# Environmental Health Focus

*Managing the Environment for Health in the AsiaPacific*

**Volume 1, Number 1 2003**

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# WHO Statement of Support

WHO is pleased to have collaborated with the Malaysian Institute for Medical Research (IMR) over the past five years in the development of its Environmental Health Research Centre (EHRC). An integral approach in this process has been problem-based learning that encourages, among other things, the sharing of information and emphasizes the importance of learning from and building on the experience of others. The *Environmental Health Focus* will serve as an important communications forum for enhancing this approach both in Malaysia and throughout the Western Pacific Region.

The solving of environmental health problems of common interest among countries in the Region can benefit greatly from thorough and open discussion. By promoting this type of robust discussion, the *Environmental Health Focus* will contribute to improve understanding of complex issues and enhance leadership development in environmental health research. The extent to which this is accomplished, however, will depend on the enthusiasm and participation of an informed readership. So, every effort will be made to engage people in meaningful dialogue, through the *Focus*, about real problems in practice and place.

WHO is happy to support and be part of this initiative.

Stephen A. Tamplin
Acting WHO Representative for Malaysia, Singapore and Brunei Darussalam
December 2002

## ACKNOWLEDGEMENTS

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# Environmental Health Focus

## *Managing the Environment for Health in the AsiaPacific*

**Volume 1, Number 1 2003**

This EH Focus serves an Environmental Health Research Information Clearinghouse function. It aims to develop environmental management for health with the following purposes:

- To promote Environmental Health (EH) research and development within Malaysia and the AsiaPacific
- To translate research outcomes to EH policy makers, EH practitioners, community leaders and researchers
- To engage stakeholders locally, nationally and regionally in Environmental Health Action Planing (EHAP)
- To equip these stakeholders as environmental managers for health in Malaysia and the AsiaPacific.
- To render national, regional and community life sustainable

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About the cover

# Editorial

## Policy and Contacts


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### Availability

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### Editorial policy

The Editorial Board will be the final arbiter of publishable materials in this Focus.

Rankings may be denoted by footnotes attached to the following symbols: primary author[i] ; major contributor(s)[ii] ; supporting author(s)[iii].

Instructions to authors and other policy details may be obtained from either the Editor in Chief or the Associate Editor at addresses shown adjacent.

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### Sponsorship


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### Peer Review

In this edition all contributions have been peer reviewed to determine suitability for publication.

# Board and Panels

# Contents

## In this Focus

# Setting the scene

## How EH Focus promotes interaction

Environmental health is emerging as a broad intersectoral strategy to manage the environment for health. It engages on local to global scales to influence policy, practice, people and place for the sake of sustainable living. Stakeholders in government agencies, NGOs, industries and communities all need ways for connecting health and environment to make this possible.

Environmental health research and deployment are now critical in charting the future, as countries struggle to shape their development into healthy settings.

There are sometimes gaps between conduct of EH research, creation of EH policy and its deployment in communities by EH practitioners. This confounds good intentions and confuses decision makers, often with disastrous results.

This publication has been designed to promote dialogue in the hope of bridging some of these gaps. The Environmental Health Research Centre, at its very outset, was designated as an EH Information Clearinghouse for this purpose.

Editorially this poses a challenge in addressing multiple audiences of technical and non-technical readers. The EH Focus has been structured with interactive devices, in the hope of translating research and deployment with public exchange of ideas.

### Promoting Interaction

**'Endnotes'** support non-technical readers, giving plain language explanations. Bolded alphabetical characters are inserted into the text of technical papers – for example[a].

**'Guest Editorials'** afford prominent persons opportunity to write scene setting articles to promote interaction between stakeholders.

**'News and Views'** afford readers opportunity to highlight events and write to the Editor as a form of interaction.

**'Feature Articles'** provide for authors to probe the future and challenge readers on environmental health issues.

**'Shaping NEHAP'** provides for articles which interact with **N**ational **E**nvironmental **H**ealth **A**ction **P**lanning to influence policy, practice, communities and research.

**'Neighbours'** provides for case studies which tell success stories or analyse failures in countries of the AsiaPacific.

**'Technical Notes and Articles'** affords researchers opportunity to publish technical notes and make progress reports on their work. All technical notes and articles are peer reviewed.

**'Literature Reviews'**; **'Book Reviews'** and **'Abstracts'**.

# Guest Editorial

It gives me great pleasure to pen down a few words in conjunction with the publication of the inaugural issue of the *Environmental Health Focus* journal. This journal, the first of its kind in the region has been made possible by the close collaboration between the Environmental Health Research Centre (EHRC) at the Institute for Medical Research, Malaysia, the Fiji School of Medicine and the WHO Collaborating Centre for Environmental Health, Australia. This project is funded by the World Health Organisation Western Pacific Regional Office at Manila Philippines. Environmental health (EH) is a rapidly developing field of Science and this journal will serve as a channel to promote EH research and translate its outcomes to EH policy makers, EH practitioners and community leaders. The aim of EHRC is to engage these local, national and regional stakeholders in EH Action Planning and manage the environment for health.

The journal, consisting of both technical and non-technical material, has been aptly designed to cater for a broad spectrum of readers and contributors. It is hoped that all stakeholders in EH will make use of this journal to contribute their thoughts, ideas and research updates to further achieve the purpose and aim of this journal.

EH requires our continued attention and efforts as it plays a vital role in promoting sustainable living for all aspects of life and this involves successfully translating policy into practice! The articles featured in this first issue of the *Environmental Health Focus* delve on issues pertaining to current EH concerns such as the effects of climate change and the role of the health sector and policy makers in dealing with this issue. The main section on the shaping of the National Environmental Health Action Plan (NEHAP) aims to inform readers of its role and also stimulate efforts by the various stakeholders to implement sustainable development plans in order to achieve the goals of Agenda 21.

On the international scene, it is interesting to note how Fiji has inculcated the idea of 'Healthy Islands' in their NEHAP programme. Fiji has made efforts to achieve an ideal setup for the holistic development of its people and the environment in which they live. This of course entails a lot of hard work and collaboration between EH practitioners, policy makers and the population in general. Looking back on their experience, they conclude that much has been learnt and it is their hope to continue improving the present work that is being carried out there.

Dissemination of research findings and other relevant information are crucial for the development and progress of EH in the country. People need to be informed before they can change their views and take the necessary steps to adhere to and/or promote proper EH practice. There is also a need to exchange ideas between researchers, policy makers and the general public in order to achieve an overall perspective when dealing with important issues. The EHRC has been successful in this regard as it has annually organised the EH Research Forum, a platform where various stakeholders in EH research have been able to share their knowledge, problems and expertise. This has brought about collaboration in research projects that are of national importance and which are currently contributing towards baseline data for national planning processes.

I would like to conclude by emphasizing that the role of EHRC as a 'Clearing House' for EH research data is further strengthened by the publication of the *Environmental Health Focus*. I would, therefore, like to request all researchers in environmental health to contribute articles of scientific value to make this publication a success. May I also take this opportunity to congratulate Dr Stephen Ambu, the Editor-in-Chief, and his team for spearheading this initiative.

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# Data Quality and its Importance for Decision Making in Environmental Politics – *An Issue for Air Pollution Control Supported by the Malaysian – German Technical Cooperation*

Roland Haas[i]

## Summary

Air pollution in Malaysian cities has not reached levels of other metropolitan areas in Asia, like Jakarta or Manila. However, even outside extreme haze periods, pollution levels increased despite tight regulations and this is exacerbated by the increase in the number of vehicle registration, distance travelled and growth in industrial production. Preventive action, which is perhaps the most expensive corrective activism, is recommended for Malaysia.

The Malaysian and German governments are cooperating in a project to control air pollution in a number of Malaysian cities. Apart from informing about the content of the cooperation, this article will concentrate on the importance of data quality improvements for decision making, public awareness raising and prioritisation of actions that are to be taken.

Three major questions need to be answered: (1)" What is in the air ? " - improvement of air quality monitoring (extension of networks, mobile monitoring and other measures), (2) " Where do the pollutants come from ? " - improvement of emission inventories and (3) " What is the impact of air pollution on the society in terms of health and other economic and social burdens and how much benefits arise from remedial actions ? "

## Clean Air

Clean air is a prerequisite for the good quality of life of human beings. It is also important for the health of animals and the prevention of damage to plants, soil and buildings.

In many cities around the world however, inhabitants are constantly reminded, and visitors are welcomed with warning signs such as:' Air Pollution Zone: Hazardous to your Health ! ' Indeed, the air pollution levels in many urban areas worldwide attain concentrations that cause severe damage to human health, animals and buildings.

## Poor Air Quality in urban areas

Poor air quality in urban areas is mainly caused by forest fires, dust and combustion of fossil and other fuels by industries, households and vehicles. Poisonous matters are either emitted directly or are the result of chemical reactions of the emissions, powered by solar radiation.

The main pollutants are carbon monoxide, sulphur dioxide, volatile organic compounds, particulate matter and ozone. They provoke a wide range of health effects such as lung and heart malfunctions, bronchitis, or asthma. Cancer risk increases with rising bad air quality levels.

Inadequate urban planning, the establishment of satellite cities, designs which never considered efficient public transport provision and use, and the preference of individual over public transportation have resulted in increased motor vehicle mileage which in turn has increased the level of air pollution in urban conglomerates.

Fast growing industries applying outdated technology, the use of poor quality fuel or coal, the lack of land-use planning allowing heavily polluting factories to function in urban dwelling centres also contribute to poor air quality.

## Air Pollution in Malaysia

The air pollution level in Malaysian cities is far lower than in most other Asian metropolitan areas. Bangkok, Jakarta,

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Manila, Beijing and Shanghai, just to name a few, suffer from more severe air pollution. As early as 1974 Malaysia issued its Environment Quality Act, which during its time was considered a modern and far reaching law. However, though this legislation and others have been revised several times since, pollution levels are still increasing, especially in the main metropolitan area, the Klang Valley.

More than 3 million people live in the Klang valley and they collectively own about 1.8 million motorised vehicles. The increasing economic activities in the early 1990s have resulted in higher incomes and as a consequence, the vehicle fleet has more than tripled since the end of the 1980s, causing almost the same rate of increase in pollutant emissions. Uncontrolled open burning, in particular forest fires in neighbouring countries, also contribute to the pollution from vehicles, industries and households.

Extensive forest fires in 1997 and 1998 caused a severe haze situation. More than RM 800 million per year, in terms of productive days of workers, were lost due to illnesses, treatment costs and other direct economic losses. This estimation does not include the external costs of "normal" daily pollution.

The experience gained in industrial countries and the recent experience in Santiago de Chile and Mexico City illustrate that change is possible. It needs 'know-how', experience and political will.

## The Key Questions of Air Pollution Control

For air quality to improve, the status of pollution has to be clearly analysed and actions have to be planned and carried out according to priorities. The key questions world-wide are:

- What is in the air?
- Where do the pollutants come from?
- How much damage does bad air quality cause?
- How much does it cost to control or to avoid bad air and what are the benefits from improvements?
- Which actions first?

To answer the first question, monitoring activities must be carried out, using sophisticated and expensive equipment to measure ambient air quality. In Malaysia, a network of about 50 air monitoring stations are continuously scanning the air for pollutants such as sulphur dioxide, carbon monoxide, ozone, nitrogen oxides and particulate matter. Six of these stations are located in the Klang Valley of which one is placed in the city of Kuala Lumpur.
The stations give a good representation of the state of background and pollution levels in the country as they are situated in various locations around Malaysia. The network, however, is not designed for identifying hot spots of pollution and subsequent decision making.

Having ideally analysed what is in the air, the next question which arises is "Where do the pollutants come from?"Is it from industry, traffic or is it from sources such as dust from outside or inside the cities? The point and line sources such as industries and traffic along major roads have to be analysed and their individual contributions to the overall pollution pattern identified. This requires stack sampling, modelling procedures and evaluation of the results which would eventually lead to comprehensive emission inventories.

Types of pollutants and their sources form the basic information to estimate the damage caused by pollution. What is its impact on the health of people, how much does it cost to medically treat an air pollution-affected person and how much does his/her company loose in production if he or she is not working for one day due to medical treatment in hospital? What is the damage to soil and agriculture, to buildings in the cities and to economic sectors like fisheries and tourism? Estimates of these damages allow comparison with costs involved to avoid or control pollution.

There are a wide range of actions and measures to be taken. Which ones should be implemented first, taking into consideration scarce financial resources of public and private sectors? Obviously those which have the highest impact and lowest costs.

## The Ozone and Air Particulate Matter Examples

Two examples for the illustrations of the importance of data for decision making have been chosen: Ozone is the result of atmospheric reactions between hydrocarbons (HC) and oxides of nitrogen (NOx) in the presence of sunlight. Hydrocarbons are produced from the combustion and evaporation of organic chemicals (gasoline, solvents, paints, consumer products, etc) and from motor vehicles. Oxides of nitrogen are the product of combustion and are produced from miscellaneous combustion sources, motor vehicles, etc.

Ozone formation may be limited by either the amount of HC or the amount of NOx available. Existing air quality data, ambient and emission inventory HC to $NO_x$ ratios, and meteorological data are used to infer whether ozone formation is HC or $NO_x$ limited. A qualitative evaluation of HC versus $NO_x$ limitation would require availability of air quality data and could be used to identify the most appropriate strategy to limit ozone formation.

Possibly, both HC and NOx control strategies are needed in some cases, and in some other areas maybe only HC limiting strategies are effective. NOx controls may not provide benefits in a localized area and they may show overall regional benefits. Both emission inventory data and air quality data would be needed to help to provide guidance on the most appropriate strategy for limiting ozone formation.

**Particulate Matter** (PM) is a mixture of various substances and it is composed of primary emitted PM and secondary emitted PM. Primary or directly emitted PM is composed of both fine and coarse particles. One of the major contributors to primary particles is geological material from activities such as construction, motor vehicle travel, winds, etc. Mobile sources such as diesel powered motor vehicles, motorcycles, and others contribute to the formation of directly emitted PM.

Secondary or indirectly emitted PM are mostly fine particles generated in the atmosphere from gases such as HC, NOx, and oxides of sulphur (SOx). These gases are transformed into particles through physical and chemical processes. The major contributors are combustion processes, motor vehicles, and stationary sources (factories, etc).

Emission inventories and air quality data are needed to clearly identify the quantitative contribution of various sources to the ambient PM. A source apportionment evaluation would help to identify the most effective strategies for controlling PM formation.

## Quality of Data

Good quality data would be unquestionable by lobbyists, interest and/or pressure groups. However, such ideal and transparent information will never be available. Limited resources in terms of finance and/or man-power for analysing the situations, unproved scientific relationship and room for interpretation will always affect proper decision making for politicians. Nevertheless, it must be a more than clear objective of clean air scientists and decision makers to improve the data and scientific base to be less vulnerable for deliberately or emotionally motivated opposition.

## Why is reliable data so important?

Environmental issues all over the world are highly political. “We cannot economically afford to act environmentally sound” is one of the most heard of arguments against doing something for the environment and the people. Excuses such as taking care of people and their economic welfare is used in the pretext of avoiding costly action taking. This argument, however, may most probably be weakened if the full range of damage is made transparent and compared to the costs involved to avoid it. In most cases, as it has been proven in many parts of the world, preventive actions cost much less than corrective measures. **Political will is the most crucial factor for improvements.** Thus, it is of utmost importance to convince politicians about the heavy burdens caused by bad air quality.

Purposely or unconsciously, in environmental impact analyses (EIA), cost of damage to the environment is generally underestimated. Lack of data frequently allows only a qualitative description of the impacts to the environment which can easily be overrun by economic arguments.

Authorities suffer from lost court cases when the judge has to decide in favour of the polluter due to the lack of data and scientific proof. Is it bad fuel quality or insufficient maintenance of trucks and buses which emit the well known black or white smoke? It must be made scientifically clear that black smoke is predominantly caused by badly adjusted engines and to a lower extent, if not negligible, by the high sulphur content of the fuel sold. However, in any case it is quite obvious that both effects contribute to bad air.

From a purely individualistic point of view, voluntary investment and production processes which take environmental aspects into consideration, are additional cost to investors and entrepreneurs which they try to avoid, unless they are forced to. Transparency could lead to good long term investments and availability of subsidy from the government or a comparative advantage over their competitors.

## The objectives of data quality improvements

To summarise, data availability in sufficient quality provides valuable information at three levels:

- The public, directly and through journalism: to raise awareness about the consequences of their

actions and to understand the sometimes "painful" measures to curb pollution;
- Decision makers and politicians: to prepare them with suitable knowledge and data for debates and insights to initiate and support environmentally sound preventive and corrective actions;
- The experts: to allow them to prepare for decision making based on scientific proof, particularly with respect to priority ranking.

**What can be done?**

The Technical Cooperation of the Federal Republic of Germany supports the efforts of the Malaysian Government to improve the air quality of its cities.

In the beginning of May 2002, a four-year *Air Pollution Control for Malaysian Cities: Transport and Industry* project commenced. Fields of cooperation include:

- Revision and development of existing and new emission standards, respectively for mobile and stationary sources and their enforcement;
- Improvement of fuel quality and introduction of fuel quality monitoring procedures;
- Development of a more sustainable urban development by integrating transport and land-use planning with clean air issues;
- Promotion of inter-institutional cooperation and commitment to air quality;
- Development of effective strategies for social communication and participation;
- Strengthening international cooperation with respect to climate protection, regional and local air pollution control;
- Improvement of data quality (monitoring of air quality, emission inventories) and scientific base (health and other effects);
- Promotion of business contacts between relevant Malaysian and German/European industries.

Vital instruments for project implementation are networking with national universities and experts, promotion of public-private partnerships, and strengthening of training efforts, both on the national and regional levels.

The German government provides substantial inputs to the project, among others:

- A long-term expert for the whole project period of 4 years;
- International, regional and local short-term experts of altogether more than 100 expert-months;
- Local project staff;
- Facilitation of technical visits for Malaysian experts to Germany and other countries.

The Governments have appointed the Malaysian Department of Environment (DoE) and the German Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH to implement the project.

The DoE, which belongs to the Ministry of Science, Technology and the Environment (MOSTE) was established in accordance with the Environmental Quality Act of 1974. Its main function is the preparation of an environmental policy and the enforcement of environmental legislation.

The GTZ is a German Government-owned technical assistance agency which is implementing, on behalf of the German Government, about 1800 projects in about 140 countries. Also, other governments and multi-lateral agencies like the World Bank, the Commission of the European Union and others employ the vast experience of the GTZ in the area of development.

In the field of data quality improvements the project particularly supports the fields of:

- Improvement of knowledge of the ambient air quality, through reviews and extensions of the present air monitoring network and also through the introduction of additional mobile monitoring activities,
- Improvement of knowledge as to where the pollutants come from, through revision of the emission inventory, both for mobile and stationary sources, and
- Studies of air pollution impact on health and economy.

Working groups and expert networks have to be established or strengthened. Partners include public and private stakeholders, such as the DoE, Ministry of Health, medical research institutes, universities and private sector representatives.

# Climate Change - impact on public health in Malaysia

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## Introduction

Malaysians in general are becoming aware of the effect of environmental degradation on human health. Many now express widespread and growing concern. As a rapidly developing country, Malaysia is progressing well in finding solutions to environmental health problems. Researchers are now networking with policy makers, planners and practitioners towards effective management programmes. Global warming represents a major challenge for the future.

It is predicted that human diseases will surge as global temperature increases. Such potential effects of climate change were addressed by the World Health Organisation (WHO) and the World Meteorological Organisation (WMO) in 1990 (WHO 1990b). It is evident that that lack of nighttime cooling is increasing, followed by higher temperatures in winter and at latitudes higher than 50 degrees (Epstein, 2000). Scientists by projecting greenhouse on economic activities for the rest of this century have predicted increases of 1 - 3.5ºC in the mean surface temperature of the earth, (IPCC, 1996b).

Such increases in temperature are predicted to expand oceans, melt glaciers and raise sea level one-third to one-half a meter by 2100. Death rates will increase due to weather pattern changes triggering heat waves, floods, starvation, increase in respiratory illnesses due to smog and dispersal of allergens and resurgence and spread of infectious diseases.

In Malaysia in the next 100 years, temperature is expected to increase by +3.5ºC, rainfall by 32%, and the sea level by 15 – 95cm. These changes will increase vector-borne diseases such as malaria and dengue fever. Rising temperatures will magnify suitable breeding habitats for disease vectors.

Region specific scenarios are not available currently. In consequence, the World Health Organization (WHO) sees predictions on health effects due to climate changes remaining general and speculative. However, mathematical models are utilised to study vector distributions and aetiology of tropical diseases in response to climate change at a global level. The following are examples of this approach.

## Transmission model for Malaria in relation to temperature

Transmission models are used to assess the *vectorial capacity ('C')* of mosquitoes in transmitting malaria. The mathematical formula $C = ma2pn/-ln\ (p)$ is used for this purpose.

*The person-biting rate ('ma')* is determined by the *number of mosquitoes per person ('m')* and the *person biting habit ('a')*. The number of mosquitoes is partially dependent on the rate at which mosquitoes develop. This in turn depends on temperature. In Peninsular Malaysia, the major malaria vector, *Anopheles maculatus*, was recorded with a biting rate of 20/person/night in an Orang Asli settlement in Pahang (Lee, 1998).

*The person biting habit ('a')* measures the mean frequency at which mosquitoes feed on people. In the field, tropical mosquitoes generally bite humans at regular intervals of 2-5 days. This parameter is determined by using the formula a = h/u. The proportion of blood fed mosquitoes which have fed on people ('h') is divided by the length of the gonotrophic cycle, ('u') – for *An. maculatus* u = 2.3 days (Loong et al, 1990; Chiang et al, 1991). The gonotrophic cycle is affected by temperature: higher temperatures shorten the gonotrophic cycle of the mosquitoes and worsen their person biting habits.

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*The time required for full development of the pathogen in the vector ('n')* is affected by ambient temperature. As temperatures rise the malaria parasites develop more quickly in the mosquito vectors. Studies conducted in the IMR laboratories indicated that the major malaria parasite, *Plasmodium falciparum*, took 10 days to complete its development, in most anopheline vectors at room temperature.

*The daily survivorship ('p')* of *Anopheles maculatus* in the field was estimated to be 0.71-0.76 (Loong et al, 1990) and 0.699-0.705 (Chiang et al, 1991). For these present calculations, a 'p' value of 0.7 is used.

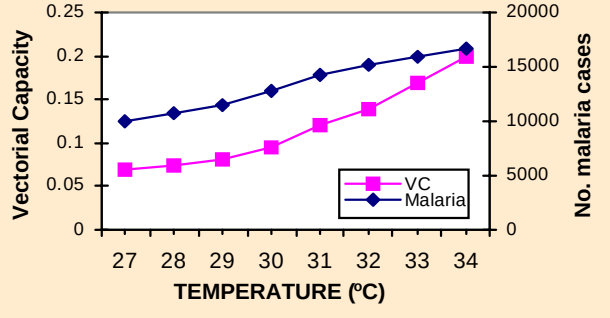
The direct effect of temperature changes on vectorial capacity is shown in Table 1. and Fig. 1. It was noted that at lower temperature, increase of temperature has a small impact on C e.g. at 27°C, C = 0.069 and at 29°C (i.e. an increase of 2°C), C = 0.081; an increase of 14.8%. However, the increase of C from 30°C to 32°C is 31.4%.

**Table 1. Direct impact of changes in atmospheric temperature on vectorial capacity of *Anopheles maculatus* in Malaysia.**

| Temp (°C) | Estimated ma | Estimated a | Estimated n | C |
|---|---|---|---|---|
| 27 | 20 | 0.04348 | 10 | 0.069 |
| 28 | 21 | 0.04348 | 9.9 | 0.075 |
| 29 | 22 | 0.04348 | 9.8 | 0.081 |
| 30 | 25 | 0.04348 | 9.7 | 0.096 |
| 31 | 27 | 0.05000 | 9.6 | 0.12 |
| 32 | 30 | 0.05000 | 9.5 | 0.14 |
| 33 | 35 | 0.05000 | 9.4 | 0.17 |
| 34 | 40 | 0.05000 | 9.3 | 0.20 |

*ma = person biting rate; a = person biting habit; n = time required for full development of pathogen in vector; C = Vectorial capacity.*

**Figure 1. Effect of temperature on vectorial capacity of *Anopheles maculates* and estimated no. malaria cases at a theoretical 10,000 at present**




This transmission model enables generalised predictions in the following assumptions:

- if the present mean atmospheric temperature in P. Malaysia is 28°C and
- it increases of 2°C by the year 2010 due to global warming (Houghton et al, 1996)
- transmission by *Anopheles maculatus* of malaria parasites is estimated to increase by about 22%. This may translate into increased human malaria cases.

Global warming may also extend the season of malaria transmission in Malaysia. A recent study in Pakistan (Bouma et al, 1994) reported that the normal malaria season was prolonged due to unusually high temperatures at the end of the normal season. This substantially increased the number of cases of falciparum malaria. In
P. Malaysia, the peak malaria season generally occurs in April-May. With higher temperatures in the future, this peak season may be extended.

## Sea level rise

Global warming may lead to a rise in sea level due to melting of polar ice caps. Consequently, sea levels are expected to rise about 50 cm by the year 2100. This estimate sits mid range within the IPCC assessment report of 1995, that predicted a sea level rise between 15 – 95 cm by the end of this century. Such a rise would cause coastal flooding in many areas (Houghton et al, 1996). Salt-water intrusion into fresh water estuaries could extend breeding grounds. *An. sundaicus* is such a brackish water breeder and a malaria vector in the coastal areas of P. Malaysia.

## Rainfall

Climate change will eventually have an uneven impact on rainfall in different parts of the world. Rainfall increases will most likely lead to a proliferation of breeding sites, enhance the vectorial capacity of the vectors and henceforth the transmission of the parasites.

In Malaysia, *Anopheles maculatus* has exhibited definite seasonal prevalence (Sandosham and Thomas, 1982). The population increases in late March and early April and again in September. The lowest population occurs in June – July and January – February. The population density peaks coincided with rainfall patterns.

In Sabah, Hii et al (1988) showed that the population of *Anopheles balabacensis*, the major malaria vector, was higher in March than November. The seasonal abundance of this vector is closely related to rainfall because the breeding places (ground pool, foot print, etc) are highly

dependent on rainfall patterns.

## Deforestation

The loss of forest can have serious effects on the ecology of malaria vectors. For example, in Malaysia, malaria transmission may increase in deforested areas. *Anopheles maculatus* prefers to breed in open slow-flowing clean stream exposed to sunlight. Disappearance of the forest can also lead to a rise of atmospheric temperature of

**Table 2. Scenario of climatic changes and malaria transmission**

| Scenario | Vectoral Capacity and Estimated Malaria Cases | | |
|---|---|---|---|
| | 28°C (1997) C=0.075 | 29°C C=0.081 | 30°C (2010) C=0.096 |
| 1. Increase of atmospheric temperature due to GHG and deforestation. | 26,652 | 30,520 | 34,110 |
| 2. Saline intrusion due to rise in sea level | 0 | 1,000 | 2,000 |
| 3. Increase of rainfall | 0 | 2,000 | 4,000 |
| **Total** | **26,652** | **33,520** | **40,110** |

3 – 4°C (Hamilton, 1989), thereby further enhancing vectorial capacity. The various scenarios of climate change impacting on malaria are shown in Table 2.

## A Transmission Model of Dengue in relation to rainfall

The relationship between rainfall and the occurrence of dengue outbreaks in Malaysia is not a simple correlation. Certain parameters such as the case distribution, probability of transmission, etc are not simple interactions. This paper has used another model (modified from Mogi et al, 1990) to study the threshold of rainfall actually required to trigger an outbreak. The example is based on available data of dengue incidence and rainfall in the years 1986 – 1997. For details of this mathematical model request the unabridged version of this paper from EHRC.

This model indicated that relatively fewer raining days are required for the high transmission of dengue. This analysis agrees with the prevailing observations that heavy rainfalls generally are associated with lower

**Table 3. Number of raining days required to induce dengue outbreak**

| No. Days Examined for Rain | Low Transmission: No. raining days required for an outbreak | High Transmission: No. raining days required for an outbreak |
|---|---|---|
| 30 | 2.89 | 0.47 |
| 60 | 4.57 | 2.15 |
| 90 | 6.25 | 3.83 |
| 120 | 7.93 | 5.51 |
| 150 | 9.61 | 7.19 |
| 180 | 11.29 | 8.87 |
| 210 | 12.97 | 10.55 |
| 240 | 14.65 | 12.23 |
| 270 | 16.33 | 13.91 |
| 300 | 18.01 | 15.59 |
| 330 | 19.69 | 17.27 |
| 360 | 21.37 | 18.95 |

transmission of dengue in terms of cases. More rain tends to flush the *Aedes* larvae out from their breeding habitats in natural and artificial receptacles. Low vector populations yield lower transmissions of disease.

## Transmission Models of Malaria, Filariasis and Japanese Encephalitis in relation to rainfall

More complex modelling similar to the kind used for dengue above, was applied to the relationship of rainfall and other vector-borne diseases such as malaria, filariasis and Japanese encephalitis. The threshold of rainfall required for the transmission of these diseases is summarized in Tables 4, 5 and 6.

This modelling indicates that, unlike dengue, more rainfall is required for high transmission of these diseases. The principal vector mosquitoes of malaria, filariasis and JE are *Anopheles*, *Mansonia* and *Culex* species, respectively. Their breeding depends on the water level in their respective habitats viz., slow-flowing streams/ seepage, and swamps/ponds and ground pools/paddy fields. These larvae generally prefer higher levels of

water. More rainfall is conducive to breeding and subsequent higher transmission of the diseases.

**Table 4. Threshold of rainfall required for transmission of malaria**

| No. Days Examined for Rain | Low Transmission: No. raining days required for transmission | High Transmission: No. raining days required for transmission |
|---|---|---|
| 30 | 5.10 | 7.54 |
| 60 | 11.4 | 13.87 |
| 90 | 17.75 | 20.19 |
| 120 | 24.08 | 26.52 |
| 150 | 30.40 | 32.84 |
| 180 | 36.72 | 39.16 |
| 210 | 43.05 | 45.49 |
| 240 | 49.37 | 51.81 |
| 270 | 55.70 | 58.14 |
| 300 | 62.02 | 64.46 |
| 330 | 68.34 | 70.78 |
| 360 | 74.67 | 77.11 |

**Table 5. Threshold of rainfall required for transmission of filariasis**

| No. Days Examined for Rain | Low Transmission: No. raining days required for transmission | High Transmission: No. raining days required for transmission |
|---|---|---|
| 30 | 7.78 | 8.95 |
| 60 | 16.15 | 17.31 |
| 90 | 24.52 | 25.68 |
| 120 | 32.89 | 34.05 |
| 150 | 41.26 | 42.42 |
| 180 | 49.62 | 50.78 |
| 210 | 57.99 | 59.15 |
| 240 | 66.36 | 67.52 |
| 270 | 74.72 | 75.88 |
| 300 | 83.09 | 84.25 |
| 330 | 91.46 | 92.62 |
| 360 | 99.82 | 100.98 |

**Table 6. Threshold of rainfall required for transmission of Japanese encephalitis**

| No. Days Examined for Rain | Low Transmission: No. raining days required for transmission | High Transmission: No. raining days required for transmission |
|---|---|---|
| 30 | 5.46 | 8.60 |
| 60 | 12.49 | 15.63 |
| 90 | 19.52 | 22.66 |
| 120 | 26.55 | 29.69 |
| 150 | 33.58 | 36.72 |
| 180 | 40.60 | 43.74 |
| 210 | 47.63 | 50.77 |
| 240 | 54.66 | 57.80 |
| 270 | 61.69 | 64.83 |
| 300 | 68.72 | 71.86 |
| 330 | 75.75 | 78.89 |
| 360 | 82.78 | 85.92 |

If climate change should alter rainfall patterns, the above modelling suggests that dynamics may differ for the various vectors and attending disease patterns. Environmental management strategies will need to pay careful attention to these contrasting ecological patterns.

## Effects of environmental changes on adult mosquitoes

Mosquitoes, like other arthropods require energy, moisture, hosts and shelters from their environment, for continued survival and reproduction. The rapid changes in social-demographic facets of the human populations and industrialisation have altered this environment radically.

Specifically, the green house effect (global warming), urbanisation and changes in natural vegetation have affected the distribution and abundance of mosquito vectors. Changes in the environmental factors (both biotic and abiotic) will eventually lead to extended range of vector-borne diseases in previously unknown territories.

Air pollution is an emerging environmental variable attending these social and demographic changes. It impacts on the human populations and has attracted attention globally and intensively in Malaysia over recent

years. Human activity in the open burning of forests in the nearby geographical regions has been an issue.

There have been no studies on the effect of this air pollution on natural mosquito population dynamics. Mosquito populations in Kuala Lumpur city are closely monitored by >25 sentinel trap houses. Air pollution parameters and meteorological data are also available.
An analysis of this data was conducted to examine the effects of rainfall and air pollution on mosquito populations.

Rainfall emerged as an environmental factor affecting the population dynamics of the mosquitoes (Fig 2). The amount of rainfall correlated negatively with the populations ($r = -0.65$, $p<0.05$). There is a lapse period before populations increase or decrease following respectively upon rainy and/or dry spells.

Since all the mosquito species breed in water, heavy rain tends to increase the water level. It flushes out the larvae in containers (*Aedes* species) and drains (*Culex quinquefasciatus*), resulting in subsequent low adult populations. On the other hand, low rainfall or intermittent rains are favourable for mosquito breeding, since the amount of water present is conducive.

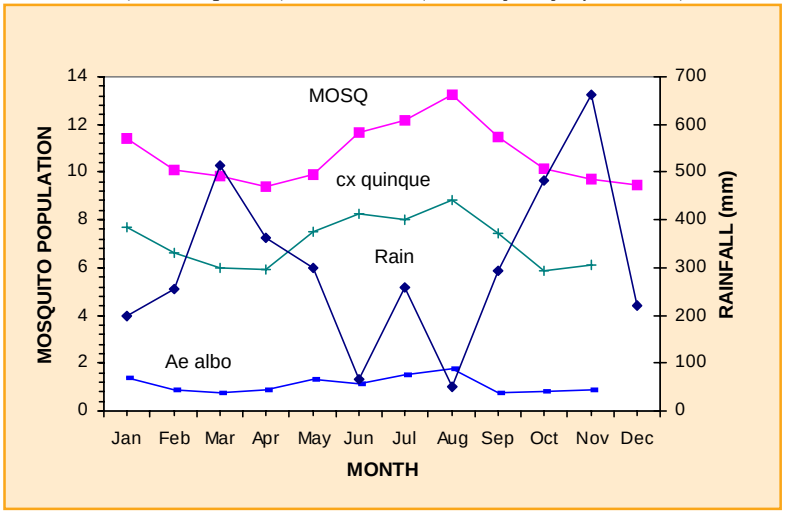



**Figure 2. Mosquito population in relation to rainfall in Kuala Lumpur City in 1997**

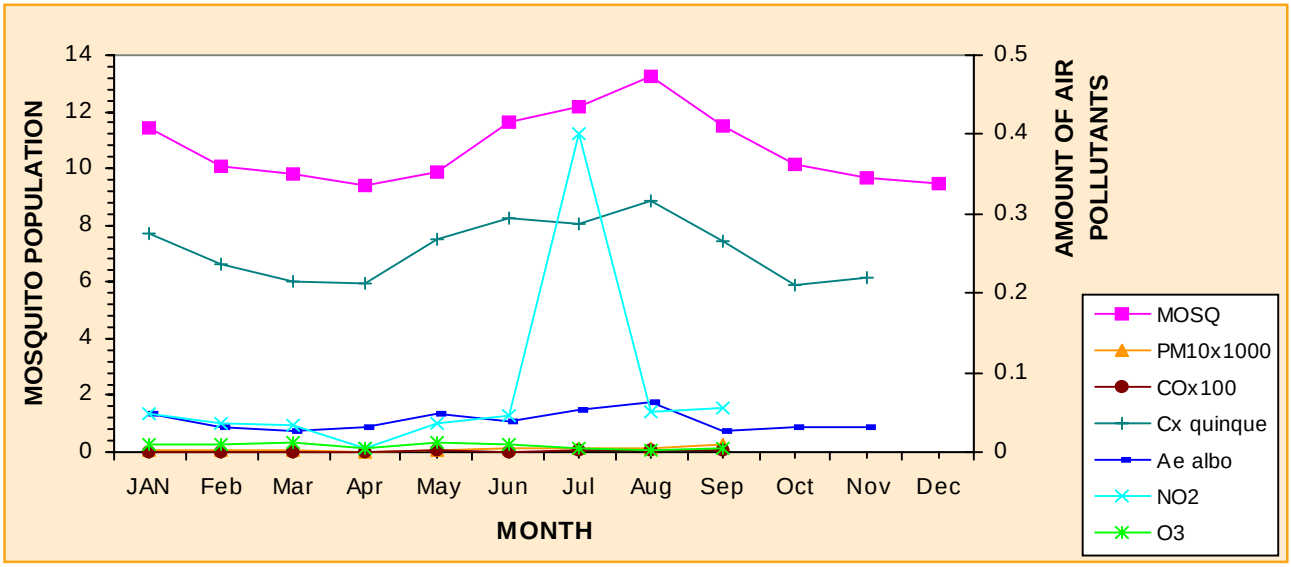



**Figure 3. Mosquito population in relation to air pollutants in Kuala Lumpur City in 1997**

## Correlations between climate patterns and disease

Health data has been statistically analysed in relation to a number of climatic parameters in Tables 7, 8 and 9 on the next page. Water, food and vector-borne diseases in Malaysia were examined for the 20 year study period 1976 – 1996. Each data set is briefly discussed.

### Water-borne and food-borne diseases

Correlation analysis showed a significant relationship between water and food-borne diseases with temperature only (Table 7).

**Table 7. Correlation between the water and food-borne diseases with temperature only**

| Water and Food-borne Diseases | Correlation Coefficient | p-value |
|---|---|---|
| Total cholera cases | 0.49 | 0.02 |
| Cholera incidence rate | 0.43 | 0.04 |
| Total food poisoning cases | 0.52 | 0.01 |
| Food poisoning incidence rate | 0.45 | 0.04 |
| Typhoid incidence rate | -0.47 | 0.03 |
| Typhoid death | -0.48 | 0.02 |
| Total dysentery cases | -0.68 | 0.00 |
| Dysentery incidence rate | -0.66 | 0.00 |
| Total dysentery deaths | -0.58 | 0.00 |

Total cholera and food poisoning cases correlated positively with temperature. In contrast, typhoid and dysentry cases proved to have a negative correlation with temperature.

Rainfall and humidity did not correlate with any of these diseases (insignificant $p > 0.05$).

## Vector-borne diseases

Vector-borne diseases had demonstrable relationships to both temperature and the relative humidity. Total malaria cases and malaria deaths correlated negatively with temperature. On the other hand the malaria case fatality rate correlated positively with relative humidity. Neither of the data sets in Table 8 showed any correlation with rainfall.

## Mutiple regressions

Multiple regression analysis was carried out to determine the impact of the 3 climate parameters on those diseases showing significant correlation. Only total malaria cases, dengue incidence rate and dysentry incidence rates proved to be significant. The multiple regression results ($y=a+bx_1+bx_2+bx_3$) are summarised below.

**Table 8. Correlation of vector-borne diseases with temperature and relative humidity**

| Vector-borne diseases | Correlation coefficient with temperature | p-value | Correlation coefficient with relative humidity | p-value |
|---|---|---|---|---|
| Total malaria cases | -0.44 | 0.04 | - | - |
| Malaria deaths | -0.58 | 0.00 | - | - |
| Malaria case fatality rate | - | - | 0.54 | 0.01 |
| Total dengue cases | 0.61 | 0.03 | -0.64 | 0.00 |
| Dengue deaths | - | - | -0.55 | 0.01 |
| Dengue incidence rate | 0.63 | 0.00 | -0.67 | 0.00 |
| Total J. encephalitis cases | 0.49 | 0.02 | -0.54 | 0.01 |
| J. encephalitis incidence rate | 0.48 | 0.02 | -0.53 | 0.01 |

*(-) = not significant correlation ( p-value >0.05)*

## Predictions

The above correlations and multiple regressions indicate the following predictive possibilities in response to climate changes in Malaysia:

- multi-parameter climate change may impact malaria, dengue and dysentry;
- temperature change alone may impact water and food borne diseases;

**Table 9. Multiple regression on diseases and weather parameters**

| Diseases ( y ) | Intercept (a) | Rainfall ($bx_1$) | Temperature ($bx_2$) | Relative Humidity ($bx_3$) | Adjusted R-squared | p-value |
|---|---|---|---|---|---|---|
| Malaria cases | 1459688 | 12.02 | -3.11 | -73001 | 0.254 | 0.04 |
| Dengue incidence rate | -123.32 | 0.04 | 73.02 | -23.4 | 0.565 | 0.02 |
| Dysentery incidence rate | 651.64 | -0.007 | -21.41 | -0.58 | 0.419 | 0.01 |

- temperature and relative humidity may alter the incidence of vector borne diseases and could contribute up to 56.5% to the incidence of dengue.

## The role of the health sector and policy makers

Malaysia is a rapidly industrialising country. The economic and social change associated with rapid urbanisation is giving rise to new environmental health concerns. As the more traditional management issues are being superseded, decision-makers need new data on health. Climate change will be superimposed on top of these local impacts, requiring different types of indicator development. As stated by The World Bank Report (1995a), "Good environmental policies are good economic policies – and vice versa". Policy makers must be pragmatic in linking key environmental issues with health, social and economic interactions. They must therefore keep abreast with changing environmental conditions and emerging economic situations (Petersons, 1997).

The publications of the IPCC second assessment report has raised markedly the profile of population health impact as a criterion for policy-making relating to climate change. This report has given substantial attention and considerable prominence to the potential health impacts of climate change and it can be used as a guide in related studies.

The Ministry of Health has an emergency preparedness and disaster management plan for the whole country. There are also plans for effective long-term measures on economy, development and health strategies in order to prevent or mitigate climate change health effects. This will require a multidisciplinary approach and collaboration with other agencies like agricultural, meteorological, environmental and planning agencies. It is essential to see that adequate weight is given to health impacts due to climate change in Malaysia.

## Conclusion

The impact of climate change in Asia and Pacific region is not adequately documented. McMichael et al. (1996) have recommended that research, monitoring, and formulation of preventive options be pursued immediately as a global approach. Malaysia has undertaken measures to strengthen existing international health surveillance and monitoring systems and is also planning effective long-term measures on economic, development and health strategies in order to prevent or mitigate climate change. However, for these measures to be on target National Action Plans must be developed with stakeholders working in collaboration with the above government agencies, non-government organisations and the public.

## References


1. Air Quality Management Study for Kelang Valley Region. Final Report Vol: 2 Main Report. Japan International Cooperation Agency (JICA), 1993.
2. MOH Annual Report 1996, Ministry of Health Malaysia.
3. Anon. (1961). Typhoid traced to bathing at a polluted beach. Public Works, Sydney, Australia. 92:182.
4. Bouma, M.J., Sondorp, H.E. & van der Kaay, H.J. (1994). Climate change and periodic epidemic malaria. Lancet I, 1440.
5. Chiang, G.L., Loong, K.P., Chan, S.T., Eng, K.L. & Yap, H.H. (1991). Capture-recapture studies with *Anopheles maculatus* Theobald (Diptera: Culicidae) the vector of malaria in Peninsular Malaysia. Southeast Asian J Trop Med Pub Hlth 4: 643.
6. Craun, G.F. (1986). In: Craun G.F. ed. Waterborne Diseases in the United States. Boca Raton, Florida: CRC Press Inc., 4-10.
7. Fang, R., Hsu, D.R. and Lim, T.W. (1980). Investigation of a suspected outbreak of Japanese encephalitis on Pulau Langkawi. *Malaysian Journal of Pathology*. 3: 23-30.
8. Foo, L.C., Lim, T.W., Lee, H.L. and Fang, R. (1985) Rainfall, abundance of Aedes and dengue infection in Selangor, Malaysia. *Southeast Asian J. Trop. Med. Pub. Htlth.* 16: 560 -568.
9. Garin, D., Fuchs, F., Crance, J.M., Rouby, Y. Chapalain, P.C., Lamarque, D. Gounot, A.M., Aymard, M. (1994). Exposure to enteroviruses and hepatitis A virus among divers in environmental waters in France, first biological and serological survey on a controlled cohort. *Epidem. Inf.* 113: 541-549.
10. Global Fever – Climate Change threatens more than megastorms, floods and droughts, the real peril may be disease. Eugene Linden. Time Magazine, July 8, 1996 Volume148,No.3. Http://www.pathfinder.com/time/magazine/archive/1996/dom/960708/environmen4/9/98
11. Hamilton, A.C. (1989). The climate of the East Usambaras. In: "Forest Conservation in the East Usambaras", eds Hamilton, A.C. & Bensted-Smith, R., pp. 97-102. Gland: Switzerland: International Union for the Conservation of Nature.
12. Hii, J.L.K., Birley, M.H. & Sang, V.Y. (1990). Estimation of

survival rate and oviposition interval of *Anopheles balabacensis* mosquitoes from mark-recapture experiments in Sabah, Malaysia. Med Vet Entomol 4: 135.

13. Houghton, J.T., Meira Filho, L.G. et al. (1996). Climate change 1995. The science of climate change. Contribution of WGI to the second assessment report of IPCC. Cambridge University Press.

14. IPCC (1996a) Climate Change 1995. The Science of Climate Change. Contribution of Working Group I to the second assessment report of the Intergovernmental Panel on Climate Change. Houghton JT et al., Eds. Cambridge, New York, Cambridge University Press.

15. Kueh, C.S.W, Grohmann, G.S. Sheehan, D. the impact of stormwater and other urban runoffs on the microbiological quality of Sydney beaches. In: Proc. 14th Australian Water & Wastewater Assoc. Ann. Conf. 17-22 March, 1991. Perth: *J. AWWA*:356-364.

16. Mak, JW., Cheong, WH., Yen PKF., Lim PKC and Chan, WC. (1982). Studies on The epidemiology of sub-periodic *Brugia malayi* in Malaysia: problems in its Control. *Acta Tropica* 39:237.

17. McNeill, A.R. (1992) Recreational waters quality. In: Connell, D.W, Hawker, and D.W. ED. Pollution in Tropical Aquatic Systems. Boca Raton. CRC Press Inc.193 – 216.

18. MOH Report 1995, Ministry of Health Malaysia.

19. Mohamad Ismail Lasa (1996) – Impact of Haze on Asthma, Acute Respiratory Infection and Conjunctivitis in Klang Valley, 1994 – Specialty Symposium – Public Health (First MOH-AMM Scientific Meeting – 3rd Nobember 1996, Kuala Lumpur Hilton.

20. Nasser, A.M. (1994). Prevalence and fate of hepatitis A virus in water (Review). *Crit. Rev. Environ. Sci. Technol*. 24:281 – 323.

21. Payment P, Franco E, and Tout, G.S. (1994). Incidence of Norwalk virus infection during a prospective epidemiological study of drinking water related gastrointestinal illness. *Can. J. Micobiol*. 40: 805-809.

22. Pillay, M. (1994). Water Quality – Problems and solutions. Report – Engineering Services Division, Ministry of Health, September 1997.

23. Potential Health effects of climate change. Report of a World Health Task Force. World Health Organisation 1990a. Http://www.ciesin.org/docs/001-007/001-007.html.

24. Vector borne Disease Control Programme, (VBDCP) Ministry of Health Malaysia, 1993.

25. WHO 1990b – Potential health effects of climate change: report of a WHO task group. Geneva, WHO (unpublished document WHO/PEP/10.10).

26. WHO Task Group, 1996 – Climate Change and Human Health. As assessment prepared by the Task Group on behalf of the World Health Organization, the World Meteorological Organization and the United Nations Environment Programme. Ed. MaMichael, A.J., Haines, A. Sloof, R. and Kovats, S. WHO, Geneva 1996.

27. World Bank, 1993. World Development Report 1993, Oxford University Press, N.Y.

28. Mogi, M., Choochote, W., Khamboonruang, C. & Suwanpanit, P. (1990) Applicability of presence-absence and sequential sampling for ovitrap surveillance of *Aedes* (Diptera: Culicidae) in Chiang Mai, Northern Thailand. Journal of Medical Entomology 27: 509-514.

29. Air Quality Management Study for Kelang Valley Region. Final Report Vol: 2 Main Report. Japan International Cooperation Agency (JICA), 1993.

30. MOH Annual Report 1996, Ministry of Health Malaysia.

31. Anon. (1961). Typhoid traced to bathing at a polluted beach. Public Works, Sydney, Australia. 92:182.

32. Bouma, M.J., Sondorp, H.E. & van der Kaay, H.J. (1994). Climate change and periodic epidemic malaria. Lancet I, 1440.

33. Chiang, G.L., Loong, K.P., Chan, S.T., Eng, K.L. & Yap, H.H. (1991). Capture-recapture studies with *Anopheles maculatus* Theobald (Diptera: Culicidae) the vector of malaria in Peninsular Malaysia. Southeast Asian J Trop Med Pub Hlth 4: 643.

34. Craun, G.F. (1986). In: Craun G.F. ed. Waterborne Diseases in the United States. Boca Raton, Florida: CRC Press Inc., 4 – 10

35. Foo, L.C., Lim, T.W., Lee, H.L. and Fang, R. (1985) Rainfall, abundance of Aedes and dengue infection in Selangor, Malaysia. *Southeast Asian J. Trop. Med. Pub. Htlth.* 16: 560 – 568.

36. Garin, D., Fuchs, F., Crance, J.M., Rouby, Y. Chapalain, P.C., Lamarque, D. Gounot, A.M., Aymard, M. (1994). Exposure to enteroviruses and hepatitis A virus among divers in environmental waters in France, first biological and serological survey on a controlled cohort. *Epidem. Inf.* 113: 541 – 549.

37. Hamilton, A.C. (1989). The climate of the East Usambaras. In: "Forest Conservation in the East Usambaras", eds Hamilton, A.C. & Bensted-Smith, R., pp. 97 – 102. Gland: Switzerland: International Union for the Conservation of Nature.

38. Hii, J.L.K., Birley, M.H. & Sang, V.Y. (1990). Estimation of survival rate and oviposition interval of *Anopheles balabacensis* mosquitoes from mark-recapture experiments in Sabah, Malaysia. Med Vet Entomol 4: 135.

39. Houghton, J.T., Meira Filho, L.G. et al. (1996). Climate change 1995. The science of climate change. Contribution of WGI to the second assessment report of IPCC. Cambridge University Press.

40. IPCC (1996a) Climate Change 1995. The Science of Climate Change. Contribution of Working Group I to the second assessment report of the Intergovernmental Panel on Climate Change. Houghton JT et al., Eds. Cambridge, New York, Cambridge University Press.

41. Kueh, C.S.W, Grohmann, G.S. Sheehan, D. the impact of stormwater and other urban runoffs on the microbiological quality of Sydney beaches. In: Proc. 14th Australian Water & Wastewater Assoc. Ann. Conf. 17 – 22 March, 1991. Perth: *J. AWWA*:356 – 364.

42. Lee, H.L. (1998). Comparative field evaluation of deltamethrin and DDT for malaria control in Peninsular Malaysia-midterm review. 5 pages.

43. Lee, H.L. (1999). Comparative field evaluation of deltamethrin and DDT for malaria control in Peninsular Malaysia-final report. 6 pages

44. Mak, JW., Cheong, WH., Yen PKF., Lim PKC and Chan, WC. (1982). Studies on The epidemiology of sub-periodic *Brugia malayi* in Malaysia: problems in its Control. *Acta Tropica* 39:237.

45. McNeill, A.R. (1992) Recreational waters quality. In: Connell, D.W, Hawker, and D.W. ED. Pollution in Tropical Aquatic Systems. Boca Raton. CRC Press Inc.193 – 216.

46. MOH Report 1995, Ministry of Health Malaysia.

47. Mohamad Ismail Lasa (1996) – Impact of Haze on Asthma, Acute Respiratory Infection and Conjunctivitis in Klang Valley, 1994 – Specialty Symposium – Public Health (First MOH-AMM Scientific Meeting – 3rd Nobember 1996, Kuala Lumpur Hilton.

48. Nasser, A.M. (1994). Prevalence and fate of hepatitis A virus in water (Review). *Crit. Rev. Environ. Sci. Technol*. 24:281 – 323.

49. Payment P, Franco E, and Tout, G.S. (1994). Incidence of Norwalk virus infection during a prospective epidemiological study of drinking water related gastrointestinal illness. *Can. J. Micobiol*. 40: 805-809.

50. Peter J. Peterson. (1997). Indicators of sustainable development in industrialising Countries – from concepts to actions. LESTARI Vol 2. Institute for Environment and Development, University Kebangsaan Malaysia.

51. Pillay, M. (1994). Water Quality – Problems and solutions. Report – Engineering Services Division, Ministry of Health, September 1997.

52. Sandosham, A.A. & Thomas, V. (1982). Malariology with special reference to Malaysia. Singapore University Press 382 pages.

53. Sastry, C.A. (1994). Waste water and Health. First National Conference on Environmental Health Research – State of the Art in Malaysia Today. 19 – 21 April 1994. Vol. 2; 268-287. Proceedings. Ministry of Health Malaysia.

54. Vector borne Disease Control Programme, (VBDCP) Ministry of Health Malaysia, 1993.

55. WHO 1990b – Potential health effects of climate change: report of a WHO task group. Geneva, WHO (unpublished document WHO/PEP/10.10).

56. WHO Task Group, 1996 – Climate Change and Human Health. As assessment prepared by the Task Group on behalf of the World Health Organization, the World Meteorological Organization and the United Nations Environment Programme. Ed. MaMichael, A.J., Haines, A. Sloof, R. and Kovats, S. WHO, Geneva 1996.

57. World Bank, 1993. World Development Report 1993, Oxford University Press, N.Y.

58. Gerrard, D.J. & Chiang, H.C. (1970). Density estimation of corn rootworm egg Populations based upon frequency of occurrence. Ecology 51: 237-245.

59. Mogi, M., Choochote, W., Khamboonruang, C. & Suwanpanit, P. (1990) Applicability of presence-absence and sequential sampling for ovitrap surveillance of *Aedes* (Diptera: Culicidae) in Chiang Mai, Northern Thailand. Journal of Medical Entomology 27: 509 – 514.

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# Strategic Directions in Research:
## Trials, tribulations, and Successes in Linking Research and Change

Stephen Ambu[ii] and Zina O'Leary[i]

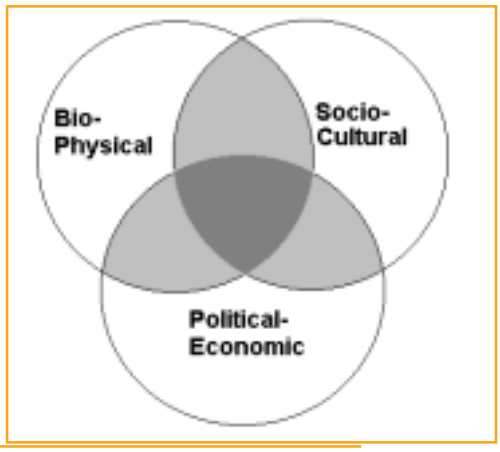
**Abstract**

Research in the area of Environmental Health relies on a wide variety of disciplines. In order to effect meaningful change it must find ways to harness the findings of multi-disciplinary science, and then use these findings to manage interactions within complex natural and man made systems. This involves a broad conception of research that goes beyond the empiricist paradigm and has traditionally faced difficulty attracting prestige, international reputability and National Government / International funding. This paper reports on an instrumental case study of an environmental health research centre in Kuala Lumpur, Malaysia (The EHRC). The EHRC was chosen as an exemplary case in that it is a research centre that has struggled with the issue of legitimization of diversified research approaches with an explicit agenda to drive change, and has in fact, successfully used an action research approach to develop a research framework for the Centre that legitimizes its agenda and multidisciplinary focus. The framework helps situate a broad range of appropriate methodologies; and allows for active engagement in the change process. The centre has been successful in not only articulating this paradigmatic shift, but in getting government and industry support for new approaches that link research and change. The implications of this case study can be seen as liberating for research centers in applied science areas that value a range of research traditions: from the quantitative to qualitative; from laboratory to community based approaches; from the production of knowledge to implementation of change.

**Rationale**

As the complexity of the postmodern world gains greater recognition in Applied Science fields, there is a growing recognition for the need to remove paradigmatic boundaries from conceptualizations of research that have permeated both the theory of science, and the application of that science. Research in the area of Environmental Health for example, must necessarily draw from disciplines such as public health, epidemiology, biology, chemistry, toxicology, and community development in ways that work with whole systems (Nicholson 2002). In order to effect meaningful change it must find ways to harness the findings of multi-disciplinary science, and then use these findings to manage interactions within complex natural and man made systems (Brown 2001, MacArthur 2000). For research centres dealing in the environmental health area, research and practice need to occur not only in the discrete realms of the bio-physical, socio-cultural, and political-economic, but also at the intersection of these arenas.

**Figure 1.** Discrete and Intersecting arenas of Environmental Health Research and Practice

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Research in the sciences, however, has been traditionally conceived of as the production of knowledge. Basic social research has as its focus the desire to understand the social world; satisfy theoretical interests, and is produced for an audience of peers within a scientific discipline. Application is not generally a high priority (Singleton and Strait, 1999).

In the applied science arena, however, the goals / objectives of research is to provide information for an immediate change oriented purpose. It seeks to provide solutions and strategies in a real world setting. The audiences can be academic, but it can also be an awaiting community, government agency, client or a profession (Rossi and Freeman, 1993). This type of research seeks to disseminate results widely an in accessible language, and uses a variety of research techniques in the field (Bickman and Rog, 1998).

The roles of the applied science research centre working in an acknowledged cross-disciplinary field can be even more complex. The goals of the centre itself may be to bridge the divide between research and action - between rigorous science and change. Goals of such centres may include designing and implementing collaborative action in a bid to reflexively review practice with sustained and explicit examination of decisions, relationships, the knowledge base used for decisions, and the learning that can be derived for action. There is a recognised desire to transform both theory and practice and is likely to rely on local knowledge (Chambers, 1997). Detailed stories of particular cases can be seen to test the validity of general laws (Punch 1998). The audience can be scientific, but is as likely to be collaborators and general stakeholders. This methodological approach to research and change sees processes, outcomes and applications of results inextricably linked (Greenwood and Levin, 1998).

The dilemma is thus the legitimization of broader conceptions of research necessary for the field of environmental health that can attract prestige, international reputability and National Government / International funding for a range of activities not traditionally afforded to research not born of positivist and empiricist schools of thought.

**Methodology**

This paper reports on an instrumental case study of an environmental health research centre in Kuala Lumpur, Malaysia (The EHRC) that has attempted to articulate a new framework for research that stretches the paradigmatic boundaries of research itself. The EHRC case was chosen as an exemplary case in that it is a research centre that has struggled with the issue of legitimization of diversified research approaches with an explicit agenda to drive change, and has in fact been successful in using an action research approach to develop a research framework for the Centre that legitimizes its agenda and multidisciplinary focus.

The authors of this paper have in fact been intimately involved with the development of the Centre and its research framework through the first author's role as WHO consultant and the second author's role as Centre Director. Over the past five years the authors have engaged in a reflexive action research process that has included, structured and unstructured, formal and informal interviews, and a number of focus groups that has led to an ongoing learning cycle. The authors have drawn on the methods of that action research process, and have complemented these methods with additional document analysis, focus groups and interviews to present the case study.

## The EHRC

**Background**

In April 1994, the Malaysian Ministries of Health (MOH) and Science, Technology and the Environment (MOSTE) jointly sponsored the "First National Conference on Environmental Health Research - State of the Art in Malaysia Today". The Institute for Medical Research (IMR) served as the Secretariat for this conference. It recommended that an Environmental Health Research Centre be established, and coordinated a task force to shape the development proposal. Cabinet approved the proposal in 1995, and the Director General for Health chose the IMR as the base to establish the centre. In September 1996, The Medical Ecology Unit, which had long been in the Service Division of IMR, was redesignated as the Environmental Health Research Centre.

EHRC's brief was exceedingly broad and intersectoral. The vision for the EHRC was articulated as follows:

> To equip Malaysia to be a steering force
> to promote change in managing the environment
> for health in the Asia Pacific.

**The Challenge**

The challenge for the IMR was to build the former Medical Ecology Unit, whose work was predominately based in the discrete disciplinary realm of the bio-physical, into an inter and cross disciplinary research

team whose brief included the socio-cultural and political-economic as well as the bio-physical. Further, in order to 'act as a steering force to drive change' as stated in the vision statement, the EHRC also needed to establish management and development skills.

The vision of the EHRC required research staff to engage in a major paradigm shift that involved an engagement in integrative and diverse methodologies that were grounded in the principals of ecologically sustainable development and primary health care. This research work then needed to be directed towards change. Holistic research not directed towards change was seen to be too 'academic'. The EHRC was to act as a clearing house or disseminating point for EH research, and as a force that could drive policy decisions in both Malaysia and Asia in general.

EHRC staff needed to be able to explore a multiplicity of strategies to research and change: both immediate and long term; policy as well as practice; working with community as well as government; reactive and proactive styles, thinking locally and globally, directive and facilitative change. In short, the EHRC needed to become a learning organisation capable of driving real change in Asia through research.

Many of these concepts were quite new to IMR, and required different intellectual tools to those of traditional disciplinary science. It required holistic thinking, and interdisciplinary teamwork in mutual collaboration with stakeholders. It entails a very different way of looking at the world, usingdifferent methods and less conventional intellectual tools.

While the paradigmatic shifts necessary for the development of the EHRC have been occurring within this institution over the past four years, a lingering difficulty for the Centre has been its ability to capture the scope and range its research for external acknowledgement. The ERHC's research brief now includes traditional scientific disciplinary areas in the bio-physical, research into governance and policy; and explorations within the community.

The consequent research methodologies mirror this diversity. The EHRC's methodological approaches include lab based classic scientific method, social science methodologies such as interviewing and surveying, action research strategies that investigate, develop, and implement change, as well as evaluation research. The EHRC, therefore, needed a framework that could capture both this disciplinary and methodological diversity, while keeping 'research for change' as a central tenant of all activities.

**Developing a Research Framework**

In 1995, the EHRC embarked on a Strategic Planning process using the ACDB (Ireland, 1994) model in order to initiate its own change process from its original focus on medical ecology into the arena of environmental health, with an explicit agenda to drive and support change in the region.

The ACDB Model (figure 2) helps formulate five distinct strategies for change:

A. Where are we now: Explores the situation, complication, and focusing question
B. Where do we want to be: Explores the 'vision' for change
C. How do we begin to move step by step: Realistic planning for change
D. Who else must act – what else must happen: Involving all relevant stakeholders
E. How will we know when it is working: Auditing and evaluation

The model in totality defines an action plan complete with background, rationale and potential stakeholder involvement. The EHRC had great success with the ACDB change model at the organizational level, and decided to begin to explore their research in terms of the components of the ACDB.

**Researching A: Where Are We Now**

Under A, the EHRC began to explore its potential to benchmarking and the collection of baseline data as one of it's core research objectives. There was recognition of a need for Malaysia to assess the state of environmental health at all levels from local districts to international regions. From the health of the water systems to understanding the issues in the development of healthy workplaces, the need to collect rigorous and valid baseline data was recognized. Understanding the current landscape is seen as a first order need in the development of effective research driven change initiatives. Traditional science and social science research was seen as an important strategy for supporting change. At level A, the EHRC could provide the nation/ region with 'objective scientific' research to identify problem areas in environmental health.

The EHRC's first five-year cycle (1997-2001) saw the development of a baseline environmental health data in a number of areas. Assessing the health impacts of: various

parasites; air pollution, particularly haze; herbicides; pesticides; water pollution, as well as having conducted a number of epidemiological studies has left Malaysia better equipped to answer the question: Where are we now – in relation to the state of environmental health in Malaysia.

### Researching *B*: Where Do We Want To Be

Researching under Level B allowed for a more qualitative research approach to exploring and creating goals and visions. The EHRC recognized that many of the strategies for change in environmental health used in Malaysia have been imposed, top down, legislative strategies made by policy makers. The EHRC wanted to understand perspectives of environmental health from a variety of stakeholder positions. Using collaborative and participative approaches, this level of research, allowed the EHRC to ask the question of themselves, government, workers, communities and families: where do we want to be. It involves, for example, working 'with' communities, not just 'on' or 'for' communities. It involves a deeper level of participation and collaboration that gives a voice to stakeholders who often lack power in decision making.

The EHRC believes that a focus on development at the community level could become a potential approach to provide an alternative way for meeting human needs and managing their interactions with the environment. Working with the community as the core component of local knowledge in sustainability could provide a possible partner to the dominant scientific studies in sustainable development. With a better understanding of the community, it could provide an insight on how they could be supported to facilitate their actions towards sustainability. The EHRC is currently attempting to identify an alternative approach in managing the environment for health starting from local knowledge and experiences working together with the communities in their natural settings.

### Researching *C*: How Do We Begin to Move Step By Step

At this level the EHRC began to look at the potential for moving from research to action. One of the new paradigmatic dilemmas for the EHRC is the need to work at the nexus of research and change. The EHRC has clearly articulated that its research is not for information or a knowledge base alone. The findings produced are to be clearly linked to change initiatives and policy development. This has created two needs. The first is for the EHRC to be strategic in making explicit how its research outcomes will be linked to implementation. The Centre needs to work closely with collaborators and external agencies, so that research results are not only disseminated, but are in fact acted upon. The second need is for the EHRC to begin exploring change itself as a topic of research. Questions such as, how evidence can lead to policy development and how can awareness lead to action, are being addressed as the EHRC undertakes researching the question of how to begin to move.

### Researching *D*: Who Else Must Act

The D of the model allows for two distinct strategies for collaboration: response based and collaborative research. The first strategy allows the EHRC to be a partner in the initiatives of stakeholders in government, private and community sectors. Others who need 'research' into particular specialist arenas of environmental health can call on the expertise of the EHRC. This would include Government calls to contract research in response to crisis. In other words, the EHRC engages in response based research. In the past five years the EHRC has been called on to monitor air and water quality for the Commonwealth games, conduct a number of environmental impact assessments, and most recently, respond to the Nipah virus crisis.

The second strategy puts focus on the range of potential stakeholders and collaborators with whom the EHRC has begun to establish links. Research and change initiatives reliant upon the expertise not available from within the EHRC are thus readily engaged. The EHRC can also work in partnership sharing their own expertise, therefore building capacity within various stakeholder groups. Finally, through collaborative networks, the EHRC is well placed to link with outside implementation arms, ensuring that the research in which they engage, supports the development of action plans that will be carried out for Malaysia's benefit.

In the past five years the EHRC has established linkages with a variety of collaborators.

**Networking Within Health**

IMR Interdivisional collaborators
Public Health Institute
Engineering Services
Food Quality Control Division
Environmental Health Unit
Occupational Health and Safety Unit

**Networking Government Agencies Outside Health**

Chemistry Department
Veterinary Department
Meteorological Department
Ministry of Agriculture
Ministry of Science, Technology and Environment
Economic Planning UnitDepartment of Occ. Health and Safety
Several Malaysian Universities (UPM, UKM, UM, USM)
Department of Environment
Local Government

**Networking with Non-Government Organisations**

Institute of strategies and International Studies (ISIS)
Environmental Consulting Firms (ASMA, TNB, MINCONSULT & GMP)

**International Networking**

World Health Organization
Fiji School of Medicine
University of Western Sydney
Centre for Disease Control, Atlanta GA
University of New South Wales
University of Columbia, Ontario
New South Wales Health Department

## Researching *E* : How Will we Know When it is Working

The *E* of the framework allows for evaluation research. Given the focus on change as a goal of EHRC's research, this particular stream of research attempts to assess the success of various change initiatives including: organizational and government policy, legislative and regulatory initiatives, community and NGO based initiatives. As the EHRC begins to work through a cycle of baseline data collection, visioning and action plan development and implementation, the need for rigorous evaluation of various change initiatives will become of increasing importance. The EHRC is dedicated to both sharing the lessons learned in various programs of their own undertaking, as well as offering rigorous evaluation services to other organizations wishing to explore the depth of change their programs have been able to bring about. Generalising lessons learned so that successful initiatives can be expanded into similar arenas is of core importance.

## Using AcdB for Designing Action Research

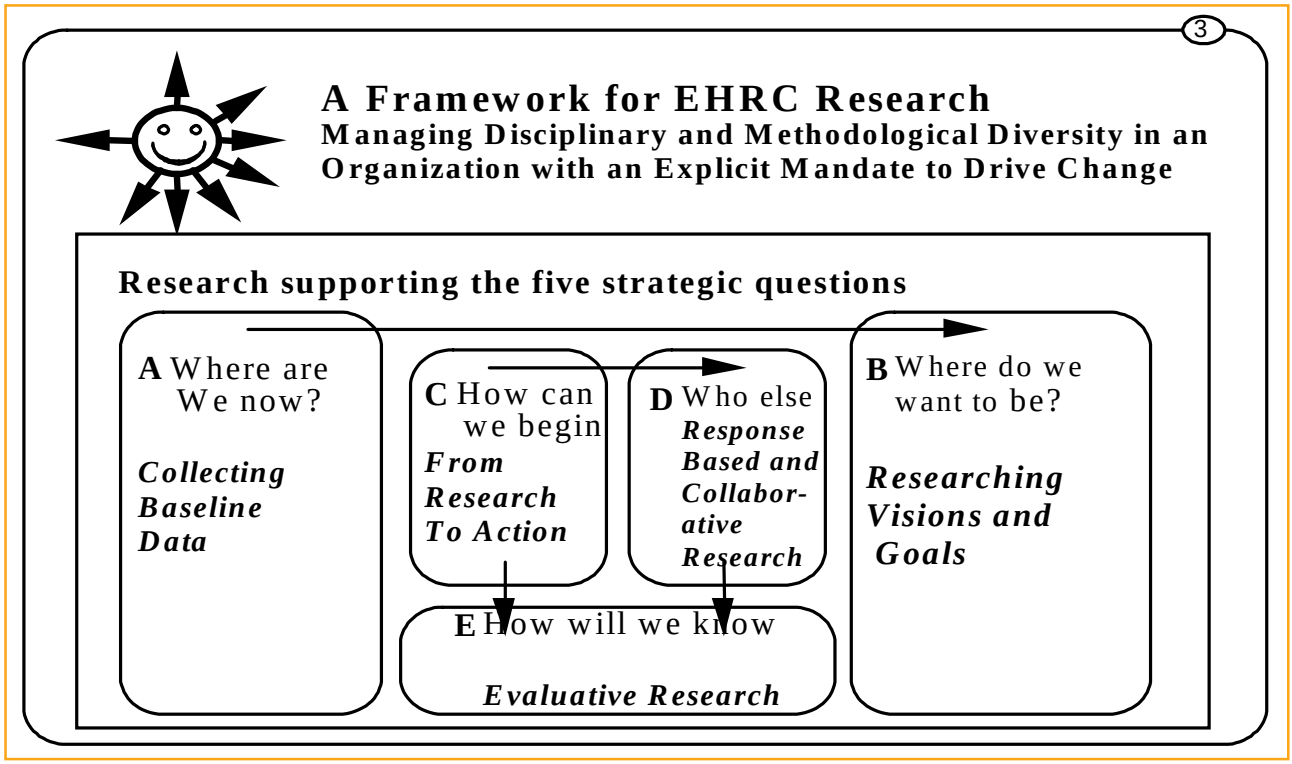
In addition to research within discrete arenas of the AcDB model, the EHRC has also begun to use this framework as a way of designing holistic and integrative action research methodologies. The EHRC is now engaging in action research that begins at situation assessment, leads to visioning, develops and implements appropriate change initiatives involved with appropriate stakeholders at all stages, and then evaluates the success of those recommended initiatives. In this case the EHRC both initiates change and researches the process of change itself.

As the EHRC enters its second five year cycle, expanded collaborative networks, increased capacity building in integrated methodologies, and greater levels of experience in change management will see this realm of research expand in the EHRC's profile.

## Conclusion

Over the past five years the EHRC has engaged in a process of organizational growth and change that involves working in and researching the intersectoral and cross disciplinary nature of environmental health, while attempting to keep change as a primary goal of its research. In doing so, it has adopted a modified AcBD framework that helps situate a broad range of appropriate methodologies; and allows for active engagement in the change process. The centre has been successful in not only articulating this paradigmatic shift but in getting government and industry support for new approaches that link the research and change nexus.

**Figure 2.** The ACDB Model




The implications of this case study can be seen as liberating for research centers in applied science areas that are dedicated to change. Rather than be limited in research approach, or be questioned over legitimacy of certain types of research being appropriate core business of a research center, this center has offered a framework that articulates a strategic direction for multidisciplinary research that transcends paradigmatic boundaries. It values a range of

## References

1. Bickman, L. and D. Rog, 1998, *Handbook of Applied Social Research Methods*, Sage: Thousand Oaks

2. Brown, V. A. 2001, 'Monitoring Changing Environments in Environmental Health', *Environmental Health*, vol 1, no 1, pp. 21-34.

3. Chambers, R., 1997, *Whose Reality Counts? Putting the First Last*. Intermediate Technology Publications: London.

4. Greenwood and Levin, 1998, *Introduction to Action Research*, Sage: Thousand Oaks.

5. MacArthur, I. D., 2000, *Local Environmental Health Planning: Guidance for Local and National Authorities*, WHO/Euro, Department for International Development and the Chartered Institute of Environmental Health, London.

6. Nicholson, R., 2002, 'Environmental Health Practice: For today and for Tomorrow'. *Environmental Health*, vol 1, no3, pp. 73-84.

7. Punch, K. 1998, *Introduction to Social Research*, Sage: London.

8. Rossi, P. and H. Freeman, 1993, *Evaluation: A systematic Approach.* Sage: Newbury Park.

9. Singleton, R. and B. Straits, 1999, *Approaches to Social Research,* Oxford: New York.

# Shaping NEHAP

## National Environmental Health Action Planning

# Shaping of the National Environmental Health Action Plan (NEHAP) for Malaysia

S.Pillay[i], Mohd. Nazeri b. Salleh[iii] and Zaman Huri b. Zulkifli[iii]

**Abstract**

Environmental Health activities in Malaysia were carried out by various agencies. The protection of environmental health is done through enforcement and implementation of various laws, regulations, specific programmes and other administrative measures. Due to fragmentation of responsibility across a large group of agencies there is a need to be brought together and common goals and aspirations developed. A national agenda is needed to plan, allocate resources, carry out activities and to realize the goals and outcome. This national plan called the National Environmental Health Action Plan (NEHAP) is a critical tool that will aid in development of sound policies and strategies towards enhancing environmental health status in Malaysia. The shaping of NEHAP is done through shaping of all related components in environmental health management such as environmental health policy, practice, research and participation of communities.

**Keywords**

Environmental health, policy, practice, research, communities

**Introduction**

Environmental health is a subject that is multi-disciplinary requiring a multi-agency approach. Both environment and health are inter-related and should always be discussed together. Agents in the environment can cause health problems to humans and the behavior of humans can cause damage to the environment. According to WHO, 1993, environmental health was defined as follows:

*" Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations."*

Environmental health is the science of protecting human health from the damaging effects of physical, chemical and biological agents in the environment. This science strives to identify harmful agents, determining exposures, relating to deteriorating health conditions and to develop sound principles, strategies, programs and approaches to eliminate or minimize health risks. The environmental hazards and risk factors relationship in environment is shown in **Figure 1**. Environmental health combines disciplines in environmental sciences and health sciences together with management sciences to create a healthy environment.

Environmental health is a relatively new discipline, which is growing in importance. It is particularly attracting attention due to its multi-disciplinary character and approaches and the successes achieved through cooperative initiatives. Key players have to be brought together and common goals and aspirations developed. In Malaysia, among key players or agencies involved with environmental health activities are summarised in **Table 1**. A national agenda is needed to plan, allocate resources, carry out activities and to realize the goals and outcome. This national plan called the National

Environmental Health Action Plan (NEHAP) is a critical tool that will aid in development of sound policies and strategies towards enhancing environmental health status in Malaysia. The shaping of NEHAP is done through shaping of all related components in environmental health management such as environmental health policy, practice, research and participation of communities.

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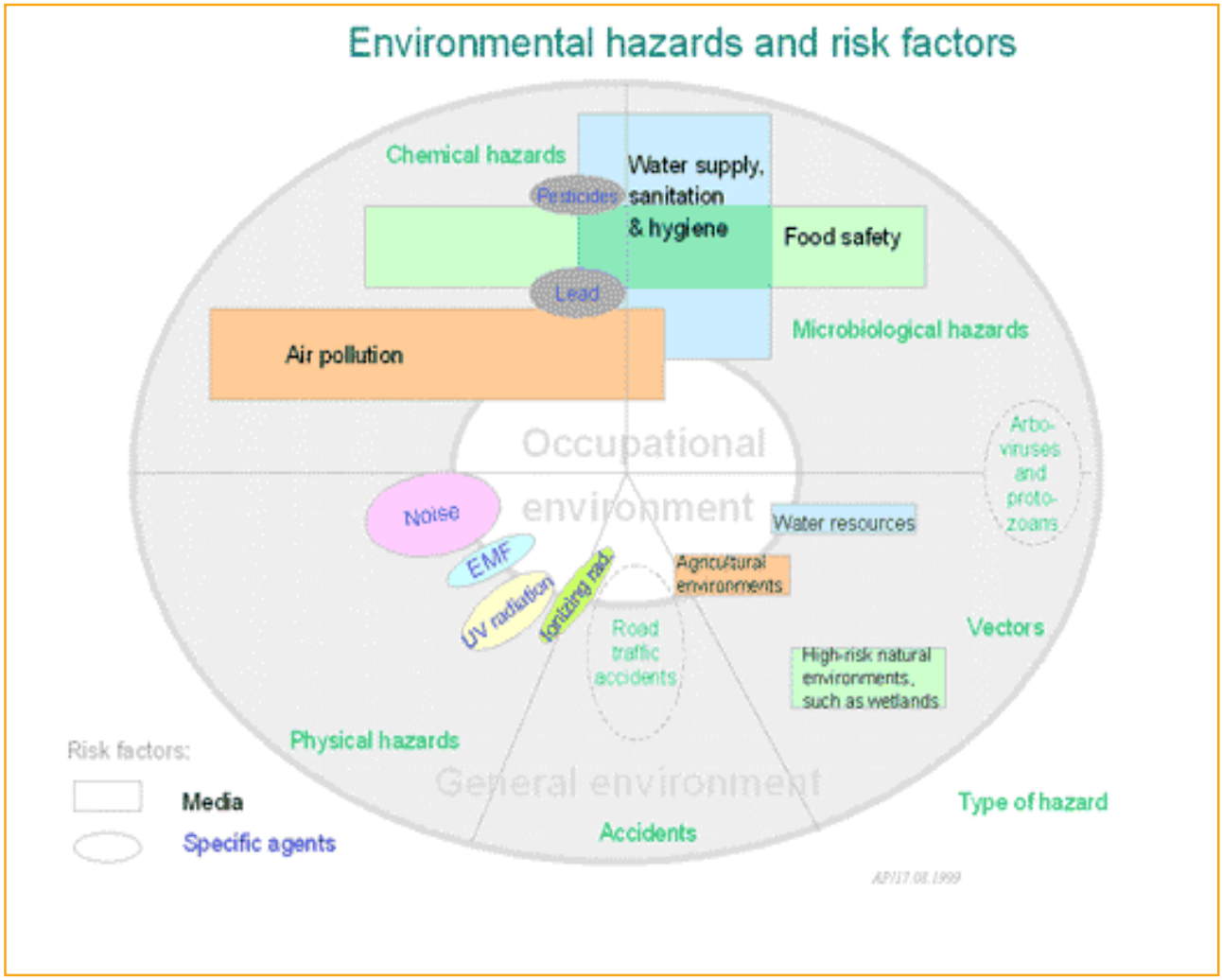
**Figure 1: Environmental hazards and risk factors relationship**




**Source: WHO**

**Table 1. Responsibility and Functional Delineation of Environmental Health Activity**

| Activity | Agency responsible | Agency executing |
|---|---|---|
| Solid waste management | Local authority | Local authority with advise from MH&LG |
| Sewerage | Sewerage Department | Sewerage Department |
| Water supply/Drinking water quality | Water authority Water Works Depts. Public Works Dept. | Water authority Drinking water quality surveillance by MOH |
| Toxic and hazardous waste | Dept. of Environment | Local authority Dept. of Environment |
| Air pollution | Dept. of Environment | Dept. of Environment |
| Occupational Health | Dept. of Occupational & Safety Ministry of Health | Dept. of Occupational & Safety, Ministry of Health |
| Industrial Waste | Local authority Dept. of Environment | Local authority Dept. of Environment |
| Food Sanitation | Local authority Ministry of Health | Local authority Ministry of Health |
| Urban drainage | Local authority | Local authority Advise from D.I.D |
| Building safety and sanitation | Local authority | Local authority (Uniform Building By-Laws) |

Source: Adapted from Pillay, (1994)

## APPROACH TO SHAPING NEHAP

### Shaping EH Policy

Malaysian society is increasingly urbanised, more populous and more complex. To support this situation we have increased air, water and soil contamination, persistent chemical pollutants have become widespread, and global climate change presents new environmental health hazards. These factors contributing to respiratory and cardiovascular diseases, physiological and neurological disorders, and increased incidences of a range of cancers. With these situations it is necessary for Malaysia to formulate and established the environmental health policy for planning, control and mitigate the emerging health impacts from existing and new environmental health hazards.

As mentioned before, in Malaysia, environmental health activities were carried out by various agencies under different ministries (Table 1). These agencies have played major role in protection of environmental health through enforcement and implementation of various laws, regulations, specific programmes and other administrative measures. Currently, there are over 40 environment-related legislation in Malaysia, some of which are under the purview of the State Governments while others are either under the purview of Federal Government or concurrent responsibility of both the federal and State Governments (Pillay, 94).

As mentioned above, it show that environmental health activities in Malaysia requires a clear direction, more organised and integrated approach towards improving human health. In other word, a policy on environmental health need to be formulated so that all stakeholders have clear direction in the implementation of environmental health programs in their respective agencies. Through this policy, the objectives and strategies in implementing the environmental health programs will be clearly addressed. This policy will complement the National Policy on Environment that is already in place.

### Shaping EH Practice

The affect of physical, biological, chemical, social and psychosocial factors in the environment to human health dependent on our capacity to prevent and manage those factors. The environmental health practitioners must understand the best practice available to them in order to

have good health outcomes. These practices can be achieved, for examples through improving legislative instruments, national standards, risk assessment etc.

In Malaysia, environmental impact assessment (EIA) is a powerful tool that is used in the planning of development projects that have environmental consequences. However, very little attention has been given to the health components in the EIA process. It is critical therefore to monitor and evaluate all major activities including environmental resources and conditions and the health consequences that can result from development projects. This aspect which is referred to as environmental health impact assessment (EHIA) often only takes secondary importance to the more established process of EIA. Therefore a detail risk assessment on the health consequences is need to be incorporated in the EIA to any development projects so that all positive and negative health outcomes will be properly addressed and controlled.

In Malaysia many laws and regulations have been enacted to control the various environmental health concerns. Currently, there are over 40 environment-related legislation in Malaysia. But from the survey, it can be seen that laws are still lacking to comprehensively control environmental health issues. Therefore it is essential to review all related laws and regulations to incorporate current environmental health issues.

The healthy setting approach introduced by WHO is another best practice in order to have good health outcomes. According to WHO, the healthy setting approach is a cooperative approach to improving environments for health by encouraging greater community involvement and greater cooperation between different sectors of the community, industry, and government. The aim is to create settings that offer living and working conditions that are safe, stimulating and enjoyable for everyone. This embodies promotion of social justice and sustainable development to benefit all members of the community, not only for the present but also for future generations.

## Shaping EH in Communities

Community is one of the important stakeholders beside government, industry and academia in environmental health management. The implementation and development of environmental health policies requires the involvement of the community. In particular, the community must be provided with appropriate information and be given the opportunity to participate at all levels of policy development and decision making.

The protection of environmental health cannot be effectively carried out by the government alone. With the wide scope of environmental, the task of environment health protection requires input from people of all sectors including the public at large, the NGOs and especially the mass media which have important roles as information providers; educators and as a watch-dog for the public. In other words, success in environmental health protection requires the total commitment and teamwork from every Malaysian.

The are three key strategic areas which can enable the community to become involved in environmental health issues as underlined by Australia National Environmental Health Strategy:

- A health promotion approach
- Development of infrastructure which enables communities participation
- Provision of information and development of appropriate skills

## Shaping EH Research

The relationship between human health and the environment is evidently highly complex. Each of the traditional and modern hazards is associated with a variety of aspects of economic and social development. According to WHO, rational in management of environmental health is often hampered by gaps in our knowledge of how the environment effect health. Among the gaps are:

- How environmental factors relate quantitatively to health effects
- How demographic factors of our population correspond to environmental factors and to what extend
- The effect of multiple environmental factors that may interact with each other and with other factors (for example, lifestyles, socioeconomic factors), which themselves mat contribute to the causation of the same diseases.

The respond to the above issues, well-planned and systematic evidence-base researches are required.

Government research is mostly used to evaluate programs and management options for specific environmental health issues. However, much of the information obtained from

this research remains largely untapped. In particular, the investigation and management of issues at institutes of higher learning, Department of Environment (DOE) and consultant are under-utilised. Research from all sources needs to fostered and actively used in evidence-based decision making in environmental health.

Much other research, which is non-health disciplines such as urban planning, engineering includes many topics relevant to environmental health management. However this research is geared towards the perspective of specific disciplines, there is often insufficient attention paid to the health impact to particular issues. As such MOH must work with non-health disciplines to ensure that relevant research is integrated into the evidence base for environmental health decisions.

Environmental health research in Malaysia must also be strong linked to international research in order to benefit from work conducted overseas, and should contribute to the international research effort on both local and global problems.
In addition, in order to strengthen and support evidence-based decision-making, dissemination of research findings is essential.

## Conclusion

The NEHAP for Malaysia is an important initiative that will determine the future health status of the population. It is crucial therefore that all stakeholders play their part in the development of the NEHAP for the country. The NEHAP once developed should not be a static document but must be dynamic in nature and continuously evolve to take care of unexpected changes in the future. The success of the plan is in its implementation resulting in the realization of expected outcomes.

## References

1. Pillay, M.S., Environmental Health is our Responsibility, unpublished paper presented at theMedia Seminar on Health, Hotel Merlin, Kuantan, 22-24 August 1994

2. Pillay, M.S., Ong Sian, Debbie Siru, Environmental Health Impact Assessment, Persidangan Kajian Semula Rancangan Malaysia Keenam (RM6) Kearah Penyediaan Rancangan Malaysia Ke tujuh (RM7), 18-20 Oct. 1993, Hotel Ming Court, Kuala Lumpur.

3. Kee, L.W., Environmental Health Towards 2020, Persidangan Pengarah-Pengarah Kementerian Kesihatan Malaysia di Genting Highland (30 May – 1 Jun 1991)

4. The National Environmental Health Strategy, Commonwealth of Australia 1999.

5. National Policy on the Environment, Ministry of Science, Technology and the Environment, Malaysia (2002)

6. http://www.who.int/peh/burden/burdenindex.htm

Neighbours

Case Studies: successes and failures analysed

# Integrating Plans, Practice and Place in Fiji

## *Settings approaches to National Environmental Health Planning*

B.J. Powis, Z. O'Leary and N. Litidamu

This paper will briefly describe how 'healthy settings' were incorporated into the development of the Fiji's National Environmental Health Action Plan (NEHAP). It draws from the experiences of Environmental Health practitioners, with integrating settings into the planning and practice of 'Healthy Islands' and 'Healthy Cities'.

### Healthy Islands and Environmental Health

Healthy Islands arose in a conference of the Ministers of Health of the Pacific Island countries in Fiji in March 1995. The Yanuca Island Declaration on Health in the Pacific in the 21st Century adopted the concept of 'Healthy Islands' as its unifying theme. This reflected a desire to seek Pacific solutions to Pacific problems, and achieve this through broad based participation. The Declaration opens with these words:

"Healthy islands should be places where:
- children are nurtured in body and mind;
- environments invite learning and leisure;
- people work and age with dignity;
- ecological balance is a source of pride."

In relation to environmental health the Declaration called for a range of environmental health initiatives:
- "encourage governments to designate a focal point to design with an appropriate mandate and sufficient authority to design and implement the activities which follow from this agreement ;
- participate in designing a common protocol for developing national action plans and delineating these activities;
- develop national action plans which align with the unique health and environmental needs of each country jointly identify factors which adversely influence environmental health;
- share information concerning effective policies, legislation, intersectorial actions and other enabling strategies to promote health and protect the environment;
- to identify innovative approaches, such as the healthy islands concept, and promote their application;
- collaborate in building capacity at all levels to develop and manage environmental health programmes and activities;
- grant new status to environmental health professionals in government services;
- formulate performance indicators to measure outcomes, and monitor and evaluate environmental health initiatives, including training." (WHO 1995, p9)

The National Environmental Health Action Plan (NEHAP) reported here was initiated through the Fiji Institute of Environmental Health, its own formation a direct response to the Yanuca Declaration. At the time no Pacific nation had commenced development of any such plan (WHO 1997). The only example internationally was the UK Draft National Environmental Health Plan, which was criticised at the time by the UK Chartered Institute of Environmental Health. The NEHAP had formatted a prescribed planning approach with no scope for strategic approaches to individual systems and cultures.

Other concerns included:
- lack of a visionary perspective;
- lack of specific detail on "what, how and when";
- failure to engage people at the local level to inform national policy development.

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Indeed these concerns are reflective of a more general tendency in 'top down planning.' Resultant 'blueprint' style policies are often poorly connected to implementation, practice and place.

The Fiji Ministry of Health and the Institute were challenged to develop an action plan that reflected Fiji's unique cultural character. They were determined not to follow the apparent shortfalls then evident in the Draft UK Plan. Indeed the Fiji practitioners wanted to break down old colonial models of Health Inspection practice and rebuild culturally appropriate capacity at all levels. The 'Healthy Islands' concept provided an entry point and a catalyst for change.

The first opportunity to explore change came in 1995 with an AUSAID funded health development project on the island of Kadavu. This involved the construction of a hospital and health facilities and included a community development and community-training component (Roberts 1997).

Comprehensive island wide training followed for all chiefs, turaga ni koros and health workers (Roberts 1997). Litidamu (1996) subsequently described at a Healthy Cities conference as developing a "new cadre of health workers called Environmental Health Workers". The approach adopted bad a dual strategy:

- providing village leaders with new knowledge about environmental health issues;
- introducing them to the strategic management tool 'ABCD'.

A three-week program (Litidamu 1996) sought to equip the communities to:

- be responsible for their own decision making processes; and
- develop and implement new village policies related to environmental health.

We took the opportunity to walk around one of the villages during one training program to interview village chiefs and turaga ni koros regarding the program. Those approached were all positive:

- they had all learnt much about environmental issues; and
- particularly valued the concept of developing an action plan using the ABCD planning tool.

Typical responses included:

*"Yeah we had a good time. We all hope that when we go back after the course we are laying the base for a five years plan. I think our progress, five years we have to look at different…we have got to try and deal with projects like water supply and kitchens."*

*"Oh it's very good. It gives us some ideas of how to solve problems in the village... We should be laying out a program of all these development things and then you can put it into a weekly program."*

*"It was quite easy because we used that model there, the ABCD model and we do a lot of problems, that's why it was easy to do that assignment. We just have to prioritise, make one really important."*

The AUSAID funded project on the island of Kadavu neared completion in June 1996. The Fiji Environmental Health practitioners had redefined their role, and had established a new 'healthy village' concept and framework. However there were on growing concerns amongst practitioners about sustainability of the process and the ability to transfer the concept to other settings.

By June 1996:

- the formation and pro-active involvement of the Institute of Environmental Health had implemented the 'Healthy Village' concept in Kadavu;
- the Ministry of Health had established an important platform for the further development of more national approaches.

The Institute together with the Ministry of Health immediately began to explore organisational issues. Those associated with work culture and management systems needed addressing in order to sustain and transfer the emerging 'Healthy Island' principles. They chose one district in which to ground and develop 'Local Environmental Health Plan' (LEHAP). In the first six months they proved that policies and practices could be transformed. But this would take time and would require action at both local and national levels.

Following these early advances, WHO and UNDP provided support to further develop these initiatives at a national level. Figure 1 shows the projects goal, objectives and outcomes and Figure 2 the framework for the overall process.

**Figure 1. Goals and Objectives of National Plan (Fiji Govt 1998)**

## Goal

The goal of this project is to enhance the country's capacity for integrating health and environment issues in the formulation of plans for sustainable development and to harmonise the various activities related to health, environment and sustainable development. The project will be carried out at both local and national levels. More specifically the objectives are:

## Objective 1

To demonstrate the feasibility of integrating the management of health and environment into local community decision making systems.

## Objective 2

To collaborate with the government to develop strategic management approaches to the development and implementation of environmental health policy at the local level.

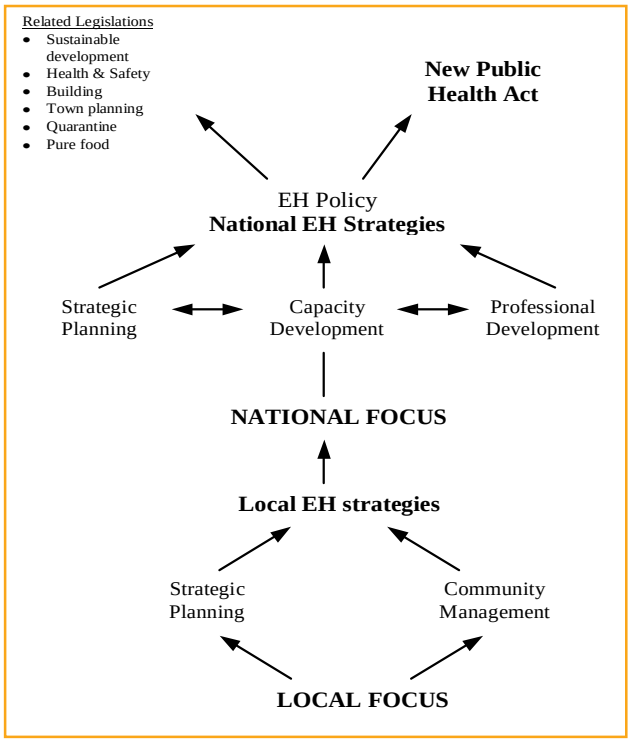
## Objective 3

To collaborate with the government in the formulation of a National Strategy for strengthening consideration of health and environment issues in sustainable development planning.

## Expected outputs

1. Development of community based strategies for the management of environmental health issues in rural and urban areas.
2. A Strategic Management Plan of Action for the management of local environmental health issues – Local Environmental Health Action Plan (LEHAP).
3. A National Environmental Health Action Plan (NEHAP) which will harmonise the various activities related to health, environment and sustainable development and propose new environmental health policy initiatives.

**Figure 2. Overall Framework for Development of NEHAP (Fiji Govt 1998)**




## Action research and learning in settings

The sequence of events up to this point in the Healthy Islands venture had passed through uncharted waters. Fiji's Environmental health practitioners had been on an experiential learning path. Formal adoption by government of the need for a national plan required this learning to become more structured. The practitioners settled upon an action research approach within a range of 'healthy settings.'

Action research entails a cyclical process in four major phases of planning, acting, observing and reflecting (Zuber-Skerritt 1991). These authors point out that the now widely varied definitions of action research found in the literature all share four common themes:
1. empowerment of participants; 2. collaboration through participation; 3. acquisition of knowledge and 4. social change. Reason (1994) describes action research as a form of inquiry into practice. It is concerned with the development of effective action that may contribute to transformations of organisations and communities. This involves systematic evaluation and feedback of collective

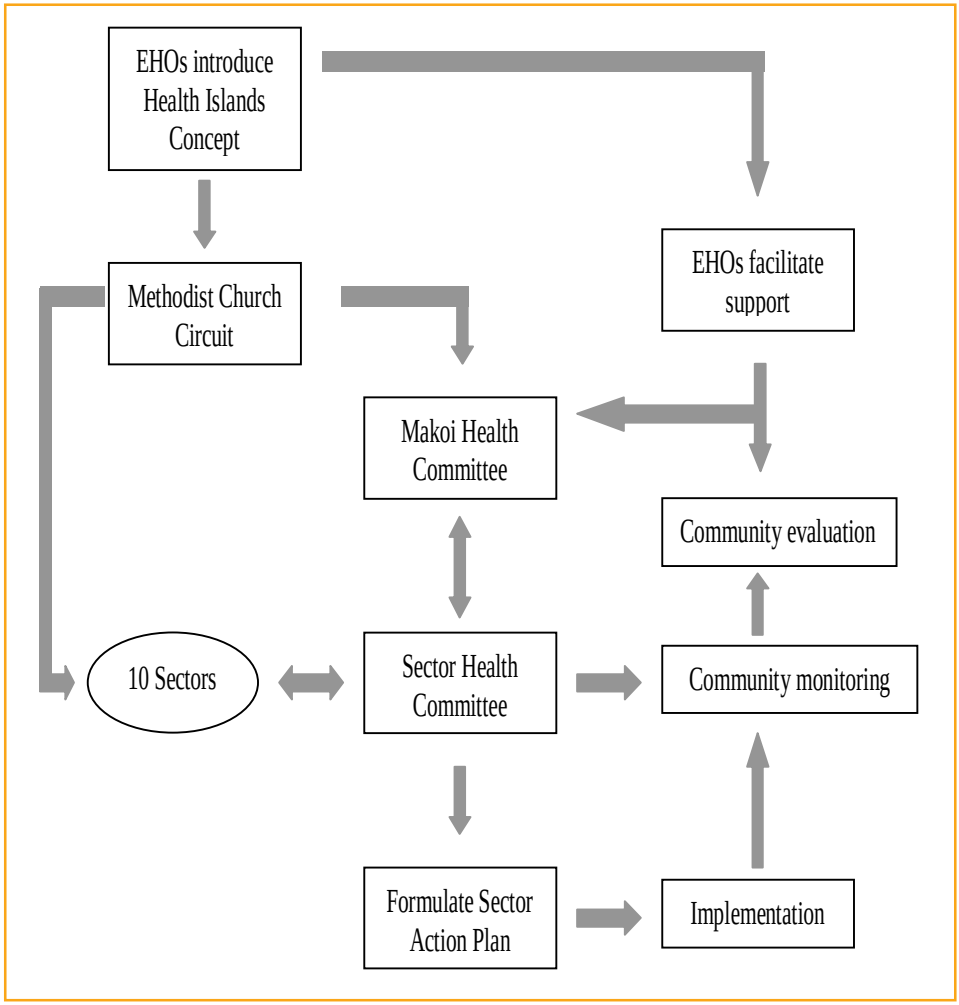
and individual performance.

Schon (1999) recently reviewed the various forms of such participatory research, and describes it as a movement that was originally designed to:

*"…resist the intellectual colonialism of western social research into the third world development process. Participatory research developed a methodology for involving disenfranchised people as researchers in pursuit of answers to the questions of their daily struggle and survival."*

It is also a way of connecting practitioners to policy development in the context of a place or setting. This way of developing a national plan further unfolded with a commitment from senior environmental health officers within the Ministry. They agreed to undertake the planning as a participatory action research process.

**Figure 3. Healthy Makoi (National Environmental Health Workshop, 1997)**




## Focus on Communities and Settings

The 'healthy village' framework developed on Kadavu was subsequently adapted by the 'research group' and applied to urban environments. They engaged in four National Workshops where environmental health officers from throughout Fiji progressively developed a vision of future practice. They then identified opportunities to establish healthy settings in their own districts and learn from the experiences of others.

Throughout the following two and half years a large number of settings were explored. Four in particular were actively managed and flourished as 'healthy settings':

- 'Healthy Makoi' a suburb of Suva;
- 'A Healthy Squatter Settlement';
- 'A Healthy School'; and
- 'Healthy Korovu' a small town.

Each provided unique challenges to the practitioners both in terms of conceptualising their role and in terms of engaging communities in social change. "Healthy Makoi" serves to illustrate the process.

## 'Healthy Makoi'

In July 1997 the second National Conference of practitioners heard the research group report on developments and explored the 'Makoi Model' (Figure 3).

The team reported:

*"Initial contact was made with the Makoi Methodist Circuit Minister, who summoned a few church elders for a traditional Fijian introductory ceremony and informal discussions with environmental health officers on the objectives of the Ministry of Health in regard to community based projects."* (Institute of Environmental Health Minutes, 1997).

The study had included a 'needs' assessment, formation of community committees and development of action plans by the community. The report highlighted that the practitioners played a facilitating role with decisions about implementation being made by the community.

The team celebrated successes:

- in attempting to deal with unemployed youth; and
- litter reduction in one innovative program that saw the community win a contract with the Public Works Dept for roadside cleaning ;
- in one program, the community gained control over street cleanliness and employed its out of work youth to carry out the tasks.

The 'Makoi' project had gained a lot of momentum within the community and among the team. A community newsletter was distributed throughout Makoi to regularly announce progress and future events. The first of these newsletters described the approach in the following terms:

***Local community environmental health centre built to support urban communities.***

*"The Healthy Islands concept encourages the members of any community to examine their own situation and lets them decide for themselves what they need to do to improve their health and quality of life. In doing so, Makoi becomes one of the first peri-urban areas in Fiji where the concept is being tried. The exercise will have the benefit in that what we learn together and will be a useful model to be tried in other peri-urban communities around Fiji."* (Makoi Community Newsletter, 1997).

In presenting these findings to the national workshop the Environmental Health officers also related their experience. They began to appreciate that Environmental Health practitioners may need to deal with issues that are not traditionally considered part of their role. In one instance they had worked with local crime issues, in order to develop community oriented programs (Institute of Environmental Health Minutes, 1997). One of the workshop participants reflected his learning from Makoi in these terms:

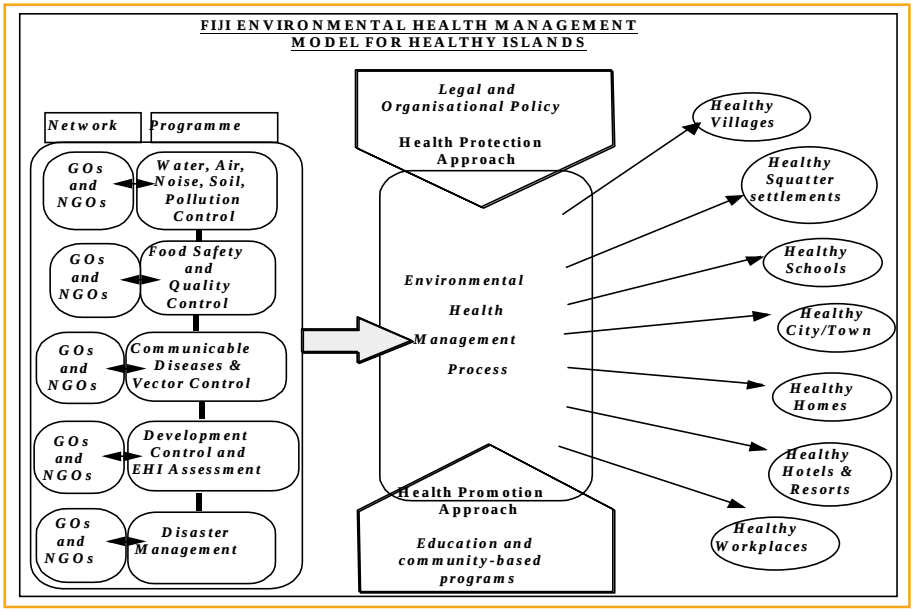
*"This is new ground that we are going into. Again the definition of environmental health is to manage people. One thing that we have come up with is that we can't restrict ourselves only now to traditional areas of environmental health, there has to be more than that now."*

A major innovation to emerge over the first year was the concept of building an 'environment and health office' whereby the practitioner could facilitate improved service and access to and by the community. By June 1997 the community had adopted the concept and funding and land donation was being sought. The Centre is now constructed and operating with community and government officers working in partnership. The role of the Centre and the partnership continues to evolve.

## An environmental health model for Healthy Islands

By mid 1997 the team of practitioners working on the plan began to articulate a broader model. They needed to link the settings into a broader canvas of programs and policy. The model (Figure 4) formed the basis of much discussion both within the group and subsequently at the Rarotonga Ministerial Meeting held in August 1997.

**Figure 4. Environmental health model for Healthy Islands (Fiji Govt 1998)**




## Settings and process

Each of the settings provided a broad range of experiences for EH practitioners to draw upon in continuously refining models and making them explicit. Processes depicted in the models devolved into guiding principles for new environmental health policies and practices. The action research approach ensured that the NEHAP was 'emergent' in nature.

In each of the settings some western management 'tools', methods and practices were adapted to the needs of both practitioners and communities. These included the ABCD Strategic Management system, mental models and facilitation techniques. In other instances teams radically addressed old management systems. Changes in approach, involved issues such as reporting, work times, style of interaction with communities and practitioners' work culture. These changes often altered past colonial administrative approaches and structures. Systems more in keeping with the cultural features of Fiji began to emerge.

In Fiji, this emerging NEHAP will ultimately provide the framework for new public health legislation. This must provide an improved framework to link national policy development with local environmental health practice.

In adopting this approach, Fiji Environmental Health Service is emerging as a 'Learning Organisation', along the lines advocated by Senge et al, (1996). This concept is discussed in more detail elsewhere in this Dialogue (see EHRC – A Research Centre in Transition).

## References


1. Chartered Institute of Environmental Health. 1995. The UK Environmental Health Action Plan. London: England.
2. Fiji Government. 1998. National Environmental Health Action Plan.
3. Institute of Environmental Health. 1997. Minutes of National Workshop. Suva: Fiji.
4. Litidamu, N. 1996. Healthy Islands - Environmental Health Initiatives in Fiji. In Proceedings of Healthy Cities Conference, Beijing.
5. Makoi Community Newsletter, No. 1. 1997.
6. Reason, P. 1994. Three Approaches to Participatory Inquiry. In Handbook of Qualitative Research. N Denzin and Y Lincoln. Sage Publications: Thousand Oaks, California.
7. Roberts, G. 1997. The Kadavu health promotion model, Fiji. *Health Promotion International* 12, no. 4: pp283-90.
8. Senge, P, A Kleiner, C Roberts, R Ross, and B Smith. 1996. The Fifth Disipline Fieldbook. *Stategies and Tools for Building and Learning Organisations.* Nicholas Brealey Publishing: London.
9. Schon, S. 1999. *Participatory Research and Community Organizing"*. Internet reference: 7ejamexher/ sue.htlmµdocid=2410110. pp1-22
10. WHO. 1995. Yanuca Island Declaration.
11. WHO. 1997. Healthy Islands Positive Paper. In Proceedings of Raratonga Meeting on Healthy Islands. Cook Islands
12. Zuber-Skerritt, D. 1991. Professional Development in Higher Education: A Theoretical Framework for Action Research. Griffith University: Brisbane.

# Setting ambient air quality standards in Australia

Bin Jalaludin[i] and Geoffrey Morgan[ii]

**Abstract**

The human health impacts of ambient air pollutants include increases in both mortality and morbidity[1;2]. There are significant public health implications as millions of residents of major cities are exposed to levels of air pollution that are capable of affecting health. One of the factors contributing to the control of air pollution is the development and implementation of air quality standards and guidelines that define goals or targets to be met in reducing various ambient air pollutants. This paper briefly discusses the process of setting ambient air quality standards in Australia.

## Introduction

The human health impacts of ambient air pollutants have now been more widely documented than ever before. The pollutants that have been most extensively studied are ozone ($O_3$) and fine particles (particles less than 10 microns in diameter [$PM_{10}$] and particles less than 2.5 microns in diameter [$PM_{2.5}$]), whereas nitrogen dioxide ($NO_2$), carbon monoxide (CO) and sulfur dioxide ($SO_2$) have been less frequently studied.

Adverse human health effects include increases both in mortality and morbidity (for example, emergency department presentations and hospitalisations)[1-4]. Further, children may be particularly at increased risk, especially from fine particle air pollution[5]. Although the health risks to individuals due to air pollutants are generally low, the public health implications are large when millions of residents of major cities are exposed to levels of air pollution that are capable of affecting health.

The health costs of air pollution are considerable. It was estimated that the annual economic value of $PM_{10}$-related health effects in the San Francisco Bay Area in 1994 was about USD2 billion.[6] More recently, it has been estimated that the health costs due to air pollution would be about CAD10 billion (costs for 2000) in Ontario, Canada[7] and about EUR50 billion (costs for 1996) in France, Austria and Switzerland[8].

This article will mainly discuss the process of setting ambient air quality standards in Australia. However, it will also, but only very briefly, discuss how ambient air quality standards are set in the United States of America (US) and in the United Kingdom (UK).

## Setting ambient air quality standards

During the past 30 years, much progress has been made towards controlling air pollution and thereby reducing the adverse impacts on human health and the environment. Factors contributing to the control of air pollution include[9]:

1. the codification, into national laws and/or international agreements, of approaches for establishing air quality standards and guidelines that define goals or targets to be met in reducing various ambient air pollutants and their precursors,
2. the development of specific guidelines or standards for particular substances, and
3. the implementation of control strategies that contribute towards meeting the established goals.

*Standard setting in the United States of America*[10]
In the US, the 1970 amendment to the 1963 US Clean Air Act (CAA) mandated that the US Federal Government develop and promulgate National Ambient Air Quality Standards (NAAQS) specifying uniform, nationwide limits for certain major air pollutants. The CAA directed the US Environmental Protection Agency (US EPA) to identify and issue air quality criteria for the common air pollutants that may reasonably be anticipated to endanger public health or welfare. These air quality criteria reflect the latest available scientific literature on the nature and extent of all identifiable effects on public health or welfare that may be expected from the presence

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of the pollutant in ambient air. The CAA also directed the US EPA to develop primary and secondary NAAQS for the identified pollutants. Primary standards are for the protection of public health whereas secondary standards are for the protection of human welfare, for example, damage to vegetation, impacts on visibility and climate. Reviews of the criteria and standards are conducted at least every five years.

*Standard setting in the United Kingdom*[10]
In the UK, an Expert Panel on Air Quality Standards derives and recommends standards for the common air pollutants. No air quality standards had been set in the UK prior to the formation of the Expert Panel in 1991. Following the establishment of the Expert Panel, it was anticipated that standards for all the major common air pollutants would be set within a period of about five years. In view of the time constraints, more reliance was placed upon the judgement of panels of experts in developing the initial air quality standards.

*Standard setting in Australia*
Historically, in Australia, the control of air pollution had been in the province of individual State governments rather than the Commonwealth government. The first piece of legislation to be passed to control air pollution was the Victorian Clean Air Act of 1958, legislation which was modelled after the UK Clean Air Act of 1956.[11] Soon after, in 1961, followed the New South Wales (NSW) Clean Air Act.[11]

Up until 1998, when the first ever national ambient air quality standards were set by the National Environment Protection Council (NPEC), individual States set their own ambient air quality standards or guidelines. The NSW Environment Protection Authority, for example, had not defined any air quality standards, as there were few Australian data on the health effects of ambient air pollution. Therefore, NSW primarily adopted as air quality objectives National Health and Medical Research Council (the primary health advisory body to the Commonwealth) guidelines, World Health Organization long term goals and the US EPA Air Quality Standards. Currently in Australia, national ambient air quality standards are set by the NEPC, which was established in 1992 by an inter-governmental agreement.[12] The NEPC is a statutory body with law making powers and its role is to develop consistent national approaches for environmental protection. The NEPC has the responsibility for making National Environment Protection Measures (NEPMs) for a range of environmental issues (for example, ambient air pollution, water pollution, protection of amenity in relation to noise, environmental impacts of hazardous waste, the re-use and recycling of used materials).

NEPMs are broad framework-setting statutory instruments and become law in each participating jurisdiction once it is made by the NEPC. They outline agreed national objectives for protecting or managing particular aspects of the environment and may consist of any combination of goals, standards, reporting protocols, and guidelines on how standards might be achieved or environmental problems addressed.

Following the establishment of a NEPM, its implementation is the responsibility of each individual State and Territory and the Commonwealth. Performance in relation to the standards is assessed by measurements made at specified monitoring stations or by equivalent methods approved by the NEPC. Governments are required to provide an annual progress report that is publicly available. Annual monitoring reports are also publicly available.

In 1998, Australia adopted an Ambient Air Quality NEPM that, for the first time, set national ambient air quality standards (Table 1).[13] These standards cover six "priority" air pollutants - particles (measured as $PM_{10}$), $O_3$, $NO_2$, CO, $SO_2$ and lead. The standards are the first step in developing a more consistent national approach to air quality management. The Ambient Air Quality NEPM also provides monitoring protocols for the air pollutants.

The process for developing a NEPM is shown diagrammatically in Figure 1.[14] Part of the process of assessing the health effect of pollutants generally follows some form of health risk assessment. The NEPC describes a four-stage health risk assessment[15;16], that is, hazard identification, dose response assessment, exposure assessment and risk characterisation. Together with the risk evaluation, social and economic impacts are also prepared as well as monitoring protocols and air quality management options. These documents comprise the draft NEPM and Impact Statement which are then widely circulated for comment prior to being promulgated into legislation.

Currently there are two further initiatives related to the Ambient Air Quality NEPM. Firstly, in December 2000, the NEPC initiated a review to determine whether a new ambient air quality standard for $PM_{2.5}$ was needed in Australia, and the feasibility of developing such a standard.[17] The review concluded that there was sufficient community concern about $PM_{2.5}$ to warrant a separate standard and in September 2001 the NEPC commenced a statutory process to make a variation to the Ambient Air Quality NEPM to extend coverage to $PM_{2.5}$. This process will include consultation with industry, conservation groups and the public. Secondly, there is a discussion paper, for public comment, on the development of a NEPM for ambient air toxics.[18] The discussion paper addresses five air toxics – benzene, formaldehyde, polycyclic aromatic hydrocarbons, toluene and xylenes. Comments from the discussion paper will then be used in the preparation the draft NEPM and Impact statement.

Although ambient air quality standards are set nationally by the NEPC, it is the responsibility of State and Territory Governments to ensure the development and implementation of strategies to meet the ambient air quality standards. The State of NSW, for example, has adopted a whole of government approach to address the issue of ambient air pollution. In 1998, the NSW Government launched a 25-year plan ('Action for Air') to improve air quality in the Sydney metropolitan region and in the industrial regions to the north and south of Sydney.[19]

The "Action for Air" Plan takes a broad approach encompassing the concept of total air quality management. Although it mainly targets the increasing use of motor vehicles in urban areas (motor vehicles are the largest source of air pollutants, especially, in metropolitan Sydney), the Plan also examines the role of industry, pollution sources within homes, as well as issues surrounding urban planning and public transport (Figure 3). The Plan focuses on both technological solutions (for example, to reduce motor vehicle emissions through cleaner engine and fuel technology) as well as on better public policy (for example, promoting cycling and walking, changing travel behaviour through education) to improve air quality.

## Summary

As more studies demonstrate the adverse health effects of ambient air pollution and with increased community awareness of the impacts of air pollution, there is increasing pressure on governments to control air pollution. Setting air quality standards on the basis of health impacts is only the first step towards controlling air pollution. Development and implementation of policies and strategies to address air pollution and subsequent monitoring of air quality to test the effectiveness of those strategies are the next major steps. These initiatives, to be successful and sustainable, require significant political commitment, a whole of government approach and adequate resources. There is no "magic bullet".

## References


1. Marks GB. A critical appraisal of the evidence for adverse respiratory effects due to exposure to environmental ozone and particulate pollution: relevance to air quality guidelines. Australian & New Zealand Journal of Medicine 1994;24:202-13.

2. Committee on the Medical Effects of Air Pollutants (COMEAP). The quantification of the effects of air pollution on health in the United Kingdom. 1998.

3. Pope CA, III, Dockery DW, Schwartz J. Review of epidemiological evidence of health effects of particulate air pollution. Inhalation Toxicology 1995;7:1-18.

4. Kunzli N, Kaiser R, Medina S, Studnicka M , Chanel O, Filliger P *et al.* Public-health impact of outdoor and traffic-related air pollution: a European assessment. Lancet 2000;356:795-801.

5. Pope CA, III. Epidemiology of fine particulate air pollution and human health: biologic mechanisms and who's at risk? Environmental Health Perspectives 2000;108:713-23.

6. Hall, J., Brajer, V., Kleinman, M., and Fairley, D. The economic evaluation of quantifiable ozone and PM10 related health effects in the San Francisco Bay Area. 1994. San Francisco, CA, Bay Area Air Quality Management District.

7. DSS Management Consultants Inc. Illness costs of air pollution. 2000. Ontario, Canada.

8. Sommer, H., Seethaler, R., Chanel, O., Herry, M., Masson, S., and Vergnaud, J. C. Health costs due to road traffic-related air pollution. Economic evaluation. 1999. Berne, Switzerland, Federal Department of Environment, Transport, Energy and Communications.

9. Grant LD, Shoaf CR, Davis JM. United States and international approaches to establishing air standards and guidelines, In: Holgate ST, Samet JM, Koren HS, Maynard RL, editors. Air Pollution and Health, First ed. London: Academic Press; 1999.

10. Lippmann M, Maynard RL. Air quality guidelines and standards, In: Holgate S, Samet J, Koren H, Maynard RL, editors. Air pollution and health, First ed. London: Academic Press; 1999.

11. Manins PC. Air pollution in 20th century Australia. Clean Air 2000;34:30-36.

12. National Environment Protection Council Service Corporation. National Environment Protection Council.

[On-line]. Available at: http://www.nepc.gov.au/. Accessed on 30-7-2002.

13. National Environment Protection Council. National Environment Protection Measure for Ambient Air Quality. Adelaide, Australia, National Environment Protection Council Service Corporation 1998.

14. Beer, T. and Walsh, S. Ambient Air Quality National Environment Protection Measure: Exposure Assessment. SB/1/297F3C. 1997. Victoria, Australia, CSIRO Division of Atmospheric Research.

15. National Environment Protection Council. National Environment Protection (Ambient Air Quality) Measure. Report of the Risk Assessment Taskforce. 2000. Adelaide, National Environment Protection Council.

16. National Academy of Science (National Research Council) - Committee on the Institutional Means for Assessment of Risks to Public Health. Risk assessment on the Federal government: Managing the process. 1983. Washington, DC, National Academy Press.

17. National Environment Protection Council. Issues paper - the need for a PM2.5 standard in Australia. ISBN 0642 323 429. 2001. Adelaide, Australia, National Environment Protection Council Service Corporation.

18. National Environment Protection Council. Towards a National Environment Protection (Ambient Air Toxics) Measure - Discussion Paper. 2002. Adelaide, Australia, National Environment Protection Council Service Corporation.

19. Environment Protection Authority. Action for air. The NSW Government's 25-year air quality management plan. ISBN 0 7313 0160 9. 1998. Chatswood, Australia, Environment Protection Authority.

**Table 1. National Environmental Protection Measure for A mbient Air Quality, NEPC 1998**

| Pollutant | Averaging period | Maximum concentration | Goal within 10 years - Maximum number of days that may exceed guidelines |
|---|---|---|---|
| Carbon monoxide | 8 hours | 9.0 ppm* | 1 day a year |
| Nitrogen dioxide | 1 hour | 0.12 ppm | 1 day a year |
| | 1 year | 0.03 ppm | None |
| Ozone | 1 hour | 0.10 ppm | 1 day a year |
| | 4 hours | 0.08 ppm | 1 day a year |
| sulphur dioxide | 1 hour | 0.20 ppm | 1 day a year |
| | 1 day | 0.08 ppm | 1 day per year |
| | 1 year | 0.02 ppm | None |
| Lead | 1 year | 0.50 $\mu g/m^3$ | None |
| $PM^{10}$ | 1 day | 50 $\mu g/m^3$ | 5 days a year |

*ppm = parts per million

**Figure 1. Process for Developing a NEPM**

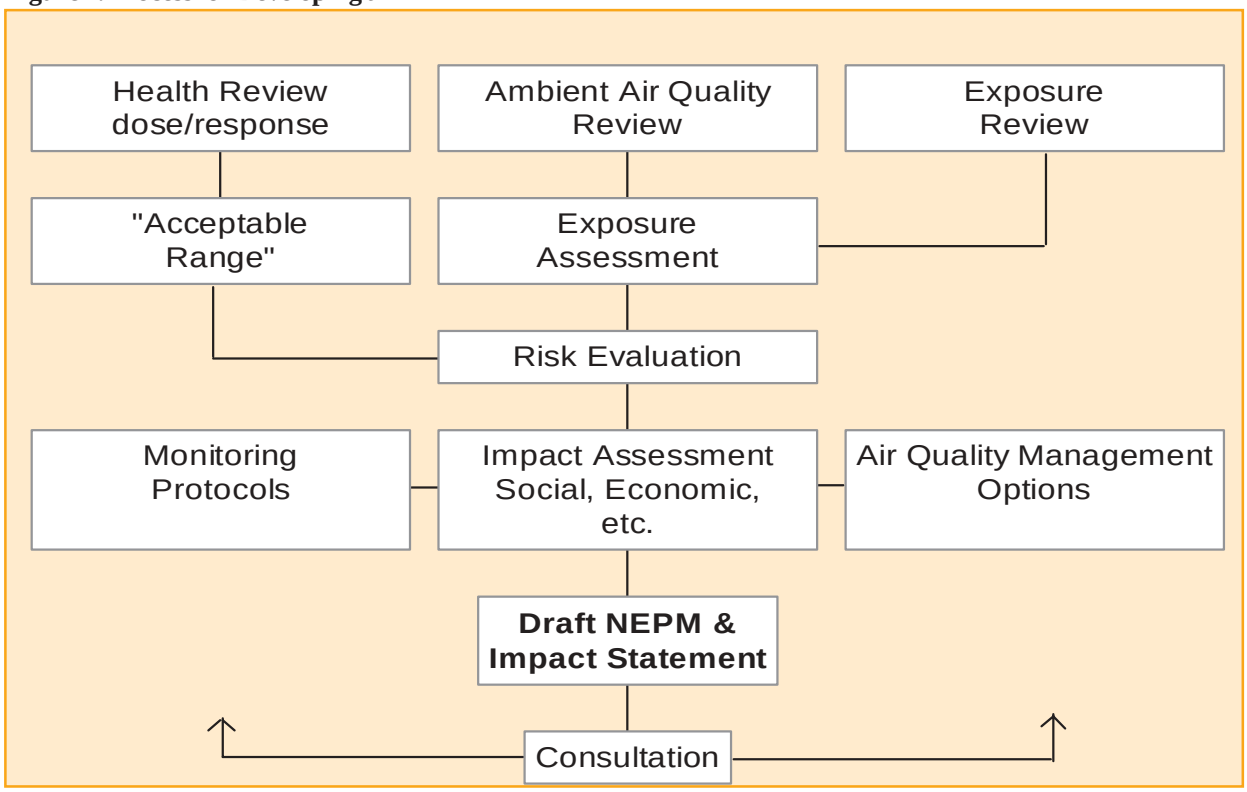
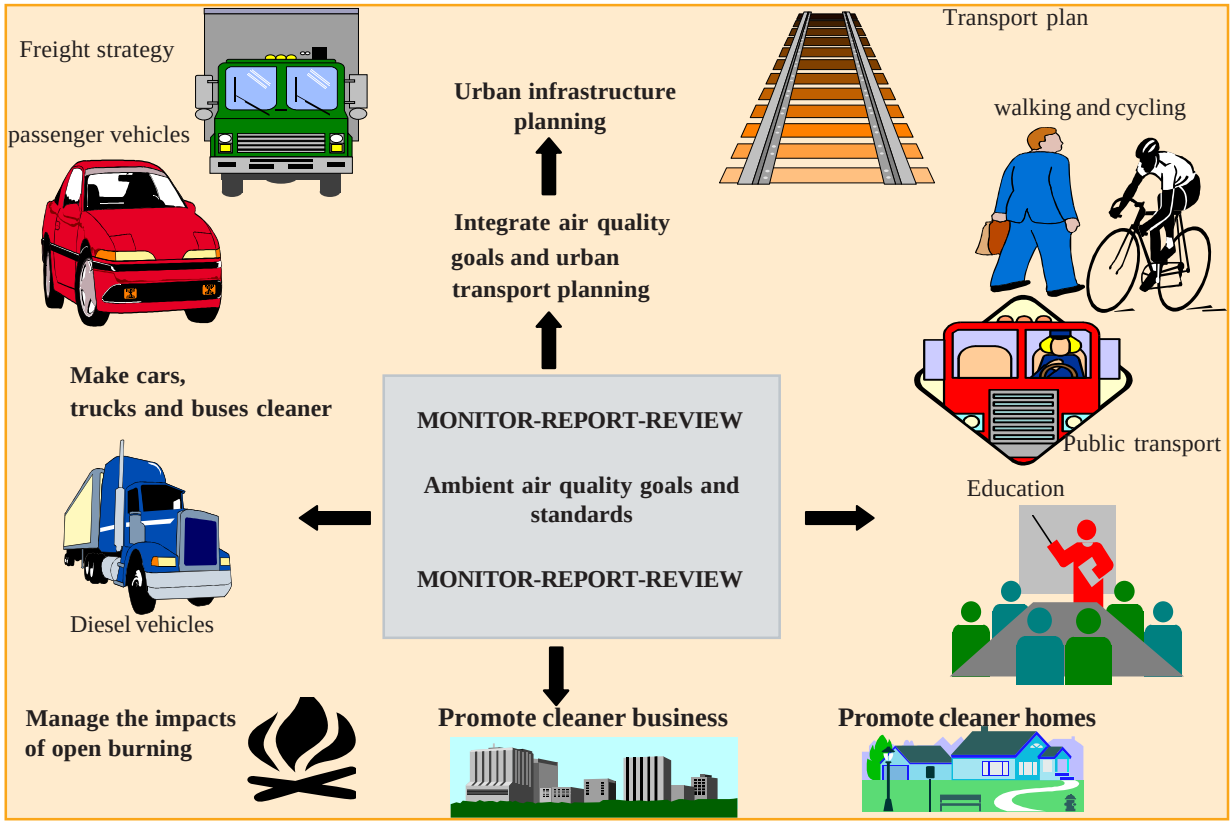



**Figure 2.Framework of Action for Air**



# Technical Notes

## Progress reports on research projects

# Evaluation of the ImmunoMagnetic Separation technique (IMS technique) for the isolation of *Cryptosporidium* oocysts from seeded water samples.

Ambu S[ii], Mastura AB[i] and Hasnah O[ii].

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## Introduction

Protozoa of the genus *Cryptosporidium* had long been thought of as interesting, but unimportant parasites in human health (Anon, 1984). Cryptosporodiosis is, however, an important causal agent of diarrhea among Malaysian children. Lai (1992) reported that in Malaysia, 11% of all diarrheic children in hospitals are infected with *Cryptosporidium*. These were mainly children from the low socio-economic groups.

Initially, veterinary research indicated that this infection was zoonotic[a], (Fayer, 1986), but current scientific evidence suggests environmental transmission. Water is probably the major mode of infection (Casemore et. al. 1985, Rush et. al., 1987). This is facilitated by the organism's environmentally robust nature, its small size and low infective dose (Robertson et. al. 1994). Recent cryptosporodiosis outbreaks in United States (Smith, 1998) have now made the protozoa one of the most important new contaminants needing control. This especially applies in drinking water, since oocysts[b] of *Cryptosporidium* are able to withstand chlorination (Matheson, et. al. 1998).

In Malaysia, preliminary prevalence studies indicate that 10.5 % of our surface waters are contaminated with *Cryptosporidium* (Ahmad, 1995). According to Ongerth (1987), *Cryptosporidium* is a major concern for global public health due to its waterborne transmission. This scenario has led to the development of environmental methods for isolation and detection of *Cryptosporidium* oocysts (Jakubowski, et. al. 1996).

Conventional methods involve elution[c], concentration, staining and microscopic examination. This technique serves as an excellent diagnostic tool (Garcia, et. al. 1983) but it is laborious and time-consuming (Smith, et. al., 1989).

The development of the IMS (ImmunoMagnetic Separation) technique has reduced the time required for the isolation and detection of oocysts (Jakubowski, et. al. 1996).

In this technique, iron-tagged anti-*Cryptosporidium*[d] selectively binds to the oocysts. A magnetic particle concentrator[e] is used to isolate the anti-*Cryptosporidium*-oocyst complexes, which are then disassociated, stained and viewed under a fluorescence microscope.

Campbell (1997) reports that information on IMS precision is minimal, so although the technique seems promising, it is yet to be verified. This exploration was undertaken to determine the efficiency of this IMS technique, for the isolation of *Cryptosporidium* oocysts from seeded water samples.

## Methods

Several trials were carried out using the commercial product Dynal ® Dynabeads anti-Cryptosporidium with some modifications to instructions. Samples were stained with FITC (flourescein isothiocyanate) labeled anti-Cryptosporidium monoclonal antibody[f] (CellLabs, Australia). Slides were viewed under an epiflourescence microscope (Nikon Eclipse E600, excitation filter 450 – 490)

The water samples were spiked with 100 *Cryptosporidium* oocysts in three trial runs.

## Results

The recovery efficiencies for *Cryptosporidium* oocysts from water samples were:

Trial 1: 56 %, Trial 2: 52% and Trial 3: 60.2%.

Statistical analysis methods were not applied in this study.

## Discussion

A major limitation of epidemiological research is the lack of sensitive, rapid and simple detection methods for isolation of oocysts in environmental samples. This stems from the fact that infective doses derive from small numbers of the parasite. The problem lies in detecting such low numbers of oocysts from large volumes of water samples.

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[ii] Dr. Stephen Ambu: Supporting Author, Institute for Medical Research
[ii] Ms. Hasnah Omar: Supporting Author, Institute for Medical Research

The generally used concentration method (sucrose flotation, formalin-ether sedimentation and calcium carbonate flocculation) is laborious and time-consuming (Vesey, 1993).

Another enumeration method uses a flow cytometry technique. This instrument detects light scattered by particles the size of oocysts after they have been concentrated and satined (Jakubowski, et. al. 1996). This method is limited to clean water samples, because debris may clog the filtering process (Valdez, et. al. 1997).

The IMS technique is more sensitive than the above methods but reported recovery efficiencies range from 25 – 65 % (Jakubowski, et. al. 1996). Our trials have fallen within this range, with average recovery efficiencies of56.1 % for *Cryptosporidium*.

## Conclusion

The ImmunoMagnetic Separation (IMS) technique is less time consuming and simple to use, but poor recovery efficiencies limit its usefulness. We recommend further research into the method in the hope of making modifications to improve recovery.

## Acknowledgements

The authors wish to thank The Director IMR and Ms. Shalini from UKM for her dedicated work in this study.

## References

1. Ahmad RA. Pathogenic protozoa in Malaysian water resources. *Sains Malaysiana*. 1995. 24: 121 – 127.
2. Anonymous. Cryptosporodiosis: a 'new' disease? (Editorial). *Med. J. Aust*. 1984. 140: 516 – 517.
3. Campbell AT and Smith HV. Immunomagnetisable separation of Cryptosporidium parvum oocysts from water samples. *Water Sci Technol*. 1997. 35: 397 – 401
4. Casemore DP, Armstrong M and Sands RL. The laboratory diagnosis of cryptosporodiosis. *J Clin Pathol.* 1985. 38: 1337 – 1341.
5. Fayer R and Ungar BLP. Cryptosporidium and cryptosporodiosis. *Microbiological Reviews*. 1986. 50: 458 – 483.
6. Garcia LS, Bruckner DA, Brewer TC and Shimizu RY. Techniques for the recovery and identification of Cryptosporidium oocysts from stool specimens. *J. Clin Microbiol*. 1983. 18: 185 – 190.
7. Jakubowski W, Boutros S, Faber W, Fayer R, Ghiorse W, LeChevallier M, Rose J, Schaub S, Singh A and Steward M. Environmental methods for Cryptosporidium. *J. Amer Water Works Ass*. 1996. 107 – 121.
8. Lai KPF. Cryptosporodiodis among Malaysians. Bulletin IMR 1992. 28: 19
9. Matheson Z, Hargy TM, McCuin RM, Clancy JL and Fricker CR. An evaluation of the Gelmann Envirochek capsule for the simultaneous concentration of Cryptosporidium and Giardia from water. *J. App. Microbiol.* 1998. 85: 755 – 761.
10. Ongerth JE and Stibbs HH. Identification of Cryptosporidium oocysts in river water. *App.Environ Microbiol.* 1987. 53: 672 – 676.
11. Robertson LJ, Smith HV and Ongerth JE. Cryptosporidium and cryptosporodiosis. Part III: development of water treatment technologies to remove and inactivate oocysts. *Microbiol Europe*. 1994. 2: 18 – 26.
12. Rush BA, Chapman PA and Ineson RW. Cryptosporidium and drinking water. *Lancet.* 1987. 2: 632 – 633.
13. Smith HV and Rose JB. Waterborne cryptosporodiosis: current status. *Parasitology Today*. 1998. 14: 14 – 22.
14. Valdez LM, Dang H, Okhuysen PC and Chappell CL. Flow cytometric detection of Cryptosporidium oocysts in human stool samples. *J. Clin Microbiol*. 1997. 35: 2013 – 2017.
15. Vesey G, Slade JS, Byrne M, Shepherd K and Fricker CR. Anew method for the concentration of Cryptosporidium oocysts from water. *J. Appl Bacteriol*. 1993. 75: 82 – 86.

## Endnotes:

[a]**Zoonotic:** refers to diseases transmitted directly to humans from an animal host or reservoir.

[b]**Oocysts:** sexual stage of many protozoa, especially Sporozoa

[c]**Elution:** the process of washing oocysts off the surfaces of particles suspended in the water samples.

[d]**Iron-tagged anti-*Cryptosporidium:*** is blood serum with antibodies against *Cryptosporidium* that have had iron chemically attached to form complex molecules. These tagged antibodies are added to water samples and cling to *Cryptosporidium* oocysts to form 'complexes'.

[e]**Magnetic particle concentrator:** is an instrument that creates a magnetic field to attract and concentrate oocyst/antibody/iron complexes, as water samples pass through.

[f]**FITC labeled:** relates to another specially refined (monoclonal) antibody preparation to which flourescein has been chemically attached. This is used to stain sample concentrates by creating oocyst/antibody/ fluorescin complexes. These complexes cause the oocysts to shine bright green when examined under a specialised 'epiflourescence' microscope.

# The incidence of parasites in a Survey of various types of Wastewater Treatment Ponds and their run-off

***Part of an Evaluation Study of Environment and Health in the Semenyih Catchment, Selangor.***

[i]Ambu S., [ii]Krishnasamy M. and [iii]Barbinder Singh

## Abstract

This technical note records the incidence of protozoan and helminthic contaminants issuing from various types of treatment ponds into the Semenyih River Catchment, Selengor. Discharges from pig farms and cattle farms passed through several common oxidation ponds. Other discharges variously passed through common oxidation ponds, one Imhoff Tank, one Bio-Soil System and two Hi-Kleen Systems. The water samples from pig farming areas contained the following: hookworm, *Ascaris* sp., *Strongyloides* sp. *Hymenolepis diminuta*, *Stephanurus dentatus* and *Trichuris* sp. ova as well as Coccidia oocysts. The cattle farm area had Strongyloides sp. ova. The urban areas had *Ascaris* sp., *Strongyloides* sp. *Trichuris* sp., *Enterobius* sp. and hookworm ova along with some trematode egg-like eggs.

## Introduction

The Semenyih River is polluted with both agricultural and industrial run-off. If this pollution is allowed to continue unabated, the potable water supplied from this area may become a risk to human health. Drinking water contamination by sewage is still a health problem in many developing countries.

Typical municipal sewage contains oxygen-demanding material, sediment, grease, oil, scum, parasite eggs and cysts, pathogenic bacteria, viruses, salts, algal nutrients, pesticides, refractory organic compounds and heavy metals. Water for domestic use must be well treated to eliminate disease-causing organisms. Therefore a good treatment system must be utilised.

Medical parasitology has advanced with improved techniques for the identification and enumeration of helminth eggs and larvae in faeces (Bailenger, 1979; Bouhoum & Schwartzbrod, 1989). These techniques have now been modified to analyse wastewater samples for helminth eggs and other parasite cysts (Ayres and Mara, 1996). The present evaluative study has used the technique of Ayres and Mara (1996) to test wastewater samples from the Semenyih Catchment area.

## Methodology

The water samples from the study area were collected with the help of the District Health Office at Semenyih. Water samples were taken from a total of 22 sampling points (as indicated on the Catchment Map). Four types of wastewater treatment plants were involved vis-a-vis Common Oxidation ponds[a], Imhoff Tank[b], Bio-Soil System[c] and the Hi-Kleen System[d].

For analysis, sample sizes were as follows: 5 litres of wastewater, 10 litres of effluent, 10 litres from small streams and 20 litres from rivers. The analysis of wastewater was carried out according to the method of Ayers and Mara (1996). The McMaster slide[e] was used for the identification and quantification of helminth eggs.

A total of 19 sites were surveyed in the Semenyih Catchment Area. The following site characteristics were notable:

- The Nirvana Park is a human memorial park, which is undergoing continuous development.
- The storm-water from the sugar plantation and the Sungai Beranang Cattle Farm flows directly into nearby streams, which join the Sungai Semenyih.
- The wastewater from residential areas drains off into standard Oxidation Ponds in most cases. However Taman Sri Bangi Lama has an Imhoff Tank and Taman

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Sungai Buah has a HiKleen Tank. The effluent from these ponds and tanks are discharged into a drain which in-turn drains off into the main Semenyih River.

## Results

Sites surveyed and the incidence of parasites, are displayed in Table 1. The following findings were notable:

- At the Nirvana Park, Sugar Plantation and the Semenyih River sites no helminth eggs were found in the raw water samples.
- At the Pig Farms, the waste water from the oxidation ponds contained the following: Hookworm, Oocysts (*Coccidia*), *Ascaris* sp, *Strongyloides* sp, *Hymenolepis diminuta, Stephanurus dentatus* and *Trichuris sp.*
- At the Cattle Farms, river water samples had *Strongyloides* sp at the Bangi Lama site.
- The residential areas had different types of oxidation ponds and the effluent water samples collected from these sites had *Ascaris* sp. *Trichuris* sp. *Strongyloides* sp. Hookworm, Trematode egg-like and *Enterobius sp*.

## Discussion

In Malaysia before 1993, the responsibility for our sewerage system was in the hands of the 144 Local Authorities. These agencies had limited funding and lacked technical expertise. In order to improve the sewerage infrastructure, the Government privatised the sewerage services. Failed Imhoff Tanks and unmaintained treatment plants are now being rehabilitated (Indah Water Report 1997).

This survey indicates that inadequately treated human and animal waste may carry helminths such as those listed above. Polluted rivers can also be the focal point for disease outbreaks such as cholera, typhoid and hepatitis A. The new sewerage infrastructure being implemented by the government programme should help alleviate these problems. Enforcement of the Environment Quality Act by relevant agencies will then ensure a cleaner environment and better health for all in Malaysia.

Refer to Table 1. over page.

## Acknowledgement

The authors wish to thank the Director IMR, Dr. Lye Munn Sann for permission to carry out this study and the WHO/WPRO Malaysia for funding the project.

## References

1. Ayers, R.M & Mara, D.D. (1996) – Analysis of wastewater for use in agriculture. A laboratory manual of parasitological and bacteriological techniques. Department of Civil Engineering, University of Leeds, Leeds, England. World Health Organisation. Geneva. 1996.
2. Bailenger, J. (1979) – Mechanism of parasitological concentration in coprology and their practical consequences. *Journal of American Medical Technology*, 41: 65–71.
3. Bouhoum, K and Schwartzbrod, J. (1989) – Quantification of helminth eggs in wastewater. Zentralblatt fur Hygiene und Umweltmedizin – quoted by Ayers, R.M & Mara, D.D. (1996 ) – Analysis of wastewater for use in agriculture. A laboratory manual of parasitological and bacteriological techniques. Department of Civil Engineering, University of Leeds, Leeds, England. World Health Organisation. Geneva. 1996.
4. Indah Water Report (1997) – Developing a modern and efficient sewerage system for Malaysia. February 1997. Indah Water Consortium Pvt. Ltd. Malaysia
5. Stanley E. Manahan (1993) – Fundamentals of Environmental Chemistry – Water Treatment, Lewis Publishers, 121 South Main Street, Chelsea, Michigan, USA.

## Endnotes

[a]**Oxidation Pond:** This pond uses the natural aerobic process whereby the bacteria in the pond keeps the algal growth under control, digests the organic matter and kills possible pathogens. The kill efficiency is estimated to be about 99.99% if the pond is well maintained.

[b]**Imhoff Tank:** In this system the tank consists of two floors whereby digestion and settling takes place in separate compartments. The floors are separated by an inclined false bottom with holes. The efficiency is 40% and the effluent must be treated with a secondary system such as oxidation/stabilization ponds. This system usually covers about 30–100 homes.

[c]**Bio-Soil System:** The Bio-Soil System has a highly efficient biological action and economically uses external energy to treat agricultural and domestic waste. The system has two tanks made of reinforced concrete, of which one is for aeration and the other for settling sludge.

[d]**Hi-Kleen System:** The Hi-Kleen wastewater treatment system uses the advanced Fibre Reinforced Plastic technology. It is stable and reliable in treatment performance.

**Table1. Shows the collection site, amount of water analysed and the types of parasite eggs and cysts detected.**

| Site No. | Site Name | Source | Sample amount (Litres) | Eggs/Litre |
|---|---|---|---|---|
| 7 | Nirvana Park (Cemetery) | River water | 10 | 0 |
| 8 | Sugarcane Plantation | River water | 10 | 0 |
| 14 | Semenyih River | River water | 10 | 0 |
| 14A | Pig Farm (LY) | Oxidation Pond | 10 | Hookworm - 60<br>Oocysts (*Coccidia*) - 100 |
| 14B | Pig Farm TT Semenyih | Oxidation Pond | 5 | *Ascaris* sp. - 20<br>Hookworm - 60 |
| 14B | Pig Farm TT 1 Semenyih | Oxidation Pond | 10 | Hookworm - 20 |
| 14C | Pig Farm TT2 Semenyih | Oxidation Pond | 10 | Hookworm - 40 |
| 14C | Pig Farm TT 2 Semenyih | Oxidation Pond | 5 | *Ascaris* sp. - 120<br>*Strongyloides* sp. - 60<br>*Hymenolepis diminuta* - 20<br>*Stephanurus dentatus* - 20<br>Hookworm - 500 |
| 14D | Pig Farm | Oxidation Pond | 10 | 0 |
| 14D | Pig Farm | Oxidation Pond | 5 | 0 |
| 14E | Tmn Bunga Raya | Effluent (Biosoil System) | 10 | 0 |
| 14F | Bandar Rinching T.P. | Wastewater Oxidation Pond | 5 | *Ascaris* sp. - 40<br>*Trichuris* sp. - 40<br>*Strongyloides* sp. - 680<br>Hookworm - 270<br>Trematode egg-like - 20 |
| 14F | Bandar Rinching T.P. | Effluent Oxidation Pond | 10 | *Ascaris* sp - 470<br>*Trichuris* sp. - 20<br>*Strongyloides* sp. - 270<br>Hookworm - 440 |
| 14G | Pig Farm AB<br>Ladang Balau, Rincing | Effluent Oxidation Pond | 10 | *Trichuris* sp. ….. 120<br>Hookworm ….. 60 |
| 14G | Pig Farm AB<br>Ladang Balau, Rincing | Wastewater Oxidation Pond | 5 | *Trichuris* sp. ….. 260 |
| 15A | Pig Farm (YB) | Effluent Oxidation Pond | 10 | Oocysts (*Coccidia*) ….. 1,800 |
| 15A | Pig Farm (YB) | Wastewater Oxidation Pond | 5 | *Ascaris* sp. ….. 40<br>Hookworm ….. 320<br>Oocysts (*Coccidia*) ….. 100 |
| 15B | Cattle Farm | River water Oxidation Pond | 10 | 0 |
| 16A | Tmn PKNS, Beranang T.P. | Effluent Oxidation Pond ) | 10 | 0 |
| 18A | Cattle Farm, Bangi Lama | River water | 20 | *Strongyloides* sp. ….. 80 |
| 18B | Tmn Sri Bangi | Effluent (Imhoff tank) | 10 | *Ascaris* sp. ….. 240<br>Hookworm ….. 160<br>*Enterobius* ….. 120 |
| 21A | Cattle Farm Sg Beranang | River water | 20 | *Strongyloides* sp. ….. 20<br>Hookworm/20<br>Trematode eggs-like ….. 80 |
| 22A | Sg. Buah T.P. | Wastewater (Hikleen) | 5 | *Ascaris* sp. ….. 180<br>Hookworm ….. 120 |
| 22A | Sg. Buah T.P. | Effluent (Hikleen) | 10 | *Ascaris* sp. ….. 80 |

# Drinking Water Risk Assessment: Microbiological Issues for the Semenyih River Catchment, Peninsular Malaysia

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## Summary

A paradigm shift is occurring in the assessment of water quality. The new vision which is being driven by WHO is based on a sanitary survey and risk management approach from catchments to tap. No longer are end-of-pipe guidelines considered effective or affordable ways to reduce risks from water. The new framework commences with the setting of acceptable risk and health targets. Iterative data collection/analys is emerging as a way to evolve quantitative values, such as the one infection in 10 000 people per annum ($10^{-4}$) - the benchmark sought by the US-EPA; or a certain level of Disability Adjusted Life Years (DALY) promoted by WHO. These new frameworks will control end-product water quality using a sequence of barriers reducing hazards. These barriers would be monitored at critical control points (CCP), preferably by on-line control instrumentation. There.fore the initial sanitary survey is used to identify the nature and extent of different pollutant sources, so appropriate barriers are put in place (such as catchment management, water filtration and disinfection).

This paper describes part of the new WHO paradigm. It focuses on source water assessment and issues related to undertaking an initial sanitary survey for the Semenyih catchment. This is a major source of water for southern Kuala Lumpur and newly establishing centers in Peninsular Malaysia. Previous water quality studies in Malaysia have relied upon faecal indicator bacteria. These have principally been total and thermotolerant (faecal) coliforms, to indicate faecal pollution and thus potential health risk. Yet, in tropical waters such coliforms may grow.

In this work, *E. coli*, enterococci, sulphite-reducing clostridia and F-RNA coliphages {[1]} were used to indicate the level of contamination from a range of generic sources in the catchment. Eenterococci appeared to give the most discrimination between the level of faecal contamination at different sites. Furthermore, a palm oil estate and intensive animal husbandry were shown to release the highest, of all sites examine, for concentration of faecal wastes. The water treatment works appeared to be performing adequately. Of all the pathogen groups, the behaviour of human enteric viruses in tropical waters is least understood. Hence, ongoing work is characterizing the sources and ways of rapidly undertaking molecular typing of the human model viruses ( F-RNA and F-DNA coliphages [bacterial viruses] ). Work is also in train to improve the analyses of parasitic protozoa, with a view to identifying faecal sources and human health risks.

## INTRODUCTION

### Drinking water quality guidelines in Malaysia

Malaysia, as with most countries, has looked to WHO's earlier drinking water guidelines (WHO, 1993). Over 99% of Malaysia's drinking water comes directly from surface supplies, many of which are facing increasing levels of pollution (Pillay & Mohd Zaharon, 1997; Tong & Goh, 1997). Peninsular Malaysia has undergone rapid industrialisation and socio-economic development since the late 1980's. In consequence there has been concern over river pollution. Nonetheless, the rate of drinking water compliance to the microbiological parameter, thermotolerant (faecal) coliforms, is in excess of 95%. There are a number of deficiencies, however, in applying "end-of-treatment" guidelines. Foremost is the poor allocation of resource in collecting monitoring data that is not used to control the production of drinking water. Secondly it provide inadequate data on likely health outcomes to consumers. WHO is aware of these and other deficiencies, and is developing a "whole-of-system" risk assessment framework. This is designed to guide agencies through the processes of risk analysis and management, to improve community health outcomes (Figure 1). This paper describes part of the new WHO paradigm, with a focus on source water assessment. It canvasses issues related to undertaking an initial sanitary survey and water treatment works study in Peninsular Malaysia's rapidly developing tropical environment.

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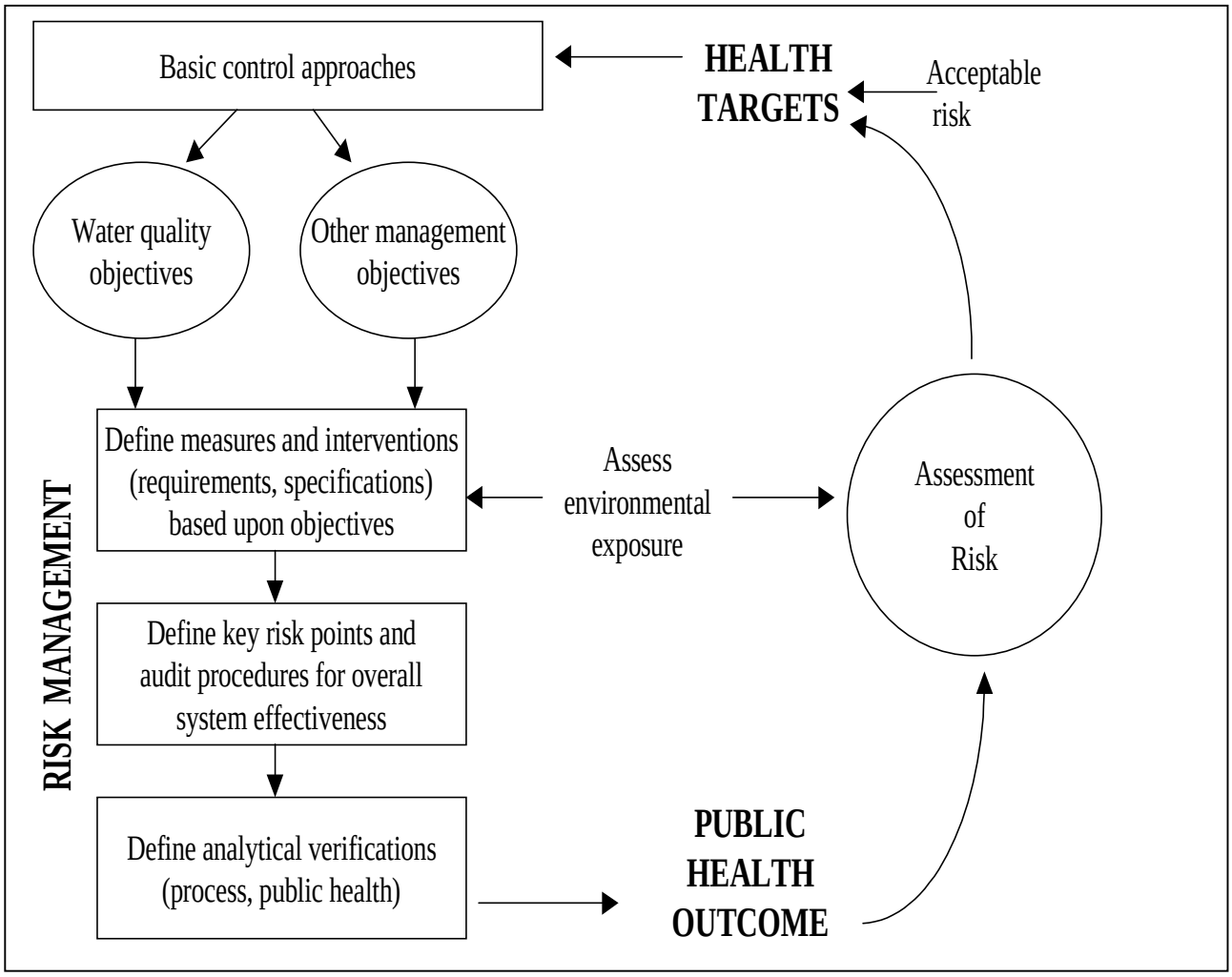



**(committee, Stockholm 1999)**

**Rationale for a risk assessment approach**

Sanitary surveys of the source water should be the first step when undertaking a human health risk assessment of a drinking water system. Subsequent steps involve evaluation of the performance of various treatment barriers (having first understand the level of treatment required from the source water survey). Further steps then assess the integrity of the distribution system (the treatment barriers are called control points). More detailed information is collected on hazards (contaminants), at each of these control points. Iterative cycles examine implied risks to exposed populations. This overall process is referred to as risk assessment.

When applying the WHO framework summarized in Figure 1, it is apparent that acceptable risk and health targets should be known (top right of Fig. 1). Initially these health targets are qualitative, but with use of the system (iterations) the goal is to evolve quantitative values. An example would be one infection in 10 000 people per annum ($10^{-4}$) – a benchmark sought by the US-EPA (Regli *et al.*, 1991). Another example would be a certain level of Disability Adjusted Life Years (DALY) (Havelaar *et al.*, 2000). Hence, the difference with the new framework is that end-product water quality objectives are met by a sequence of barriers reducing hazards. A few are critical control points (CCP) that need to be monitored, preferably by on-line control instrumentation. Therefore the initial sanitary survey is used to identify the nature and extent of different pollutant sources. Appropriate barriers are then put in place (such as catchment management, water filtration and disinfection).

The risk assessment stage is initially commenced with a screening-level risk assessment, where limited existing datasets are used with conservative assumptions in a semiquantitative manner. An alternative approach used by the food industry is called Hazard Analysis and

Critical Control Points (HACCP, Table 1). This is an assessment that ranks risks on likelihood and severity. HACCP has recently been applied by some water supply agencies. Havelaar (1994) first developed a theoretical proposal regarding the applicability of HACCP to a water supply. This was done shortly after the WHO codified HACCP through the Codex Alimentarius commission. Practical examples have been published referring to work in the United States (Barry *et al.* 1998) and Australia (Brisbane Water: Gray and Morain 1999; South East Water/Melbourne Water: Hansen, Scott and Deere 1999).

## Waterborne microbial hazards

Domestic sewage in Malaysia has been epidemiologically linked to many waterborne problems. Significant diseases such as cholera, dysentery, hepatitis A and typhoid have emerged. These acute diseases were also correlated with poor water supply status in the 1986-1987 Malaysian National Health and Morbidity Survey (Ismail, 1988; MoH, 1988).

More recently, waterborne outbreaks recorded include: 940 cases of hepatitis A in Kota Belund (1988) and 72 cases in Peninsular Malaysia (Di Napoli *et al.*, 1996), 300 cases of typhoid fever in Johor Bahru (1990), 1278 cases of cholera centred around Penang (1996) and in 1997 an enterovirus 71-adenovirus outbreak in Peninsula Malaysia and in Sarawak, where several children died (AbuBakar *et al.*, 1999; Cardosa *et al.*, 1999).

High levels of endemic illness also hide problems of waterborne disease, and most gastrointestinal illness is expected to go unreported (Frost *et al.*, 1996).

Nonetheless, waterborne pathogens would seem to be critical hazards to assess in Malaysia, and the ability of the conventional water treatment plants to remove these pathogens under local conditions is untested.

Previous water quality studies in Malaysia have relied upon faecal indicator bacteria, principally total and thermotolerant (faecal) coliforms, to indicate faecal pollution and thus potential health risk. Yet, in tropical waters, we know that such bacteria can be poor indicators of human faecal contamination (Loh *et al.*, 1990) and may indeed grow in soils and waters (Fujioka & Shizumura, 1985; Rivera *et al.*, 1988; Hardina & Fujioka, 1991; Ashbolt *et al.*, 1997).

Furthermore, coliforms are poor indicators of water treatment performance for the pathogens of concern in chlorinated waters, *viz.* enteric viruses and parasitic protozoa (Sobsey, 1989; Venczel *et al.*, 1997; Shin & Sobsey, 1998; Smith & Rose, 1998). On the other hand, direct detection of the >150 possible pathogens in waters is not practical. Hence, various index organisms, which may reflect the presence of specific groups of pathogens are now advocated when particular pathogen data is missing.

Examples are:

- spores of the anaerobic bacterium *Clostridium perfringens* which index for the parasitic protozoa and enteric viruses from human faeces, and
- bacteriophages for enteric viruses removal by treatment barriers (Payment & Franco, 1993; Ferguson *et al.*, 1996; Lucena *et al.*, 1996).

**Table 1. Expanded notes on the implementation of HACCP principles (from Deere & Davison, 1998)**

| Principle | Implementation |
|---|---|
| Initial Steps | |
| Assemble HACCP team | · A core HACCP team is formed to steer the overall process. This would include the HACCP coordinator (champion) and some of the more experienced staff. May also include outside experts. · Smaller project teams are put together to address their specialist areas (catchment management team, treatment plant operation team, system maintenance team). These teams would include the lowest level of operators through to experienced experts (may be externally sourced). |
| Describe product and its intended use | · Reference appropriate guidelines and legal requirements · Determine product to be water intended for consumption by the majority of the population |
| Produce and verify flow chart | · Each HACCP team and project team produce and then carefully verify a flow chart of the water supply process or sub-process. This also defines the scope of the plan. · The series of flow charts should illustrate what happens to the water between catchment and consumption in sufficient detail for potential entry points for contaminants to be pinpointed and any detected contamination to be traced. |
| Core Principles | |
| Hazard Analysis | · Identify hazards, potential points and modes for water supply contamination. · Determine significance of possible contamination risks (based on judgement, quantitative and qualitative risk assessment as appropriate). · Identify preventive measures (control points) for all significant risks. · Ensure those that will control the risk are responsible for and understand the risk. |
| Critical Control Points | · Identify whether controls are part of the supporting program (good operating practice, sanitation standard operating procedures) or singled out as critical control points. |
| Critical Limits | · Determine measurable control parameters and their critical limits. Ideally, assign target and action limits to pick up trends towards critical limits. |
| Monitoring | · Establish a monitoring regime to give early warning of exceedances beyond critical limits. Those responsible for the monitoring should be closely involved in developing monitoring and response procedures. |
| Corrective Actions | · Prepare and test corrective actions to prevent contaminants reaching consumers in the event of critical limits being exceeded or operational procedural failures |
| Validation | · Obtain objective evidence that the control measures and critical operational envelopes identified will in fact maintain water safety. This would draw from the literature and in-house validation exercises |
| Verification | · Obtain objective evidence that the water is in fact safe and that the good operational practices, monitoring and corrective actions are being complied with at all levels. |
| Record keeping | · Ensure that monitoring records are retained in a format that permits proof of compliance and traceability. These should be designed in close liaison with those that will be using the documents and records. |

Therefore, as an example of an integrated approach to drinking water risk assessment, this study focused on a limited group of key index organisms in the Semenyih river catchment and an associated drinking water treatment plant. The ultimate goal of this work is to provide data for rational implementation of corrective and protective measures for sustainable development of this catchment, based on a risk assessment approach.

## Semenyih River catchment

The Semenyih Catchment was identified by the Engineering Division of the MoH Malaysia as having water quality problems that are believed to be impacting on human health. The catchment encompasses the Semenyih Dam (3.6 $km^2$, 61,400 ML), which has been operating since July 1982. The Semenyih River is the source water for the Semenyih water treatment works (WTW), which currently extracts some 685 $ML.d^{-1}$ 250m upstream of the confluence with the Langat River (Figure 2). Though the catchment spans two states (Selangor and Negeri Sembilan), its drinking water is consumed in the Sepang District, Selangor and in the areas on the southern outskirts of Kuala Lumpur. Population growth in the Putra Jaya (Government Administrative City) and along the Information Technology Super Corridor (Cyber Jaya and related areas mainly within Sepang District) however, will reduce the supply to Kuala Lumpur.

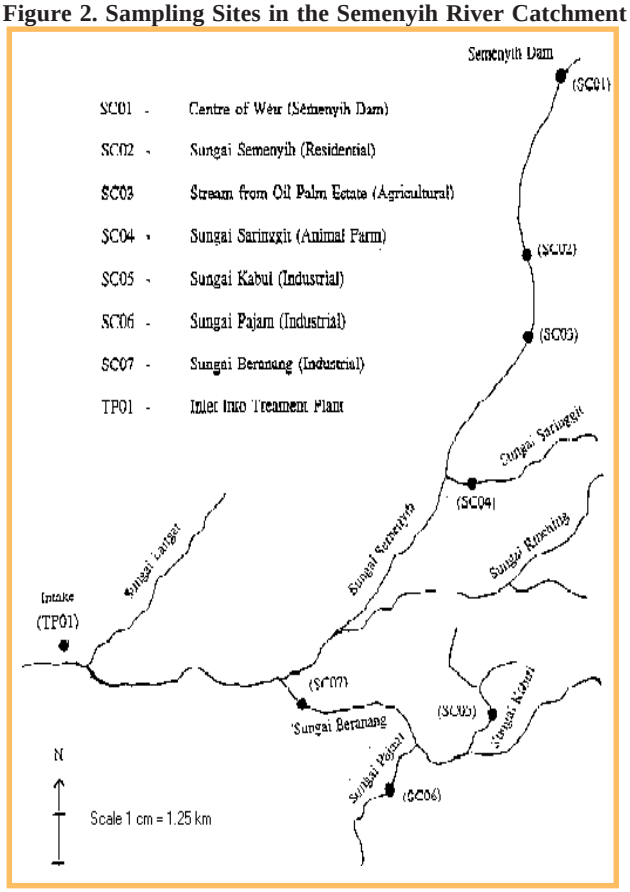
**Sampling sites and analytes**

A total of 22 water sampling sites were selected within the catchment and four within the Semenyih WTW. These represent respectively: the various types of contaminate sources within the catchment; and assessment of the treatment plant performance. A schematic diagram of the river sites is given in Figure 2 and methods used are summarised in Table 2. All microbiological data were $log_{10}$ transformed before undertaking analyses of variance (ANOVA, SigmaStat V2.0, SPSS) so that the data passed normality and equal variance tests.

**Table 2. Mycological Analytes Determined and Their Indexed Pathogens and Methods**

| Analyte {v } | Surrogate/Index for: {vi} | Method {vii} |
|---|---|---|
| Total coliforms & E. coli | Faecal contamination | Colilert 24h (IDEXX Pty. Ltd.) |
| Enterococci | Faecal contamination | Enterolert (IDEXX Pty. Ltd.) |
| Sulphite-reducing clostridia | Human-derived enteric viruses and Cryptosporidium & Giardia | MF on Perfringens agar (Oxoid) (Davies et al., 1995) |
| *Cryptosporidium* & *Giardia* spp. | *Cryptosporidium parvum* & *Giardia lamblia* | 100L by ICR yarn-filter, sucrose gradient, IFA (US-EPA, 1996) |
| F-RNA coliphages | Persistence of human enteric viruses | Double agar layer on E. coli HS(pF*amp*)R (ISO, 1995) |

**Figure 2. Sampling Sites in the Semenyih River Catchment**



## Results and Discussion

**Suitability of faecal indicators**

Concern over the unsuitability of coliforms comes from two areas, possible environmental growth, and lack of correlation to human pathogens. The first of these two issues was address by looking at correlations between the microbiological parameters analysed (Table 3). The highest correlation was seen between the sulphite-reducing clostridia (SRC) and enterococci, with moderate relationships between the F-RNA coliphages and the enterococci and SRC. The only non-significant correlation ($p>0.05$) was between total coliforms and *E. coli*, supporting the widely held understanding that many of the total coliforms present in waters were there from environmental growth (Bitton, 1994).

The relatively poor correlation between *E. coli* and the enterococci (45.3%, Table 3) may suggest different sources and/or different die-off in the environment, and/or possibly sporadic environmental growth. Though the enterococci are less numerous than *E coli* in sewage, they are considered more persistent in the environment. This differential in persistence is the major reason why the ratio between *E. coli*:faecal streptococci (enterococci) is no longer considered a valid discriminator of animal versus human faecal contamination (Godfree *et al.*, 1997) as originally proposed by Geldreich and Kenner (1969). Nonetheless, fresh faecal sources significantly higher in enterococci than *E. coli* would indicate animal rather than human faecal contamination.

Looking at the raw data between the most strongly related microbial groups, it is clear that there is a threshold for the bacterial indicators before any F-RNA coliphages were detected (about 100 enterococci or *E. coli* and 1 000 SRC). The expected ratios of the indicators in human sewage per 100mL are approximately $10^7$ *E. coli*: $10^6$ enterococci: $10^5$ SRC: $10^5$ F-RNA coliphages (Calci *et al.*, 1998). Hence, at a detection limit for the F-RNA coliphages of about 1 pfu.100mL$^{-1}$, one would expect to detect phages with about 100 *E. coli*, 10 enterococci or 1 SRC per 100mL. In reality, phages were not detected until >100 enterococci and >1000 SRC. Hence, the results may imply a more rapid die-off by the coliphages, compared to the bacterial indicators.

Though SRC are expected to be very persistent (Davies *et al.*, 1995), the persistence of coliphages (and for that matter human viruses) in tropical environmental waters is poorly understood, although die-off is considered to largely depend on water temperature and sunlight intensity (Sinton *et al.*, 1999). Therefore, the relationship between coliphages and human enteric virus persistence is an important question to answer for tropical waters. Recent data indicates that coliphage presence (in 100mL) may not be a good indicator of human enteric virus presence in tropical waters (Griffin *et al.*, 1999). Coliphages however, can be readily genotype to aid in the identification of the faecal source (Hsu *et al.*, 1995), and are considered conservative indicators of enteric virus removal by various treatment barriers (Tree *et al.*, 1997).

Comparing the microbiological data between the main river sites, it appears that site SC03 (stream from palm oil estate) is generally significantly more contaminated than many of the other sites, and site SC01 (Semenyih Dam) is the least contaminated (Table 4). Furthermore, enterococci counts, not coliforms, gave the highest definition of these differences.

One of the major advantages of studying the F-RNA coliphages as models of enteric virus persistence and removal is their assumed lack of replication in temperate and tropical waters (Havelaar *et al.*, 1993; Hernandezdelgado & Toranzos, 1995). F-RNA coliphage behaviour in tropical waters, however, has not been extensively investigated, and practically nothing is known of the faecal indicator role of the often associated F-DNA coliphages (Sinton *et al.*, 1999; Yanko *et al.*, 1999). Theoretically F-specific coliphages (RNA or DNA) could replicate in waters above 25°C, if their *E. coli* host cells are healthy enough to express the F-pilli required for phage infection (Woody & Cliver, 1995).

The ICR method employed for the parasite analyses has been shown to significantly underreport the presence of *Cryptosporidium* oocysts and *Giardia* cysts and the US-EPA have developed an improved methodology (Clancy *et al.*, 1999). Nonetheless, the results confirm the presence of these parasitic protozoa in both the protected source water at site SC01 and at the water treatment plant river offtake (TP01). Hence, it would be reasonable to assume that actual numbers of oocysts could be ten-fold higher if method of recovery was taken into consideration.

**Microbiological removal a water treatment plant (WTP)**

Treatment barriers are often considered the principal means of managing safe drinking waters. While they are a major set of barriers (sedimentation, filtration and disinfection), they should not be the sole control point. For example, the integrity of the distribution system is also critical to check by say chlorine residual maintenance or pressure changes. Conventional sedimentation, sand filtration and chlorine disinfection water treatment should remove in excess of six logs of coliforms, and this was the case for the examined plant (Table 5). Furthermore, >4.4 $\log_{10}$ enterococci and SRC were removed, the latter being a reasonable indicator of likely enteric viral and parasitic protozoan oo/cysts

physical removal (Payment & Franco, 1993) and disinfection (Venczel *et al.*, 1997). Due to the lower number of F-specific coliphages in the raw waters, the maximum removal detected was > 3 $\log_{10}$. Large volume samples (>100L) will be examined in future work on virus removal.

**Table3. Pearson correlations between F-RNA coliphages, coliforms, enterococci, sulphite-reducing clostridia (SRC) for all sites in the Semenyih catchment**

| Group | TC | *E. coli* | Enterococci | SRC |
|---|---|---|---|---|
| F-RNA phages | 0.684*** | 0.347*** | 0.748*** | 0.757*** |
| Total coliforms | | 0.252 | 0.511*** | 0.505*** |
| *E. coli* | | | 0.453*** | 0.424*** |
| Enterococci | | | | 0.964*** |

*** Correlation was significant at the 0.001 level (2-tailed), N=55.

**Table 4.** Mean microbiological numbers at the Semenyih River sites[1]

| Site (type) | Log10 Microbiological Counts (per 100mL) | | | | |
|---|---|---|---|---|---|
| | E. coli | Enterococci | SRC | F-RNA coliphage | Oocysts/ cysts[2] |
| SC01 (Dam) | 2.56 | 1.72 | 3.41 | -1.00 | 5.9/ND |
| SC02 (Residential) | 3.70* | 2.97* | 3.68 | 0.21 | ND/ND |
| SC03 (Horticultural) | 4.81* | 4.62* | 4.91* | 1.95* | ND/ND |
| SC04 (Farm animals) | 4.55* | 3.75* | 4.68* | 2.30* | 1.2/5.3 |
| SC05 (Industrial) | 4.66* | 3.77* | 4.34 | 1.23* | ND/ND |
| SC06 (Industrial) | 4.00* | 3.34* | 4.52* | 1.10* | ND/ND |
| SC07 (Industrial) | 3.77* | 3.01* | 4.22 | 0.68* | 2.4/2.5 |
| TP01 (River offtake site) | 4.01* | 3.41* | 3.99 | 2.04* | 1.2/ND |
| Std. Err. (n=5) | 0.238 | 0.254* | 0.208 | 0.334 | |

[1]See Figure 2 for site locations, means of five samplings. [2]*Cryptosporidium* oocysts/*Giardia* cysts per litre (not corrected for recovery). ND = none detected.

* *E. coli*: all sites significantly higher ($p<0.05$) than SC01.
* Enterococci: site SC03 significantly higher ($p<0.05$) than SC01, SC02, SC06, SC07, TP01; and sites SC02, SC04, SC05, SC06, SC07 and TP01 significantly higher ($p<0.05$) than SC01.
* SRC (sulphide-reducing clostridia): site SC03 significantly higher ($p<0.05$) than SC01and SC02; SC03 significantly higher ($p<0.05$) than SC01and SC02; SC06 significantly higher ($p<0.05$) than SC01.
* F-RNA coliphages: all sites except SC02 significantly higher ($p<0.05$) than SC01; sites SC03, SC04 and TP01 significantly higher ($p<0.05$) than SC02; SC04 significantly higher ($p<0.05$) than SC07.

**Table 5. Mean $log_{10}$ microbial numbers during water treatment**

| Group | Inlet (TP01) | Settled (TP02) | Filtered (TP03) | Post-chlorination (TP04) | Overall reduction ($log_{10}$) |
|---|---|---|---|---|---|
| Total coliforms | 5.11 | 2.80 | <-1.0 | <-1.0 | >6.0 |
| *E.coli* | 4.01 | 2.06 | <-1.0 | <-1.0 | >5.0 |
| Enterococci | 3.41 | 0.34 | <-1.0 | <-1.0 | >4.4 |
| SRC | 3.99 | 1.94 | <-0.3 | <-0.3 | >4.7 |
| F-RNA coliphage | 2.04 | <-1.0 | <-1.0 | <-1.0 | >3.0 |

## Conclusion

The initial sanitary survey has highlighted the significant level of faecal pollution present in Semenyih catchment waters. In particular, a palm oil estate and chicken houses released both significant concentrations and volumes to the Semenyih River. The methods used, however, could not discriminate between human sewage and animal wastes as the most important source of faecal pollution. Ongoing work is focusing on sourcing the faecal contamination types.

Various methodological problems were also experienced when undertaking largely novel methods in Malaysia. In particular, evidence was present for environmental growth of *E. coli*, and the very poor recovery of the parasitic protozoan oo/cysts of *Cryptosporidium* and cysts of *Giardia*. Both of these issues are being tackled by on-going research by the EHRC group, along with novel faecal stanols analyses (Leeming *et al.*, 1998) to further identify the source(s) of faecal contamination.

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## References

AbuBakar, S., H.Y. Chee, M.F. Al-Kobaisi, X.S. Jiang, K.B. Chua and S.K. Lam (1999). Identification of enterovirus 71 isolates from an outbreak of hand, foot and mouth disease (HFMD) with fatal cases of encephalomyelitis in Malaysia. Virus Res. 61(1):1-9.

Ashbolt, N.J., M.R. Dorsch, P.T. Cox and B. Banens (1997). Blooming *E. coli*, what do they mean? In: Coliforms and *E. coli*, Problem or Solution? (Eds.: Kay, D. and C. Fricker) The Royal Society of Chemistry, Cambridge, pp:78-85.

Barry, S.J., Atwill, E.R., Tate, K.W., Koopman, T.S., Cullor, J. and Huff, T. (1998) Developing and Implementing a HACCP-Based Programme to Control *Cryptosporidium* and Other Waterborne Pathogens in the Alameda Creek Watershed: Case Study. Proceedings of the American Water Works Association Annual Conference, 21-25 June 1998, Dallas, Texas *Water Resources* Vol. B: 57-69

Bitton, G. (1994). Wastewater Microbiology. Wiley-Liss, John Wiley & Sons, Inc, New York. 478 pages.

Calci, K.R., W. Burkhardt III, W.D. Watkins and S.R. Rippey (1998). Occurrence of male-specific bacteriophage in feral and domestic animal wastes, human feces, and human-associated wastewaters. Appl. Environ. Microbiol. 64(12):5027-5029.

Cardosa, M.J., S. Krishnan, P.H. Tio, D. Perera and S.C. Wong (1999). Isolation of subgenus B adenovirus during a fatal outbreak of enterovirus 71-associated hand, foot, and mouth disease in Sibu, Sarawak. Lancet 354(9183):987-991.

Clancy, J.L., Z. Bukhari, R.M. McCuin, Z. Matheson and C.R. Fricker (1999). USEPA method 1622. J. AWWA 91(9):60-68.

Davies, C.M., J.A. Long, M. Donald and N.J. Ashbolt (1995). Survival of fecal microorganisms in aquatic sediments of Sydney, Australia. Appl. Environ. Microbiol. 61:1888-1896.

Deere, D.A. and Davison, A.D. (1998) Safe Drinking Water. Are Food Guidelines the Answer? *Water* November/ December: 21-24

Di Napoli, A., Y.F. Ngeow, C.W. Wang and P.I. Chew (1996). Recovery of hepatitis A virus and other enteroviruses from water samples. Asia Pacific J. Mol. Biol. Biotechnol. 4(4):243-249.

Ferguson, C.M., B.G. Coote, N.J. Ashbolt and I.M. Stevenson (1996). Relationships between indicators, pathogens and water quality in an estuarine system. Wat. Res. 30(9):2045-2054.

Frost, F.J., G.F. Craun and R.L. Calderon (1996). Waterborne disease surveillance. J. AWWA 88(9):66-75.

Fujioka, R.S. and L.K. Shizumura (1985). *Clostridium perfringens*, a reliable indicator of stream water quality. J. Wat. Pollut. Contr. Fed. 57:986-992.

Geldreich, E.E. and B.A. Kenner (1969). Concepts of faecal streptococci in stream pollution. J. Wat. Pollut. Contr. Fed. 41:R336-R352.

Godfree, A.F., D. Kay and M.D. Wyer (1997). Faecal streptococci as indicators of faecal contamination in water. J. Appl. Microbiol. 83:S110-S119.

Gray, R and Morain, M (1999) HACCP application to Brisbane Water. *Water* November/December: in press

Griffin, D.W., C.J. Gibson III, E.K. Lipp, K. Riley, J.H. Paul III and J.B. Rose (1999). Detection of viral pathogens by reverse transcriptase PCR and of microbial indicators by standard methods in the canals of the Florida Keys. Appl. Environ. Microbiol. 65(9):4118-4125.

Hansen, G. Scott T. and Deere, D. (1999) Applying the Risk Management Standard in a Water Business. Proceedings of the Australian Water and Wastewater Association Conference, 21 to 23 October 1999, Albury, NSW Australia.

Hardina, C.M. and R.S. Fujioka (1991). Soil: The environmental source of *Escherichia coli* and enterococci in Hawaii's streams. Environ. Toxicol. Wat. Qual. 6:185-195.

Havelaar, A.H. (1994) Application of HACCP to Drinking Water Supply. *Food Control* **5**: 145-152

Havelaar, A.H., M. Vanolphen and Y.C. Drost (1993). F-specific RNA bacteriophages are adequate model organisms for enteric viruses in fresh water. Appl. Environ. Microbiol. 59:2956-2962.

Havelaar, A.H., A.E.M. De Hollander, P.F.M. Teunis, E.G. Evers, H.J. Van Kranen, J.F.M. Versteegh, J.E.M. Van Koten and W. Slob (2000). Balancing the risks and benefits of drinking water disinfection: DALYs on the scale. Environ. Health Perspect. 108:315-321.

Hernandezdelgado, E.A. and G.A. Toranzos (1995). *In situ* replication studies of somatic and male-specific coliphages in a tropical pristine river. Wat. Sci. Tech. 31(5-6):247-250.

Hsu, F., C. Heih, J. Van Duin, M. Beekwilder and M. Sobsey (1995). Genotyping male-specific RNA coliphages by hybridization with oligonucleotide probes. Appl. Environ. Microbiol. 61(11):3960-3966.

Ismail, A. (1988). An update on diarrhoeal diseases in Malaysia. SE Asian J. Trop. Med. Pub. Health 19(3):397-400.

ISO (1995). Water Quality - Detection and Enumeration of Bacteriophages. Part 1: Enumeration of F-specific RNA bacteriophages. (, ISO 10705-1.) International Organization for Standardization, Geneva. 15 pages.

Leeming, R., P.D. Nichols and N.J. Ashbolt (1998). Distinguishing Sources of Faecal Pollution in Australian Inland and Coastal Waters using Sterol Biomarkers and Microbial Faecal Indicators. Research Report No. 204. Water Services Association of Australia, Melbourne. 46 pages.

Loh, C.L., H.M. Zain, Y.F. Ngeow, C.W. Wang and Y.C. Ho (1990). Assessment of standard methods for the detection of faecal contamination in the monitoring of streams in an equatorial rain forest. Malay. Nat. J. 44:77-83.

Lucena, F., R. Araujo and J. Jofre (1996). Usefulness of bacteriophages infecting *Bacteroides fragilis* as index microorganisms of remote faecal pollution. Wat. Res. 30(11):2812-2816.

MoH (1988). National Health and Morbidity Survey 1986-1987. Vol. III Overview of findings and recommendations. Public Health Institute, Kuala Lumpur, Malaysia.

Payment, P. and E. Franco (1993). *Clostridium perfringens* and somatic coliphages as indicators of the efficiency of drinking water treatment for viruses and protozoan cysts. Appl. Environ. Microbiol. 59:2418-2424.

Pillay, M.S. and M.T. Mohd Zaharon (1997). Water quality - probles and solution. Engineering Services Division, Misistry of Health, Kuala Lumpur, Malaysia.

Regli, S., J.B. Rose, C.N. Haas and C.P. Gerba (1991). Modeling the risk from *Giardia* and viruses in drinking water. J. AWWA 83(11):76-84.

Rivera, S.C., T.C. Hazen and G.A. Toranzos (1988). Isolation of fecal coliforms from pristine sites in a tropical rain forest. Appl. Environ. Microbiol. 54(2):513-517.

Shin, G.A. and M.D. Sobsey (1998). Reduction of norwalk virus, poliovirus 1 and coliphage MS2 by monochloramine disinfection of water. Wat. Sci. Tech. 38(12):151-154.

Sinton, L.W., R.K. Finlay and P.A. Lynch (1999). Sunlight inactivation of fecal bacteriophages and bacteria in sewage-polluted seawater. Appl. Environ. Microbiol. 65(8):3605-3613.

Smith, H.V. and J.B. Rose (1998). Waterborne cryptosporidiosis - current status [review]. Parasitology Today 14(1):14-22.
Sobsey, M.D. (1989). Inactivation of health-related microorganisms in water by disinfection processes. Wat. Sci. Tech. 21(3):179-195.
Tong, S.L. and S.H. Goh (1997). Water quality criteria and standards development and river classification in Malaysia. J. Ensearch 10:15-26.
Tree, J.A., M.R. Adams and D.N. Lees (1997). Virus inactivation during disinfection of wastewater by chlorination and UV irradiation and the efficacy of F+ bacteriophage as a viral indicator. Wat. Sci. Tech. 35(11-12):227-232.
US-EPA (1996). ICR Microbiology Laboratory Manual. (, EPA600-R-95-178.) United States Environmental Protection Agency, Washington, D.C.
Venczel, L.V., M. Arrowood, M. Hurd and M.D. Sobsey (1997). Inactivation of *Cryptosporidium parvum* oocysts and *Clostridium perfringens* spores by a mixed-oxidant disinfectant and by free chlorine. Appl. Environ. Microbiol. 63(4):1598-1601 with ereatum 63(11):4625.
Woody, M.A. and D.O. Cliver (1995). Effects of temperature and host cell growth phase on replication of F-specific RNA coliphage $Q^2$. Appl. Environ. Microbiol. 61:1520-1526.
Yanko, W.A., J.L. Jackson, F.P. Williams, A.S. Walker and M.S. Castillo (1999). An unexpected temporal pattern of coliphage isolation in groundwaters sampled from wells at varied distances from reclaimed water recharge sites. Wat. Res. 33(1):53-64.

# A Review of an Isolated Dengue Outbreak in Perak Tengah Health District, January 2002

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## Introduction

An outbreak of dengue occurred at Taman Parit Jaya, Parit during January - February 2002. A total of 13 people were infected. The last episode of dengue outbreak was in February 1992.

**Findings**

Their ages varied from 10 years to 62 years. There were 8 males and 5 females. Only one person was an Indian and the rest were Malays. The mean age was 30 years. All of them stayed in Taman Parit Jaya. The notification time after onset of symptoms varied from less than 1 day to 14 days. The mean notification time was 5.7 days. All of them were admitted to a nearby government hospital. Three of them were referred to a government specialist hospital. Four of them were positive of IgM. *Aedes* survey done inside and just outside the houses was not significant. There was massive breeding in the nearby "no man's land" where the residents have been dumping their garbage.

**Summary**

The attitude of the community regarding cleanliness and disposing of garbage is important. The community must be civic minded and not self-centred.

**Conclusion**

This dengue outbreak was contained because of remedial action taken by the local community, local town council, fire brigade and village safety committee. Inter sectoral collaboration and community participation are important ingredients to a successful public health programme.


***Key Words*: Dengue, Community participation, Perak Tengah**

## Introduction

Dengue virus is widely distributed throughout the tropics and subtropics. Dengue fever which occurs intermittently in large epidemics is clinically similar to fever caused by chikungunya, O'nyong-nyong and West Nile viruses. Four types of dengue virus exist. Type 1 was first isolated from Hawaii in 1944, Type 2 from New Guinea in 1994 and Type 3 and Type 4 from the Philippines in 1956 (Ananthanarayan 1981). Dengue fever has been known in Asia for more than a century, as a mild disease in children and more severe in adults. DHF was first recognized as an illness in the Philippines in 1953, and occurred in epidemic form in Manila in 1956 and in Bangkok in 1958 (Poon and Chen 1987). Since then there have been major outbreaks of DHF in large urban areas in Southeast Asia including Bangkok, Jakarta, Yangon, Manila, Singapore and Malaysia. The disease has spread from urban areas to smaller towns and cities in provincial areas, occurring in small communities where the *Aedes aegypti* mosquitoes are prevalent. As a rule the population of *Aedes aegypti*, increases before an outbreak occurs. *Aedes albopictus* is also incriminated as another important vector of dengue (Rudnick 1986). The outbreak usually commences at the beginning of the rainy season, spreads to different areas of the country and lasts until the end of the season.

Dengue virus belongs to the arbovirus group. Arboviruses (arthropod - borne viruses) are viruses of vertebrates biologically transmitted by haematophagous insect vectors. They multiply in blood sucking insects and are transmitted by bite to vertebrate hosts. Arboviruses have a very wide host range including many species of animals and birds. Ability to multiply in arthopods is their special characteristic (Ananthanarayan, 1981).

## Situation in Malaysia

In 1973 a first major outbreak of DF and DHF in Malaysia occurred in Selangor, which then spread to Negeri Sembilan and Johore. Thereafter a dengue epidemic occurred after every 4 years, that was 1974, 1978, 1982 and 1986. Malaysia also experienced another major outbreak between 1997 and

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1998 where 19,429 and 27,381 cases were reported respectively (Yunus 1998). Currently the country is undergoing a severe outbreak of the disease whereby in many states like Perak, Selangor and Federal Territory there have been 2-3 fold increase in some areas and many deaths have been notified. Dengue incidence rates of 36.41 per 100,000 population in 1991 had increased to 90.21 per 100,000 population in 1997 and further increased to 123.45 per 100,000 populations in 1998 (RKPBV 1998 and RKPBV 1992).

## Background of Perak Tengah District

The Perak Tengah District is situated centrally in the Perak State. It was formed in the mid –1979. It covers an area of 1282 sq. km with 10 mukims. Its population is about 82,103 and nearly 95 percent are Malays, 3.5 percent Indians and 1.5 percent Chinese. Its main economic activity is agriculture with many oil palm, rubber, banana and coconut plantations. The Seberang Perak region is a well-developed and well-planned paddy growing area. The majority of the working population is employed at the state and federal government departments whereas the rest work in farms, factories or self employed. The Perak Tengah district has the highest population of older persons as compared to the other districts in Perak. The Perak River divides the district into two parts. The health facilities in this district is well spread. There are 6 community health centers, 1 hospital with primary care, 34 rural clinics and a few GPs. Generally there are no diseases widespread in this district. The common disease here is food poisoning or acute gastroenterities in a religious boarding school, which occurs one to two times in a year. There are not many outbreaks of contagious disease or vector borne disease. The commonest diseases are those due to old age and lifestyle related diseases like hypertension, diabetes, deaths due to road traffic accidents and cerebro – vascular accidents (Perak Tengah Health Department, Annual Report, 2001).

## The current outbreak

Generally dengue is not a major problem in this district. From 1997 to 2001 the dengue cases varied from 5 cases a year in 2000 to 21 cases in 1998, with an average of 12 cases per year for that period (Table 1). For the same period from 1997 to 2001 there were only 2 cases of dengue haemorrhagic fever. There were no deaths reported from either DF or DHF during 1997 to 2001 (Table 2) (Perak State Vector Report 1999 – 2001).

**Table 1.** Dengue cases in Perak State and Perak Tengah Health Districts, from 1997 – week 45, 2002

| | 1997 | 1998 | 1999 | 2000 | 2001 | Week 45 | Total |
|---|---|---|---|---|---|---|---|
| Perak tengah | 9 | 21 | 19 | 5 | 8 | 51 | 113 |
| Perak state | 972 | 1440 | 1029 | 381 | 1379 | 2119 | 7320 |
| Percentage% | 0.92 | 1.46 | 1.85 | 1.31 | 0.58 | 2.41 | 1.54 |

Source: Perak State Health Department, Vector Unit, Ipoh.

**Table 2**. Dengue haemorrhagic fever (DHF) cases in Perak State and Perak Tengah Health Districts from 997 to week 45, 2002

| | 1997 | 1998 | 1999 | 2000 | 2001 | Week 45, 2002 | Total |
|---|---|---|---|---|---|---|---|
| Perak Tengah | 1 | 1 | 0 | 0 | 0 | 1 | 3 |
| Perak state | 35 | 37 | 18 | 6 | 17 | 82 | 195 |
| Percen-tage(%) | 2.86 | 2.70 | 0 | 0 | 0 | 1.22 | 1.54 |

Source: Perak State Health Department, Vector Unit, Ipoh.

The isolated dengue outbreak, which occurred in Taman Parit Jaya, Parit was from January to February 2002. This housing area is situated 3 km from the Parit town. The majority of the people here are of middle income group with many of them working in factories, semi-skilled workers, government department employees and self employed. Ninety percent of them are Malays. The houses here are terrace, single storied houses. There is a good drainage system in this area with drains passing in the front and back of the houses. This housing area is situated about 5km to the Parit Health Centre and the nearest district hospital is 20 km away. The infrastructure and public transportation is very good. Garbage collection has been subcontracted to a private firm and the services are not very pleasing.

## Materials and methods

As outlined in the prevention and control of dengue program, a dengue case is defined as any confirmed or suspicious dengue case that was diagnosed by a medical officer and notified through telephone or notification form to the nearest health department (RKPBV 1986). Based on those criteria, it was decided to review all the 13 dengue cases, which were reported to the health department from 24.1.2002 to 16.2.2002. A retrospective study was conducted on these cases by going through the notification forms and reviewing all the dengue preventive work done during the same period. A similar outbreak occurred in February 1992. The information which were gathered from the investigation forms were onset of illness, date of admission, date of notification, demographic data, signs and symptoms of dengue, laboratory findings, date of blood specimen taken for IgM tests, and dengue preventive activities done during that period. These data were analyzed by computer programmed with statistics.

## Results

A total of 13 cases were reported during this 3 weeks compared to 8 cases for the whole of 2001 and 5 cases for the whole of 2000 (Table 1). This showed a tremendous and drastic increase compared to the previous years. There were children and older persons infected in this outbreak. The ages varied from 10 years to 62 years with a mean of 30 years (Table 3). There were 8 males and 5 females. Twelve were Malays and 1 was an Indian. All the victims stayed in the same locality.

All the cases were notified to the nearest health center and then to the health office. Notification time varied from less than 24 hours to 14 days. The mean notification time was 5.7 days (Table 4). All the patients were admitted to two nearby government hospitals without specialist care. Three of these patients were then sent to the nearest referral government specialist hospital, which is about 25 – 40 km from these two district hospitals. Two of the children who were sisters were issued DIL (Dangerously Ill Listed) and were admitted to the intensive care unit (ICU). Only four results results returned as IgM positive. None of the victims died during this outbreak (Perak Tengah Vector Returns, 2002).

**Table 3.** Age distribution of patients during 2002 Perak Tengah outbreak

| Age Range In Years | No. Of Patients | Percentage |
|---|---|---|
| 10 – 19 | 5 | 38.4% |
| 20 – 29 | 1 | 7.7% |
| 30 – 39 | 4 | 31.0% |
| 40 – 49 | - | - |
| 50 – 59 | 2 | 15.4% |
| 60- 69 | 1 | 7.7% |
| TOTAL | 13 | 100% |

Source: Perak Tengah Health Department, Dengue Returns 2002, Seri Iskandar

**Table 4.** Notification time of suspected dengue fever during 2002 Perak Tengah outbreak

| No. of days | No. of patients | Percentage |
|---|---|---|
| < 1 | 1 | 7.7% |
| 1- 5 | 7 | 53.8% |
| 6 – 10 | 3 | 23.0% |
| 11 – 15 | 2 | 15.4% |
| TOTAL | 13 | 100% |

** Note: All cases considered as dengue cases when notified.*
Source: Perak Tengah Health Department, Dengue Returns 2002, Seri Iskandar

*Aedes* survey was done in this area. It was not significant. The *Aedes* Index and Breteau Index were within normal range. There was 100% fogging done. ULV (Ultra low volume) spraying with 1 cup resigen diluted with 9 cups of diesel was done extensively. Although there was no clue why the cases were rising in spite of no adverse finding, the vector control team looked into the other possibility of *Aedes* breeding. There were a few "no man's land" identified in this housing area. They were the rubber estates at the back of the houses, which were not used for rubber tapping and no one really supervised them.

A random *Aedes* survey was conducted in this " no man's land". Adult *Aedes albopictus* species were identified. *Aedes albopictus* larvae were found in many water collecting receptacles. Both the adult *Aedes albopictus* and its larvae were confirmed by the state entomologist. A massive community "gotong-royong" (search and destroy) activity was conducted. The community, members of the mosque, health department workers, local council workers, fire brigade workers, village JKKK (safety and health committee) helpers and many others took part in these "gotong-royongs". Two such "gotong-royongs" were held and all the garbage were collected and disposed off. The garbage included refrigerators, television sets, fans, air-conditioners, sofa sets, washing machines and many more household goods. After this, the dengue cases dropped drastically (Tham, 2001).

## Discussion

Dengue presents typically as a fever of sudden onset with headache, retrobulbar pain, pain in the back and limbs (break - bone fever), lymphadenopathy and maculopapular rash. The fever is typically biphasic (saddle -back) and last for 5-7 days followed as a rule by recovery (Das, 1982). Dengue may also occur in more serious forms, with haemorrhagic manifestations ('Dengue Hemorrhagic Fever') or with shock ('Dengue Shock Syndrome') (Ananthanarayan 1981). Dengue is originally a disease of the canopy monkeys (Rudnick, 1986) Dengue virus is transmitted from man to man by *Aedes aegypti* and *Aedes albopictus* mosquitoes.

In DHF there is an increase of IgE in the serum. Disseminated intravascular coagulation and complement activation which leads to vascular damage are thought to be triggered by hypersensitivity to the virus (Macleod 1981). Though there is no medication that can kill the virus, the treatment of dehydration, blood loss and shock is important and life – saving (Lee, 1999).

The dengue situation in Perak Tengah district has never been more serious than in the current year of 2002. Statistics

showed that for the years 1997 to week 45 of 2002 there were 7320 cases of dengue fever and 195 DHF cases in the state. During this same period Perak Tengah had 113 cases of DF and 3 cases of DHF (Table 1 and Table 2). This was only a mere 1.54 percent of the total cases of DF and 1.53 percent of DHF. But the scenario for the year 2002 only was totally different. Until week 45 in the year 2002 Perak recorded 2119 and Perak Tengah recorded 51 DF cases respectively. This is 2.41 percent of the total cases of DF in Perak (Table 1). In other words Perak Tengah achieved a six-fold increase compared to 2001 and ten fold increase compared to 2000 for DF cases. This is for the 45$^{th}$ week ending in October 2002. For DHF there was no significant increase in Perak Tengah cases compared to Perak State DHF cases.

From 1997 to week 45 of 2002 a total of 338,715 premises were inspected for *Aedes* breeding (Table 5). During this period 2980 premises were found breeding *Aedes* (Table 6). The house index was 0.88 percent. During this period 2957 premises with *Aedes albopictus* were found (Table7) and only 23 premises were found to breed *Aedes aegypti* (Table 8) and percentage of *Aedes aegypti* is only 0.77 (Table 6, 8). This is different from some Asian and Pacific countries where *Aedes aegypti* is considerably higher. From 1998 to 2002 the *Aedes* Index varied from 0.38 to 0.70 percent and Breteau Index varied from 0.39 to 1.00 well within the normal range. So far in the district only 1 person has been taken to court for failing to settle his compound. A total of 1014 compounds were issued to premise owners and a total of RM 52,530.00 was collected as fines during this period (Table 9).

The Perak Tengah health department carried out various dengue control activities which included fogging and larviciding, health education talks, exhibitions and dialogue sessions (Table 10). The importance of dengue control was emphasized during monthly district action committee meetings where the local representatives were present. "Gotong-royong" (search and destroy) activities was also emphasized and they took place in collaboration with other agencies (Poon and Chen, 1987).

## Conclusion

In conclusion although dengue is a dangerous disease it could be controlled with the co-operation of the people. People should be civic minded and health conscious and should really care for the environment and their neighbours (Abu Baker, 2001). Indiscriminate throwing of garbage must be stopped immediately. Early identification of the sign and symptoms, prompt notification and immediate treatment are the hallmarks to prevent fatality.

**Table 5.** Total number of premises inspected for *Aedes* larvae in Perak State and Perak Tengah Health Districts from 1997 to week 45, 2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | Week 45, 2002 | total |
|---|---|---|---|---|---|---|---|
| Perak Tengah | 82,347 | 54, 740 | 54, 474 | 53, 987 | 47, 374 | 45, 793 | 338, 715 |
| Perak state | 1,029,425 | 765, 690 | 719, 486 | 715, 302 | 695, 779 | 577,158 | 4,502,840 |
| Percentage | 8.0% | 7.1% | 7.6% | 7.5% | 6.8% | 7.9% | 7.5% |

Source: Perak State Health Department, Vector Unit, Ipoh

**Table 6.** Total number of premises positive for breeding *Aedes aegypti* and *Aedes albopictus* larvae in Perak State and Perak Tengah Health Districts from 1997 to week 45, 2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | Week 45, 2002 | Total |
|---|---|---|---|---|---|---|---|
| Perak Tengah | 1622 | 382 | 340 | 272 | 182 | 182 | 2, 980 |
| Perak state | 10, 018 | 8, 342 | 5, 831 | 3, 745 | 3, 401 | 3, 501 | 34,838 |
| Percentage | 16.19% | 4.58% | 5.83% | 7.26% | 5.35% | 5.20% | 8.55% |

Source: Perak State Health Department, Vector Unit, Ipoh

**Table 7.** Total number of premises positive for breeding *Aedes albopictus* larvae in Perak State and Perak Tengah Health Districts from 1997 to week 45, 2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | Week 45, 2002 | Total |
|---|---|---|---|---|---|---|---|
| Perak Tengah | 1, 617 | 377 | 338 | 270 | 180 | 175 | 2, 957 |
| Perak state | 8, 619 | 6, 844 | 5, 176 | 3, 374 | 3, 011 | 2, 744 | 29, 768 |
| Percentage | 18.76% | 5.50% | 6.53% | 8.00% | 5.98% | 6.37% | 9.93% |

Source: Perak State Health Department, Vector Unit, Ipoh

**Table 8.** Total number of premises positive for breeding *Aedes aegypti* larvae in Perak State and Perak Tengah Health Districts from 1997 to week 45, 2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | week 45, 2002 | Total |
|---|---|---|---|---|---|---|---|
| Perak Tengah | 5 | 5 | 2 | 2 | 2 | 7 | 23 |
| Perak state | 1399 | 1498 | 655 | 371 | 390 | 757 | 5, 070 |
| Perak state | 1399 | 1498 | 655 | 371 | 390 | 757 | 5, 070 |

Source: Perak State Health Department, Vector Unit, Ipoh

**Table 9.** Number of compounds issued and total fines collected from 1997 – week 45, 2002.

| Year | Total compounds issued | Total fines collected (RM) |
|---|---|---|
| 1997 | 422 | 21,150.00 |
| 1998 | 54 | 2,890.00 |
| 1999 | 123 | 6,550.00 |
| 2000 | 130 | 6,700.00 |
| 2001 | 141 | 7,800.00 |
| Till week 45, | 144 | 7,450.00 |
| Total | 1014 | 52,540.00 |

Source: Perak Tengah Health Department, Seri Iskandar

**Table 10.** Total number of premises treated with temephos sand granules fogged from 1997 – week 45, 2002

| **Year** | **Premises with ABATE spray with fogging done** | **Premises** |
|---|---|---|
| 1997 | N/A | 12,711 |
| 1998 | 524 | 1,800 |
| 1999 | 272 | 1,759 |
| 2000 | 76 | 972 |
| 2001 | N/A | 2198 |
| until week 45, 2002 | 23 | 3832 |

Source: Perak Tengah Health Department, Seri Iskandar


## Acknowledgement

I wish to thank the Perak State health director, Deputy Director (public health), the staff of vector unit, Perak Tengah health department, Ms. N. Pushpa B.E, Mr. E. Subash and all the others who have helped me in one way or the other to present this research.


## References


1. Ananthnarayan R, Paniker CKJ (1981). Arboviruses, in "Textbook Of Microbiology" Ed. Ananthnarayan R and Paniker CKJ, 2nd edition, pg. 489 – 500.

2. Phoon WO & Chen PCY (1987), Vector borne diseases, dengue hemorrhagic fever in "A Textbook Of Community Medicine in South East Asia", Ed. Phoon WO & Chen PCY, student edition, pg. 160 – 162.

3. Rudnick A (1986). Dengue virus ecology in Malaysia, in " Dengue fever studies in Malaysia". Ed. Rudnick A & Lim TW, Bull. No. 23, Institute for Medical Research, pg. 51-153.

4. Yunus NA (2001) A review of dengue outbreak in Terengganu from January To December 1998, in "Vector Journal ".Ed. Lee HL, Vol. 7, No.1, 2001, Vector – borne disease branch, Ministry of health, Malaysia, pg. 33 – 37.

5. RKPBV (1998), Analytical report of dengue fever and dengue haemarrhagic fever in 1998. Vector borne disease control unit, Ministry of Health, Malaysia.

6. RKPBV (1992) Annual report 1992. Chapter 4.2 "Dengue". Vector borne disease control unit, Ministry Of Health, Malaysia. pg. 29 – 46.

7. Annual report, Perak Tengah Health Department 2001. pg. 1 – 5, pg. 40 – 42.

8. Perak State Vector Department, Dengue Returns 1997 – 2002.

9. RKPBV (1986). Guideline for prevention and control of dengue fever/dengue hemorrhagic fever. Vector borne disease control unit, Ministry of health, Malaysia, 1986:9.

10. Perak Tengah District Vector Borne Disease Returns. 1999 – 2002.

11. Tham AS and Ramlee HR (2001). Issues and challenges in *Aedes* surveillance and control in " Vector Journal ". Ed. Lee HL, Vol.7, no. 1, 2001, vector – borne disease branch, Ministry of health, Malaysia, pg. 38 – 46.

12. Das PC (1982) Chapter 5, Infectious diseases, dengue, in "Textbook of Medicine". Ed. Das PC, 2nd edition pg. 330 – 332.

13. Macleod J (1981) Chapter 17, Tropical diseases and helminthic infections, in "Davidson's principles and practice of medicine", Ed. Macleod J, 13th edition. pg. 845 – 846.

14. Lee YS (1999). Chapter 9, section A, Doctor I have fever; Chapter 10, Doctor I bruise easily in "Medicine facts for the layman", Ed. Lee YS 1st edition. pg. 25 and 32.

15. Abu Brakar AM and Yadav H (2001). Community participation in *Aedes* control – A case study in " Vector Journal ". Ed. Lee HL , Vol. 7 , No. 1, 2001, vector borne, disease branch, Ministry of health, Malaysia, pg. 47 – 52.

# Literature Reviews

## Healthy Workplaces – a literature review

Dr Iylen Benedict[i], Ms Rosemary Nicholson[ii], Dr Zina O'Leary[iii], Ms Megan Tranter[iii]

The changing workforce is one of the greatest challenges facing developing countries in the new millennium. Changes to work processes and technology (Bohle & Quinlan 2000) are introducing:

- hazardous substances use;
- new organizational structures and work organization;
- new workforce characteristics; and
- a new regulatory environment.

It is vital that health at work is maintained for the benefit of the individual, the community and the employer. Developed countries have already moved forward with strategies for occupational health (Rantanen 1998). At this time developing nations are still grappling to introduce and validate culturally appropriate programs. They need to move beyond minimum legislative requirements (Machida & Markkanen 2000). In doing this they must think holistically about the health of workers in terms of their physical, mental and social wellbeing (WHO/ILO, cited in NHMRC 1973).

One such approach has been the World Health Organization's 'Healthy Cities' project, which was introduced to Europe in the late 1980s. Since this time, 'Healthy Cities' has expanded throughout the world, including the Western Pacific region. The visions and outcomes of the 'Healthy Cities' project have been discussed extensively (see Ashton 1991; Flynn 1996; Gupta 1995). A key strategy in this implementation has been inter-sectoral collaboration to ensure health is explicitly considered in urban management and development planning. The project utilizes a multi-sectoral approach which is grounded within a defined population or *setting* (WHO 1999).

The settings approach takes health promotion into the arena of organizations such as schools, cities, islands, villages, marketplaces and workplaces (McMurray 1999). While not new to health promotion, this concept has brought a change of emphasis over the past decade. Formerly, settings were regarded in the health promotion arena, as little more than convenient points of access to gatekeepers and captive audiences (Lin 1999).

The significance of socio-environmental impacts on health was first recognised by the Ottawa Charter. This brought a shift away from the traditional focus on education for individual lifestyle behaviour change (WHO 1986). In this context, settings are now recognised as deeply binding social systems, each characterised by its own particular form of membership and communication. Each has the potential capacity for sustainable change, which health promotion in the 21st century seeks to facilitate (Lin 1999, Baum 1998).

'Settings for Health' were more recently affirmed by the Jakarta Declaration on Health Promotion Into the 21st Century (WHO 1997). Here settings are defined as representing the organisational base of the infrastructure required for health promotion. Furthermore the Jakarta Declaration specifically acknowledges the workplace as a setting. It offers the potential, through production and marketing practices, for significant impact on the health, not only of individual employees, but also on the wider community.

The World Health Assembly, at its annual meeting in 1998, reinforced the need for comprehensive approaches to health promotion. It derived a particular focus on 'settings' and investment in health. This approach is supported by research findings that clearly indicate how successful health promotion relies on a combination of community empowerment, supportive environments and reduction of inequities (Kickbush in McMurray 1999).

Baum (1998) describes healthy settings as characterised by a shift in organisational forms from 'hierarchical and inward-looking' to 'networked and outward-looking'. Baum defines a health promoting organization as one which:

- takes a broad view of health;
- emphasises staff development and control over their work lives;
- sees its role as developing healthy public policy and environmental improvement; and
- develops and fosters networks and alliances in pursuit of health promotion.

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The development of 'healthy workplaces' is now under consideration. Traditionally health promotion in the workplace has focused on the prevention of ill health resulting from workers' exposure to physical, chemical and biological hazards. In some instances this has been combined with lifestyle programs addressing singular behavioural issues such as alcohol consumption, smoking, diet and exercise habits.

While such strategies have resulted in some measure of success (Kemm and Close 1995), they fall short of addressing the full extent of workplace health issues. For instance neither of these approaches address psychosocial factors such as:

- workers' perceptions of their own powerlessness against exposure to occupational hazards; and
- stressful working conditions, boredom, or organisational variables such as work overload or underload (O'Connor and Parker 1995, McMurray, 1999).

Proponents of the Healthy Workplace approach argue the need for a far broader and more systemic approach to Workplace Health Promotion. For instance a 'wellness' health strategy would incorporate all activities, policies and decisions that affect the health of employees (O'Connor and Parker 1995). This must include their families, communities within which the workplace is located and consumers. Baum (1999) notes good health to be a product of coherent interactions between people and their every day environments, one of the most significant of which is the workplace.

The notion of the Healthy Workplace has strong similarities to Healthy Cities and Health Promoting Schools. All involve a comprehensive approach, addressing a combination of educational, socio-political, economic and environmental impacts on health (O'Connor and Parker 1995). This de-emphasises the individual responsibility of workers (and the associated culture of 'victim blaming'). Instead it favours creation of a health-supportive workplace environment of mutual benefit:

- to the organisation (in terms of productivity, reduction of costs due to ill health, improved industrial relations and organisational image); and
- to the employee (in terms of improved health and wellbeing) (Kemm and Close 1995, WHO 1999).

Workplace Health Promotion then, may be defined in terms of:

- a combination of individual behavioural change and structural change;
- an integration of educational, organisational and economic activities;
- corporate design to improve the health of both workers and of the wider community.

This entails management working *with* employees in *voluntary partnership* to implement jointly agreed programs within the workplace setting. Health professionals have an essential role as *facilitators* in a community development model. They must strongly espouse the value of working *with* rather than *on* communities, in this case the workplace community (Baum 1998, McMurray 1999, Kemm and Close 1995). The success of Workplace Health promotion depends on the extent to which health imperatives impact on organisational culture (O'Connor and Parker 1995).

## The Malaysian experience of occupational health

In Malaysia, the Department of Occupational Safety and Health (DOSH) and the Department of Health (DOH) regulate occupational health and safety. The approach is predominantly prescriptive with a stronger focus on safety through legislation. As a result many intangible occupational health risks are not considered, and there are inadequate resources for effective change.

There are currently only 45 qualified and practising OSH physicians in the Health Care System of Malaysia (MoH per comm 2000). This yields a ratio of one OSH physician to 2,500 operational industries. Nationally, only 15 OSH Inspectors are employed – a ratio of one OSH Inspector to 3,000 operating industries (MoH per comm 2000).

Other problems include:

- employer and employees' lack of knowledge about occupational health;
- ignorance of NGOs and consumer organizations in highlighting the workplace ill-effects; and
- inadequate occupational and environmental health professionals to meet the need.

The Department of Health manages Malaysia's occupational health performance indicators via the national occupational disease surveillance program for:

- occupational dermatoses;
- occupational lung disease;
- occupational poisoning; and
- occupational needle stick injuries.

In other respects Malaysia makes little use of occupational health performance indicators. The program lacks appropriate levels of documentation, analysis and reporting of the findings. It therefore follows that

Malaysia's occupational health interventions are largely reactive. They are not validated or benchmarked either within industry or internationally.

In determining the success of an occupational health program, benchmarking against a recognizable standard or *best practice* is essential (Shaw, in NOHSC 1994). The use of performance indicators (PIs) is one tool for determining whether the sought objectives have been achieved. These PIs can be viewed as either positive or negative.

- Positive performance indicators seek to identify proactive achievements. These approaches typically involve motivating people to change their behavior (Damrosch 1991).
- Negative performance indicators identify outcomes such as mortality or morbidity rate, frequency of injury or illness, cost of illness or injury (typically determined through workers' compensation data), number of infringements and fines.

However negative performance indicators are restricted on many fronts. The chief criticism of negative performance indicators is their latency in control of the occupational health risk. In addition, data sources are typically biased and often incomplete thus the entire picture is not fully disclosed.

There is a need to develop and validate culturally appropriate indicators for occupational health within legislation, and a need to trial a holistic program that can go beyond the scope of legislation. One such program has been suggested in the WHO's *Regional Guidelines for the Development of Healthy Workplaces*. These guidelines suggest Work Place Health Promotion, incorporating educational, organizational or economic activities designed to improve the health of workers.

This involves both senior management commitment (top-down approach) and worker participation (bottom-up approach) for effective improvement. Some of the advantages of this approach include:

- improved 'well-being' through better economic returns;
- better agonistic actions through better incentives;
- easy follow-up;
- better peer support and pressure;
- more successful implementation of existing infrastructure; and
- a decrease in large population ill-exposures as a result of development.

## Evaluation

WHO Healthy City Projects have been evaluated from two aspects – the effectiveness of action and the planning of action. This signifies that it is important to consider the health and environment impacts (using negative and/or positive impact indicators) as well as the partnership and participation processes (using process indicators). It is also important that any data collected is turned into a 'story' in order to communicate this to a broad audience.

Werna and Harpham (1992) summarise four different positions regarding the use of process and/or impact indicators:

- the sole use of process indicators;
- the primary use of process indicators supplemented by a few impact indicators;
- parallel use of both indicators;
- sole use of impact indicators.

The Healthy Cities movement uses mostly 'process indicators' to focus on the institutional and participatory aspects of its projects. Occupational health in Malaysia is regulated and there are multiple stakeholders involved. For this reason, a 'parallel approach' should be used to consider both the success of the process and the efficacy of health outcomes.

## Conclusion

WHO has vast experience with Healthy Cities and extensive evaluations have been carried out. Healthy Workplaces is following in the wake of this movement and now has Regional Guidelines to support it (WHO 1999). This mechanism for change will benefit from research backing as these guidelines are implemented in Malaysia.

New processes will need to be developed and evaluated. Impact and process indicators must be devised and ways must be found for capturing the stories, which emerge in workplaces around the country. These design and evaluation strategies must be developed within Malaysia in culturally appropriate ways. There will be a great deal for the country to learn and then share with its neighbours. Rigorous evaluation and documentation must be central to this process.

## References


1. Ashton, J. 1991 'The Healthy Cities Project: A challenge for health education', *Health Education Quarterly*, vol.18, no.1, pp.39 – 48.
2. Baum, F.,1998, *The New Public Health. An Australian Perspective.* Oxford University Press, Melbourne.
3. Bohle, P. & Quinlan, M. 2000, *Managing Occupational Health and Safety in Australia*, 2nd edn., Macmillan, Sydney.
4. Damrosch, S. 1991. 'General strategies for motivating people to change their behavior', *Nursing Clinics of North America*, vol.26, no.4, pp.833 – 43.
5. Flynn, B.C. 1996, 'Healthy Cities: Toward worldwide health promotion', *Annual Review of Public Health*, vol.17, pp.299 – 309.
6. Gupta, V.M. 1995, 'Healthy Cities vision – An emerging global awareness and Indian perspective', *Indian Journal of Public Health*, vol. 39, no.2, pp.50 – 7.
7. Kemm, J. and Close, A., 1995, *Health Promotion Theory and Practice.* Macmillan Press Ltd, London.
8. Kuorinka, I. & Patry, L. 1995, 'Participation as a means of promoting occupational health', *International Journal of Industrial Ergonomics*, vol.15, no.5, pp. 365 – 70.
9. Lin,V., 1999, *Regional overview of Healthy Setting.* WHO meeting on Health protection and health promotion: harmonizing our responses to the challenges of the 21st century. Manilla, Phillipines.
10. Machida, S. & Markkanen, P. 2000, Óccupational safety and health (OSH) in Asia and the Pacific – Recent developments and challenges for the new millennium', *Asian Pacific Newsletter on Occupational Health and Safety*, vol. 7, pp. 9 – 15.
11. Matteson, M. & Ivancevich, J. 1988, 'Health promotion at work', in Cooper, C. and Robertson, I. (eds) *International Review of Industrial and Organizational Psychology 1988*, John Wiley, Chichester, UK.
12. McMurray, A., 1999, *Community Health and Wellness: a Socioecological Approach.* Mosby, Sydney.
13. Ministry of Health – Malaysia, 2000, 'Personal Communication', Kuala Lumpur, April, 2000.
14. NHMRC 1973, *Recommended Practice for Occupational Health Services in Australia*, Australian Government Publishing Service, Canberra.
15. NOHSC 1994a, *Positive Performance Indicators for OHS – Part 1*, Australian Government Publishing Service, Canberra.
16. NOHSC 1994b, *Positive Performance Indicators for OHS – Part 2*, Australian Government Publishing Service, Canberra.
17. O'Connor, M.L., and Parker, E., 1995, *Health Promotion. Principles and practice in the Australian context.* Allen and Unwin, Sydney.
18. Rantanen, J. 1998, 'New Trends in Occupational Health Services', *Asian-Pacific Newsletter*, vol. 5, no.2.
19. Roten, W. & Rower, L. 1992, 'OHS committees-the vital link', *Australian Institute of Management*, vol.1, pp.7 – 8.
20. Wallerstein, N. 1992, 'Powerlessness, empowerment, and health: Implications for health promotion programs', *American Journal of Health Promotion*, vol.6, no.3, pp.197 – 205
21. WHO 1999, *Regional Work – Healthy Cities Around the World*,
22. http://www.who.int/hpr/cities/regional/pacific.html, Accessed 7 June 2000.
23. World Health Organisation (WHO), 1986, *Ottawa Charter for Health Promotion*, WHO, Ottawa.
24. World Health Organisation (WHO), 1997, *The Jakarta Declaration on leading Health Promotion into the 21st Century*, WHO, Geneva.
25. World Health Organisation (WHO), 1999. *Regional Guidelines for the Development of Healthy Workplaces.* WHO Regional office for the Western Pacific.

# Abstracts

## Evaluation of Take-Home Organophosphorus Pesticide Exposure among Agricultural Workers and Their Children

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**Abstract**

We analyzed organophosphorus pesticide exposure in 218 farm worker households in agricultural communities in Washington State to investigate the take-home pathway of pesticide exposure and to establish baseline exposure levels for a community intervention project. House dust samples ($n$ = 156) were collected from within the homes, and vehicle dust samples ($n$ = 190) were collected from the vehicles used by the farm workers to commute to and from work. Urine samples were obtained from a farm worker ($n$ = 213) and a young child ($n$ = 211) in each household. Dust samples were analyzed for six pesticides, and urine samples were analyzed for five dialkylphosphate (DAP) metabolites. Azinphosmethyl was detected in higher concentrations ($p < 0.0001$) than the other pesticides: geometric mean concentrations of azinphosmethyl were 0.53 µg/g in house dust and 0.75 µg/g in vehicle dust. Dimethyl DAP metabolite concentrations were higher than diethyl DAP metabolite concentrations in both child and adult urine ($p < 0.0001$). Geometric mean dimethyl DAP concentrations were 0.13 µmol/L in adult urine and 0.09 µmol/L in child urine. Creatinine-adjusted geometric mean dimethyl DAP concentrations were 0.09 µmol/g in adult urine and 0.14 µmol/g in child urine. Azinphosmethyl concentrations in house dust and vehicle dust from the same household were significantly associated ($r^2$= 0.41, $p < 0.0001$). Dimethyl DAP levels in child and adult urine from the same household were also significantly associated ($r^2$ = 0.18, $p < 0.0001$), and this association remained when the values were creatinine adjusted. The results of this work support the hypothesis that the take-home exposure pathway contributes to residential pesticide contamination in agricultural homes where young children are present. *Key words:* biologic monitoring, children, dialkylphosphate metabolites, dust, exposure, organophosphorus pesticides, take-home.

*Original Source: Environ Health Perspect 110:A787-A792 (2002). [Online 12 November 2002]*

# An evaluation of the risk assessment method used by Environmental Health Officers when inspecting food businesses

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**Abstract**

Two outbreaks of infection with *Salmonella enteritidis* phage types 5c and 6a occurred in a number of Scottish health board areas between May 2000 and January 2001. A case-control study of food businesses was subsequently carried out to ascertain whether the scores derived from Environmental Health Officers' inspections prior to the outbreaks differed between food businesses where outbreak cases had eaten in the week before the onset of their illness (case food businesses) and neighbouring food businesses at which no outbreak case had eaten (control food businesses). The study showed no significant difference between the scores of case and control food businesses. The results suggest that the inspections were ineffective in identifying those food businesses that are more likely to cause incidents of food poisoning.

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# Antibiotic resistance in soil and water environments

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**Abstract**

Seven locations were screened for antibiotic-resistant bacteria using a modified agar dilution technique. Isolates resistant to high levels of antibiotics were screened for r plasmids. Low-level resistance (25 wg $ml^{-1}$) was widespread for ampicillin, penicillin, tetracycline, vancomycin and streptomycin but not for kanamycin. Resistant populations dropped sharply at high antibiotic levels, suggesting that intrinsic non-emergent mechanisms were responsible for the multiple drug resistance exhibited at low doses. Dairy farm manure contained significantly ($P < 0.01$) more (%) resistant bacteria than the other sites. Bacteria isolated from a dairy water canal, a lake by a hospital and a residential garden (fertilized by farm manure) displayed resistance frequencies of 77, 75 and 70%, respectively. Incidence of tetracycline resistance was most prevalent at 47-89% of total bacteria. Out of 200 representative isolates analyzed, *Pseudomonas*, *Enterococcus*-like bacteria, *Enterobacter* and *Burkholderia* species constituted the dominant reservoirs of resistance at high drug levels (50-170 wg $ml^{-1}$). Plasmids were detected in only 29% (58) of these bacteria with tetracycline resistance accounting for 65% of the plasmid pool. Overall, resistance trends correlated to the abundance and type of bacterial species present in the habitat. Environmental reservoirs of resistance include opportunistic pathogens and constitute some public health concern.

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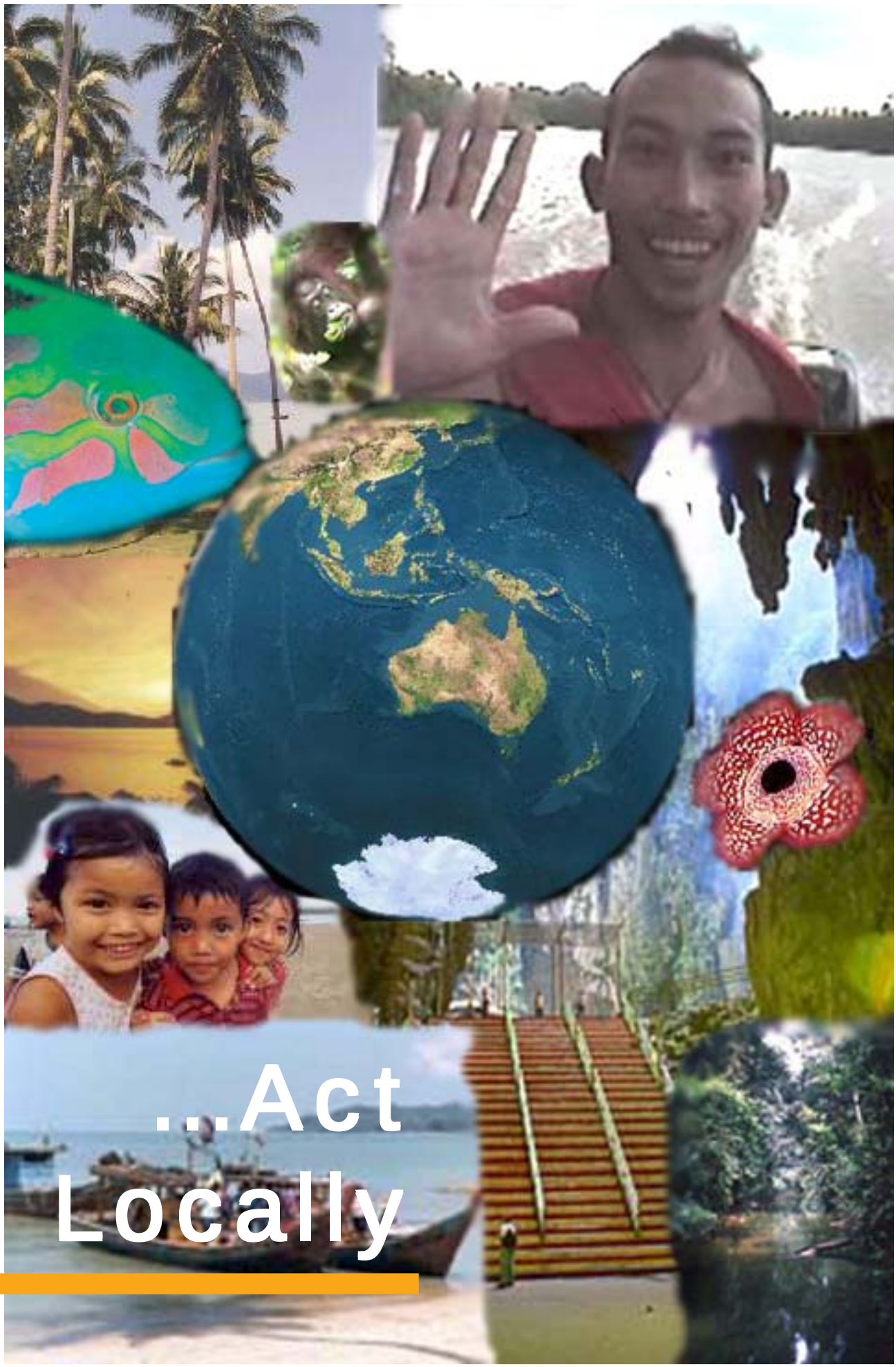
...Act
Locally

# Healthy communities are places where:

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- people work and age with dignity
- environments support learning and leisure
- ecological balance is a source of pride

*Adapted from WHO Yanuca Island Declaration (1995)*