becoming smaller as the funding of what might be considered traditional emergency management programs risks becoming subsumed in increasing allocation to intelligence and security agencies. Just as great a concern is that the new counter terrorism structure might actually progressively subsume traditional emergency management functions. Having considered the recent response to Hurricane Katrina in the US, I want to look at two ways in which we can respond to emergencies. The first of these is the management of the event within a crisis/consequence management paradigm primarily designed for terrorism response and applied widely in the US since 9/11. Figure 1 shows that in this model both pre and post event activities occur as separate processes, with increased resourcing of crisis management activities at the expense of consequence management funding, and more importantly the risk that the management of other emergencies including natural disasters will also move toward being conducted within the same crisis/consequence context.

Figure 1: Potential incident lifecycle in the crisis/consequence paradigm

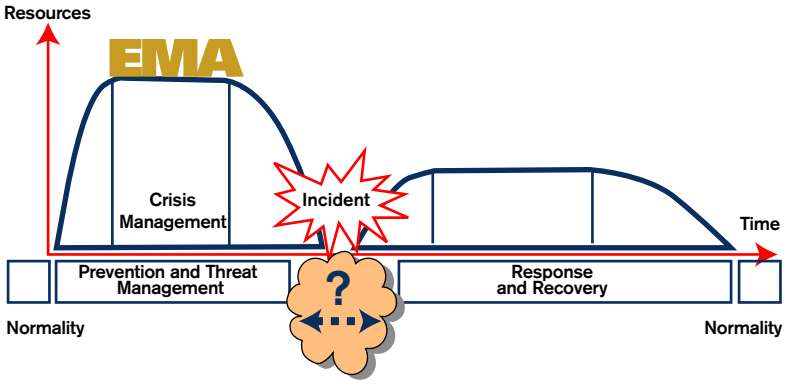
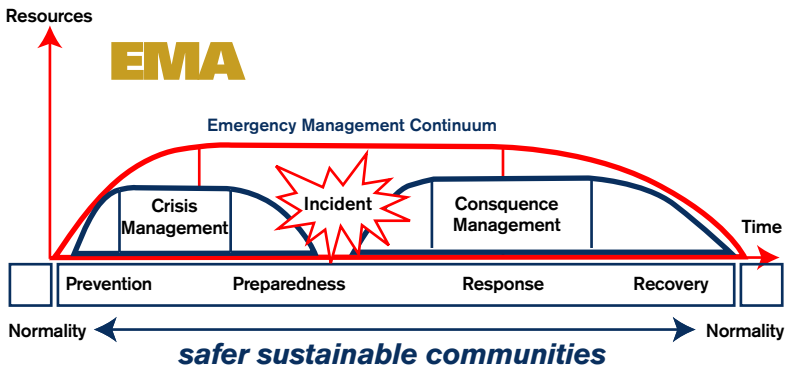


Figure 2 considers the management of emergencies as they are currently managed in Australia, terrorist events included, from an all hazards perspective. Compared to the previously described crisis/consequence management model the pre and post emergency processes occur within a Prevention, Preparedness, Response and Recovery paradigm as part of an unbroken all hazards emergency management continuum. All appropriate agencies are full participants to the extent necessary in all parts of the process and funding is applied more evenly and consistently across the full range of activities.

My hope is that we will continue to conduct emergency management activities in this way and not be tempted into using the model previously described, for if we do, the community response to Hurricane Katrina provides evidence as to the risks faced by governments and their agencies by doing so. Just as the public fear created by an explosion in a public place can act as a force multiplier for a terrorist, adopting the all-hazards approach to managing the issue maximises the existence of current and enhanced capabilities and resources and can also serve as a force-multiplier for response and recovery agencies,

Figure 2: Current incident lifecycle in the preparedness, response, recovery paradigm



that is, it can enhance the value of existing resources by more effectively combining their use.

Support for this position is provided by William Waugh, Professor of Public Administration and Urban Studies at the Georgia State University, who comments:

The all-hazards approach must be continued. The risks posed by earthquakes in California and by hurricanes along the Gulf Coast are potentially far greater than those posed by terrorists. The risks posed by influenza and other diseases witnessed by the recent SARS epidemic are far greater than those posed by terrorists with anthrax, sarin, or other biological and chemical agents.

Does a cocktail of 'weaponised' biological agents produced by a 'rogue state' or purchased (or stolen) from an old Soviet weapons lab pose a threat greater than the flu? ... In a perverse way, many emergency managers may be hoping for a catastrophe wrought by seismic or meteorological phenomena that will remind policymakers that there are forces more powerful than al-Qaeda and that the capabilities to deal with them need to be maintained (Waugh 2004).

The recent tragic Indian Ocean tsunami that took more than a quarter of a million lives and left many more homeless and more recently Hurricane Katrina and the Pakistan earthquake where another 70,000 people were killed, serves as a timely reminder that this is in fact the case.

Public/Private Partnerships in Emergency Management

Mutual obligation and public/private partnerships in emergency management is another area of concern for the future. If as mentioned above, the frequency and magnitude of natural disasters is increasing, terrorism is in the forefront of our minds, pandemics continue to threaten and complacency is ever present, then, logically, the capacity to meet these challenges must also increase.

A trend has developed in recent years within local government in Australia toward outsourcing all aspects of their business that are not seen to be core functions. This presents some distinct challenges if we are to increase capability and capacity commensurate with disaster frequency and magnitude. Formerly when emergencies occurred, local government held significant resources that while primarily utilised for their own business also formed the basis of most local area response capabilities. These capabilities included plant, water tankers, transport and various other elements of government infrastructure.

If we are going to enhance our capacity to respond to the emergencies of the future we need to identify ways to ensure that the resources required are available in a planned, timely and coordinated way. It is no longer about ownership of resources, rather it is about acquisition. The biggest holder of what is required is the private sector: tradesmen, professionals, transport providers, utilities companies, and so on.

Public/private partnerships provide the best way in the future to ensure that we are at least resourced to respond to large scale events, possibly even events of the magnitude that we have not experienced in the past. Part of our planning in the future should take options such as the development of public/private partnerships into consideration and where the option is considered appropriate, agreements should be entered into with those organisations willing to partner with us. While having agreements in place with private organisations will not ensure that all of the resources required to manage a large scale emergency are going to be available, any enhancement of capacity and capability must place us in a better position than we would be should such agreements not be in place.

Mutual Obligation

Effective management of any emergency into the future, particularly those that have the potential to reach catastrophic proportions, depends heavily on all stakeholders working together. As I have already mentioned, emergency management, critical infrastructure protection and the facilitation of enhanced public safety outcomes, is the shared responsibility of government and the public sector, the business and private sector, non-government organisations and the community.

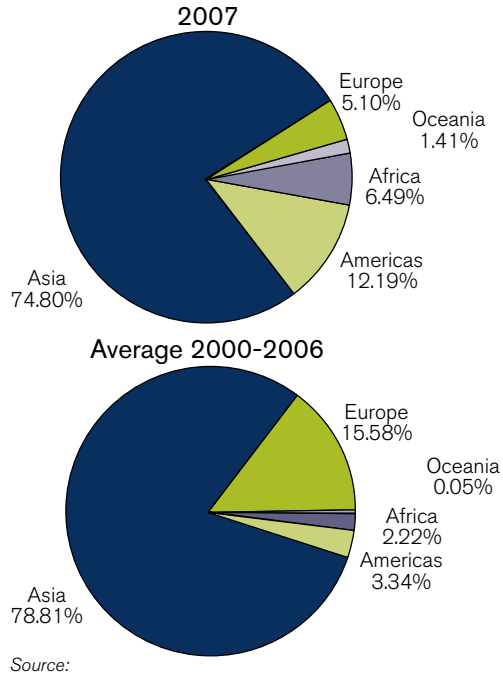
The world is no longer the massive place that it was and advances in transport and information technology have ensured that we can no longer stay working in the silos of the past. The need to be able to work across jurisdictional boundaries both domestically and internationally is being recognised. However, working in partnership in the fullest sense still does not come easily to some government departments and agencies. Unfortunately, there are plenty of examples throughout the world of agencies continuing to work in silos for both cultural reasons and because the retention of knowledge is still seen as the key to holding power by some. We still have a long way to go to overcome this in some areas, however, the heightened awareness of the terrorism potential that now exists, and the increased frequency and severity of natural disasters also makes it imperative that we learn to share information and intelligence on threats and vulnerabilities with each other, with the private sector and with the community.

Natural Disasters

Clearly, the occurrence and impact of natural disasters pose an ongoing future challenge for emergency managers. Data available through the Centre for Research on the Epidemiology of Disasters (CRED) in Brussels, Belgium shows that in 2007 there were 399 natural disasters worldwide, some 92 more than the annual average for the past decade. These disasters resulted in 16,517 deaths which is under half of the annual average of 53,000. While deaths were down for the year the total number of people affected by natural disasters worldwide stood at a huge 197 million. The economic impact of these disasters for 2006 was approximately US$62.5billion which is around a third higher than the annual average over the past decade.

The worldwide spread of natural disasters throughout 2006 saw Asia suffer significantly with 74.8% of all events. The remaining events were spread across the world with 5.1% occurring in Europe, 6.49% in Africa, 12.19% in the Americas, 1.41% in Oceania (which includes Australia). The split is shown in the following CRED figures (Figure 3) and the 2007 figures are compared to the 2000-2006 average.

Figure 3: Location of natural disasters in 2007 and compared to 2000-2006 average



Source:
Centre for Research on the Epidemiology of Disasters (CRED)

The 10 worst natural disasters by number of people killed in 2007 are shown in Table 1 and the countries suffering the greatest number of natural disasters in 2007 are shown in Table 2 below (Centre for Research on the Epidemiology of Disasters).

Table 1: Ten worst natural disasters by number of people killed in 2007

Natural disasters by number of deaths - 2007		
Cyclone Sidr, Nov	Bangladesh	4234
Flood, July-Aug	Bangladesh	1110
Flood, July-Sept	India	1103
Flood, Aug	Korea, Dem P Rep	610
Flood, June-July	China, P Rep	535
Earthquake, Aug	Peru	519
Heat Wave, July	Hungary	500
Cyclon Yemyin, June	Pakistan	242
Flood & landslides, June	Pakistan	230
Flood, July	India	225

Source: CRED

Table 2: Number of reported natural disasters by country - 2007

Country	Natural Disaster
United States	22
China, P Rep	20
India	18
Phillippines	16
Indonesia	15
Pakistan	9
Japan	8
Mexico, Haiti, Algeria, Afganistan	7
Bulgaria, Romania, Colombia	6
Mozambique, Brazil, Bangladesk Dominican Rep, Viet Nam, Thailand	5

Source: CRED

Table 3 shows the 10 countries having the greatest natural disaster impact by numbers of people killed and affected per 100,000 inhabitants, and Figure 4 shows the natural disaster occurrence by disaster type in 2007 compared to the average between 2000-2006 (CRED).

Table 3: Total killed and affected people of natural disasters per 100,000 inhabitants - 2007

Macedonia FRY	49057
Swaziland	36052
Lesotho	23657
Zimbabwe	15784
Bangladesh	14456
Zambia	12764
Dominica	11177
China, P Rep	9040
Belize	6952
Djibouti	5132

Source: CRED

The annual reported economic impact of natural disasters in absolute amounts (US$) for 2007 is shown in Figure 5 below (CRED), this can easily be compared to the years 1975-2006.

The impacts of climate change were apparent in 2007 by the number of weather related disasters that occurred, and as reported by CRED: "The small rise in extreme events is indicating that we might have to suffer more from the negative impact of climate change in the future".

Analysis of the year showed that Asia was still the continent most severely affected by natural disasters, however, a number of European countries were more severely affected by extreme weather events than normal. The analysis also showed that the number of floods occurring globally continued to rise with 206 occurrences in 2007 against a six year average of 172, the number of extreme weather events also increased slightly from an average of 23 to 24 in 2007.

Data show that more than 180 people per day on average die as a result of natural disasters world-wide, or over 67,000 per year. However, there have been many examples of single events that have impacted parts of the world, some of which in isolation have eclipsed

Figure 4: Natural disaster occurrence by disaster type in 2007 compared to the average 2000-2006

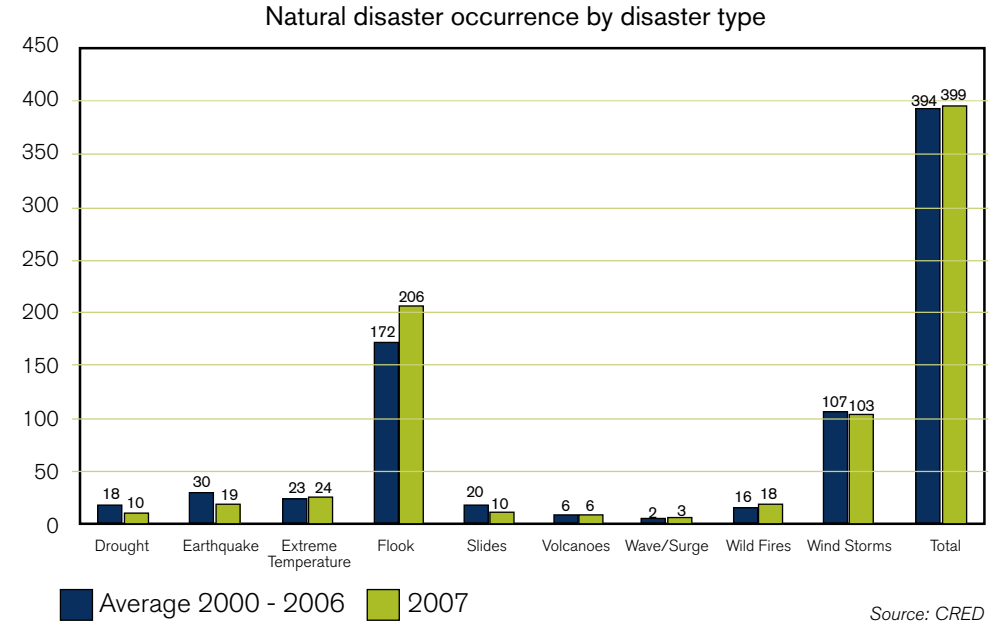
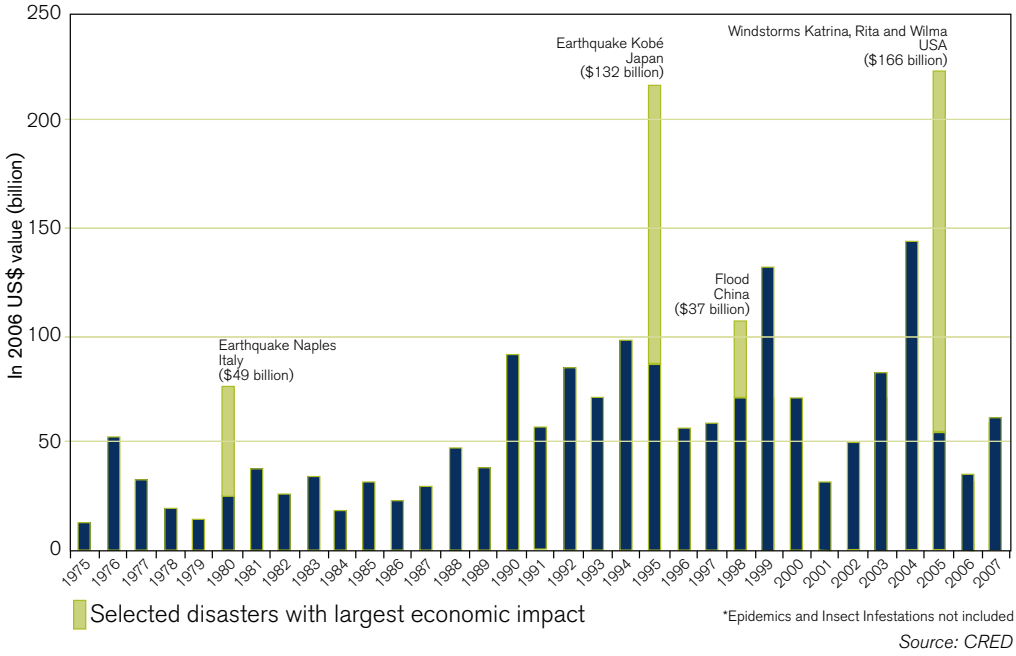


Figure 5: Annual reported economic damages from natural disasters 1975-2007



the average. Some examples of events that were catastrophic for the countries involved are shown in the following table (Table 4). It is interesting to note that countries from the Asian continent feature in the largest majority of these events.

Table 4: Examples of catastrophic events by country

Year & Location	Consequence Description
2005 - Pakistan	An earthquake impacting the disputed Kashmir region results in more than 80,000 deaths.
2004 - South Asia	An earthquake causes tsunamis that hit Sri Lanka, Indonesia, India, Thailand and other South Asian nations. The death toll is greater than 250,000.
2003 - Iran	A 6.3 quake devastated the Iranian city of Bam, killing more than 50,000 people.
1999 - Venezuela	The death toll is still unclear from the rain-caused landslides that hit Venezuela in mid-December 1999; official estimates are as high as 30,000 deaths.
1998 - Central America	Hurricane Mitch devastates much of Honduras and Nicaragua in Central America. More than 10,000 people were killed and some 2 million left homeless as mudslides swept away whole villages.
1991 - Bangladesh	Bangladesh lost more than 130,000 people in April 1991 from cyclone-induced flooding.
1990 - Iran	An earthquake triggers a landslide, causing from 40,000 to 50,000 deaths in western Iran on June 20, 1990.
1988 - Armenia	In 1988, an earthquake measuring 6.9 on the Richter scale devastates Armenia, killing over 100,000 people.
1985 - Colombia	A small eruption of the Nevado del Ruiz volcano in Colombia on November 13, 1985 leads to a massive mudflow that covers the city of Armero and kills more than 23,000 people.
1983 - Thailand	Monsoons kill 10,000 people in Thailand over the course of three months in 1983. Some 100,000 people contracted waterborne diseases as a result of the storm.
1976 - China	Earthquake with magnitude 8.0 impacts Tianjin in China, on in July 1976. The official toll provided by the Chinese government was 255,000.
1970 - Bangladesh	Bangladesh loses more than 300,000 people in November 1970 from cyclone-induced flooding.
1970 - Peru	A magnitude 7.8 earthquake at Mount Huascaran, Peru, on May 21, 1970, causes a rock and snow avalanche that buries 2 towns, killing as many as 20,000 people.
1959 - China	In July 1959, massive floods in China kill at least 2 million people.
1201 - Mediterranean	The deadliest earthquake in history kills approximately 1.1 million people in Egypt and Syria.

Sources (in part): Discovery Channel, U.S.G.S., BBC

Over the Horizon Thinking

Finally, one of the biggest risks to all countries, particularly those which might suffer emergencies or disasters infrequently is complacency. We must not allow ourselves to be lulled into a false sense of security simply because we have been relatively lucky to date with regard to the magnitude of disasters. We must develop flexible plans that will manage all of the hazards that might impact on us, and we must test our plans with exercises designed to reveal shortcomings and to ensure that they are workable and effective.

Emergency management is a shared responsibility that requires us to ensure that we are engaging the community effectively. The days of emergency management agencies delivering things to the community in the belief that they know best what they need are long gone. The community owns the emergency and agencies must assume a facilitation and

support role in allowing them where it is appropriate to take charge of their own public safety outcomes. We must work with communities to identify the risks that they face, to assist them to develop mitigation strategies that best meet their needs and to plan to respond to and recover from events as partners.

We must consider that planning for the traditional emergencies of the past might not adequately cover the real risks that we face into the future, and that the magnitude of events that we have not considered in the past might actually challenge our belief in our own ability to manage their consequences. 9/11, the Bali, Madrid and London bombings, the tragic Indian Ocean tsunami of 2004 and more recently Hurricane Katrina and the Pakistan earthquake remind us of the importance of preparing for the full range of disasters, disasters that affect people and property, critical infrastructure as well as our IT systems. We need to consider natural disasters brought about by extreme weather and geophysical anomalies as well as those caused by accidents and/or by deliberate malicious acts such as terrorism.

Recent disasters have highlighted the importance of public information and communication. It is critical for government and the emergency management sector to communicate the need for vigilance and awareness in such a way that the community feels empowered to act rather than in a way that engenders panic and anxiety, or worse still cynicism and mistrust in government.

Conclusion

The reality of life is that natural disasters will occur, that nature is not something that can be controlled, and unfortunately that our communities will at times be impacted. It is apparent that the risk of catastrophic disaster in Australia is lower than could be considered for some other parts of the world, however, the country does face real risks. Ultimately, we need to recognise that we are unlikely to be able to manage an event on the scale of the Indian Ocean tsunami in isolation, and that the assistance of the international community would likely be needed to be brought to bear. There are, however, clearly ways in which countries such as Australia and New Zealand can work to reduce the likely impact of such events on our communities.

The role of government is critical to achieving the best possible public safety outcomes in the context of catastrophic disaster whether induced by nature or man, for example, terrorism. Participation in processes such as the International Decade for Natural Disaster Reduction, and the Council of Australian Governments' review titled Natural Disasters in Australia: Reforming Mitigation, Relief and Recovery Arrangements that resulted in the current Catastrophic Disasters Emergency Management Capability review are good examples.

Government and non-government agencies involved in planning for the response to and recovery from catastrophic events need to ensure that their planning is conducted in an 'all hazards' context. Other than where absolutely necessary, planning to manage specific events in isolation is both financially and operationally inconsistent with aiming to maximise the availability of human and material resources, and with being serious about trying to achieve the best possible public safety outcomes.

It is also apparent that public education and the involvement of the community in the process of planning for the management of such events are critical. An informed and aware community is far more likely to be able to assist in its own safety outcomes.

The ability of governments to understand the reality of what the likely economic impact of a catastrophic disaster might be as well as understanding the likely

social impact is vital. Figure 5 shows that in addition to the massive loss of life and destruction of critical infrastructure that occurs in catastrophic events, the economic impact can be enormous. In fact in the case of the 2004 tsunami it varied from 1.8% to 270% of Gross Domestic Product (GDP). The following quote highlights that an appropriate amount of expenditure dedicated to prevention and mitigation would in the longer term reduce the economic and social impacts of disasters, however, it also provides some understanding of why it is not always easy to impress this upon those in a position to both authorise, and in the longer term benefit from such expenditure:

More effective prevention strategies would save not only tens of billions of dollars, but save tens of thousand of lives. Funds currently spent on intervention and relief could be devoted to enhancing equitable and sustainable development, which would further reduce the risk for war and disaster. Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible: they are the disasters that did NOT happen (Kofi Annan, Former UN Secretary General).

Public private partnerships should be an important part of the strategy to manage catastrophic disasters. Government and non-government agencies are not resourced to manage events of the magnitude of the recent tsunami, and in addition they will suffer losses too. The private sector has a significant part to play in the management of catastrophic disasters as many of the skills and resources required to resolve the consequences reside within it.

Some believe that recent world events are creating real issues for emergency managers, and that the attention being focused on terrorism is as a result of political and bureaucratic changes in priorities. The fear is that this change in priorities could result in the available slices of the emergency management budget pie becoming smaller. The funding of what might be considered traditional emergency management programs is at risk of becoming subsumed by the increasing allocation of budget to intelligence and security agencies as Waugh (2004) noted above. Waugh could not have known how prophetic his statement would prove to be when he made it in October 2004 just three months before the tragic Indian Ocean tsunami that took more than a quarter of a million lives and left many more homeless and destitute, 10 months before Hurricane Katrina and 12 months before the Pakistan earthquake that took 70,000 lives. All of these events serve as timely reminders that this is in fact the case.

Endnote

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Analysing Health Policy: A Problem-orientated Approach

Simon Barraclough and Heather Gardner (Eds)

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Analysing Health Policy is the latest in a series of highly respected books edited by Barraclough and Gardner on the subject of health policy in Australia. This book contains a collection of chapters that describe a variety of health policy "problems" and explore realistic approaches to address these. Instead of viewing the "problems" discussed in a pessimistic way, the authors "constantly remind us that policy analysis is about formulating problems which are worth solving, and which have potentially acceptable solutions" (p. ix). There is an underlying air of optimism and purpose, with the solving of policy 'problems' which have great public health benefit being a common theme throughout the book.

The book contains twenty-two chapters that span four sections. Section 1 contains five chapters that provide an overview of health policy. Chapter 1, for example, reminds us that even though the focus is on health policy:

> *problems in this policy area overlap other policy areas or have their own special qualities. The problem of health inequalities within populations cannot be understood in isolation from policy areas such as education, employment and housing...as a field of public policy, health extends beyond a narrow concern with medical care to encompass such areas as public health, population health, health promotion, human rights and the environment'* (p. 3).

The other chapters in section 1 go on to discuss the health policy process, institutional problems and health policy, and population health and health system policy.

Section 2 contains five chapters that discuss governance of the health system. This includes discussion on federalism and health, the public service and health, the health workforce, and regulation of complementary and alternative medicine. Section 3 focuses on values in health policy. Topics discussed include conflicting values in health information policy, the problem of trust in health policy, end-of-life care, and the provision of culturally and linguistically appropriate healthcare. Section 4 concludes the book by discussing perennial and emerging health policy problems. These include the ageing population, the pharmaceutical benefits scheme, mental health policy, and new technology.

From an environmental health perspective, there are a number of chapters that discuss some highly relevant policy issues such as population health, health impact assessment, municipal public health planning, uniform food hygiene regulation, and children's health in remote Indigenous communities. These chapters provide excellent discussions of the particular policy "problem" as well as the outcomes of the policy processes.

Overall, *Analysing Health Policy* provides a collection of thought-provoking and insightful essays on important health policy issues. The problem-orientated approach taken allows the authors to share their unique experiences so that the "real world" learnings are clear and able to be applied to other policy "problems". I would therefore recommend this book to students and practitioners alike who are looking to gain an understanding of the health policy process and insights into effective policy analysis.

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