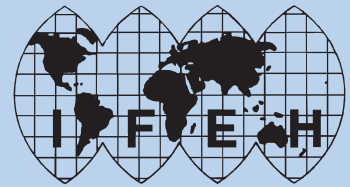


Environment and Health International



Magazine of the International Federation of Environmental Health



INTERNATIONAL FEDERATION OF ENVIRONMENTAL HEALTH

President – Jerry Chaka, South Africa



President, Jerry Chaka, South Africa

President Elect, Colm Smyth, Ireland

Hon. Secretary, Mike Halls, Scotland

Hon. Editor, John Stirling, Scotland

Webmasters, Henning Hansen and
Jan Joergensen, Denmark

Cover Photographs:

Upper: Lake Wakatipu, New Zealand

Lower: EHPs from the UK visiting Uganda in May 2005 meet Student EHOs at Makerere University and pose for a camera call after a very successful discussion.

The views expressed in this magazine are not necessarily the views of the International Federation of Environmental Health

IFEH REGISTERED OFFICE
Chadwick Court
15 Hatfields, London, UK SE1 8DJ

www.ifeh.org

CONTENTS

President's Comments	3
Levels of inorganics and organics in soil: When is high, high?	4
An assessment of Air Quality in an Enclosed Multi-Storey Car Park	13
Asbestos – Future Risks	16
Groundwater Quality and Health Risks in Onne Community near a Fertiliser Complex in Southern Nigeria	19
Assessment and Monitoring of Chemical Water Quality Parameters in the Mbabane River, Swaziland	24
NEHA Offers Avian-Flu-Pandemic Online Course	IBC

**Many thanks to all contributors to this
issue of Environment and Health
International**

**Deadline for submission of articles for the
next issue is
1st September 2006**

**The Hon. Editor, John Stirling, can be
contacted at**

11 Muirwood Drive

Currie

Edinburgh EH14 5EZ

SCOTLAND

e-mail: j.stirling@btinternet.com

PRESIDENT'S COMMENTS

Jerry Chaka

It is almost the end of my term of office. It is therefore important to reflect on how the IFEH performed during my term as well as to reflect on the challenges ahead of us.

Meetings of the Board of Directors and of the Council were held as scheduled. The Region Groups also held meetings, with the Europe Group (now EFEH) and the Africa Group meeting more regularly during the past two years whereas the Americas and the Asia & Pacific Groups managed to meet only once.

A regulation on the use of the Development Fund (Regulation 6/2004) was developed and adopted by the Council and a protocol on the role of Associate Members was finalised. Guidelines regarding twinning activities amongst IFEH members are being developed and in an effort to see if more exchanges of practitioners between countries could be attained, member organizations have been asked to submit names of contact persons who will co-ordinate these activities on behalf of their organizations in their countries.

IFEH reacted to the Tsunami Disaster in South Asia by issuing a press release on the disaster and donating one thousand pounds Sterling to the International Federation of Red Cross & Red Crescent Societies, being a contribution towards the disaster relief fund.

A new membership certificate was agreed upon and in due course all members of the IFEH will be issued with one. A policy on the use of sustainability indicators (Policy Paper no. 8) was developed and adopted by Council. A formal agreement through a memorandum of understanding was also signed between IFEH and the International Institute for Sustainable Development (IISD). It is hoped that this will ensure cooperation between the two organizations and that the IFEH sustainability indicators project is included in the IISD compendium of initiatives.

An overall strategy for the IFEH was first tabled for discussions at the Vancouver Council meeting. A workshop session is scheduled for the first day of the two-day Council meeting to be held on 17 & 18 June 2006 in Dublin, with the aim of trying to finalise the strategy during the workshop.

I wish to thank all officers and member organizations that contributed to the work of the IFEH during my term. All that was achieved was through team efforts. We still have challenges ahead of us but these are not insurmountable. The most pertinent issues were raised by several member organizations during the Vancouver meeting. Other challenges relate to the Regional Groups not functioning well and therefore failing to give direction to Council on IFEH matters; attendances at Council meetings by member organizations remains a problem and this is compounded by the failure of some organisations to respond to matters referred to them. It is necessary that there is feedback to Council from its members and that robust debates take place at Council meetings. We are still operating without an office and staff. And recruitment of new members is not happening; thus we remain with more or less the same number of members as we had two years ago. It is vitally important that we consider these challenges and take appropriate steps to address them.

To the incoming President, Colm Smyth, President-Elect, Benard Forteath and the new Honorary Secretary, whoever that be, I wish you all the best during your term of office and hope to see you all at Dublin, Ireland in June.

Levels of inorganics and organics in soil: When is high, high?

P Papapreponis,* R Robertson,**
M Roworth,*** SA Ogston*, FLR Williams*

* Section of Public Health
Division of Community Health Sciences
University of Dundee, Kirsty Semple Way
Dundee DD2 4BF, Scotland

** *Address where work was carried out:*
Department of Environmental and
Consumer Protection
Dundee City Council
Dundee DD1 3RE, Scotland

Current address:
Health Protection Scotland
Clifton House, Clifton Place
Glasgow G3 7LN, Scotland

*** Department of Public Health
Fife NHS Board
Cameron House, Cameron Bridge
Leven, Fife KY8 5RG, Scotland

Correspondence should be sent to Dr FLR
Williams, f.l.r.williams@chs.dundee.ac.uk
Section of Public Health,
Division of Community Health Sciences
University of Dundee,
Kirsty Semple Way
Dundee DD2 4BF, Scotland.
Tel +44 (0)1382 420117 fax +44(0) 1382 420101

Key words: environmental criteria, soil pollution
guidelines, health

Abstract

Background

Rapid responses to assessing problems of contamination in the environment require assessors to have a thorough and up to date knowledge of what constitutes a level of contamination that poses a threat to health. Current guidelines and recommendations for levels of inorganics and organics in soil, air and water are published in a multitude of disparate journals, policy documents, governmental and statutory publications.

Objective

The purpose of this paper was to summarize the current UK, European, or global regulations and guidelines that apply to levels of several chemicals in soil and to discuss the interpretation

of these guidelines when investigating potential threats to health.

Results

We report the current guidelines for seventeen chemicals in soil (fourteen inorganic and three groups of organic substances). There are differences between countries in the levels set. There are occasions where the acceptable levels in soil in residential land are set lower than the levels occurring naturally as background. Much of the advice on which levels are set is derived from animal studies that typically expose animals to a large, single dose of a single chemical.

Comment

Recommendations for levels of chemicals in soil that rely on animal exposures to large, single doses of a chemical do not replicate accurately the 'cocktail' of chemicals to which we are exposed to in every day life. There is some evidence from air pollution studies that exposure recommendations should be lower than current. Furthermore, the variations that exist in the guidelines for pollutants in soil are a potential cause of confusion to both assessors of the environment and also to the public and scientists trying to interpret the findings.

Introduction

Quantifying the level of pollution on the residential environment is relatively straightforward. The source of exposure needs to be correctly identified, and then samples (as appropriate) of air, water, soil and vegetation should be taken and analysed for the putative pollutant(s). A problem arises however in the interpretation of results. And with human health as a primary outcome, the crucial question is, how high is high? Nationally agreed standards are the most obvious choice for establishing a criterion.

At present, however, the guidelines are incomplete. Invariably guidelines are based on toxicological evidence and on risk assessment studies. Typically, toxicological evidence is derived from animal experiments during which the test animal is exposed to one particular chemical. To keep costs to a minimum, the dose of chemical administered is usually hundreds of thousands of times higher than those normally encountered by humans during residential exposure¹. Risk assessments aim to conceptualise the routes and the burden of human exposure under specific

conditions. The establishment of standard values for acceptable pollution levels is based on the combination of both approaches.²

Current animal models do not test the impact of chronic, low doses of exposure; they typically assess exposure to single, often massive, doses. There are two major problems with this. First, in reality individuals are exposed to a 'cocktail' of different chemicals and very little is known about the health impact of these 'cocktails'. Chemicals may act together synergistically; their effects may be additive or multiplicative; or speciation may occur. Second, standards that are based on single massive doses of a pollutant may have to be appreciably reduced when applied to chronic low-level doses. This is particularly important when setting standards for the chemicals which bioaccumulate, such as dioxins, furans and many of the other organics. Recent studies of the health outcome of exposure to chronic, low levels of airborne pollutants show that levels of exposure to particulates, nitrogen oxide, sulphur dioxide and carbon monoxide which were previously thought to be safe are in fact associated with a higher incidence of asthma³ and with an increase in mortality from various diseases in those exposed.⁴⁻⁷

In determining the health impact of exposure to pollutants the choice of disease outcome is guided generally by animal studies and by studies in occupational epidemiology. However, the drawback of this approach is that it can ignore the impact of simultaneous exposures to different chemicals. The animal studies do not mirror real life exposures and it is very likely that in some instances we do not have sufficient knowledge to identify correctly the health outcomes to monitor. Guideline levels for pollutants are derived from limited physical criteria that are generated by animal studies; other adverse outcomes, such as psychological illness, may also exist but are more difficult to elucidate. Adverse psychological outcomes are complex and may result, or be exacerbated by, poor public relations, media coverage and political views irrespective of actual levels of pollutants or any potential for, or evidence of, physical health problems. For example, studies of residents near a chemical waste dump in Love Canal, USA, found little firm evidence of exposure and ill-health. But due to poor handling of the event, the residents felt misinformed and frightened to such an extent that studies found that the residents were suffering from a range of very real psychological illnesses.⁸

The composition of effluent coming from chimneys of modern industry includes a wide range of inorganic and organic substances for instance: aluminium, antimony, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, magnesium, mercury, molybdenum, nickel, selenium, silver, thallium, tin, titanium, tungsten, uranium, vanadium, zinc and zirconium, sulphur dioxide, nitrogen oxides, polycyclic aromatic hydrocarbons, and polychlorinated aromatics.⁹⁻¹³ The challenge facing environmental and public health is to accurately describe the health impact of exposure to low levels of these pollutants.

Routine monitoring of the residential environment around industry is a crucial step in evaluating the impact of that industry upon its neighbourhood. The interpretation and dissemination of the levels of organics, inorganics and particulate matter found in the environment need to be communicated regularly and openly to the relevant communities. Currently the levels of inorganics and organics in soil, air and water are reported in a multitude of disparate journals, reports, web sites and books. In this paper we have collated the information from these disparate sources and have created a table that summarizes the recommended levels of selected chemicals in soil.

Methods

In 1998 we carried out an extensive literature search that created profiles of 25 of the common inorganic and organic chemicals that are typically found in chimney effluent.¹⁴ Each profile described the regulations and guidelines that existed for levels of the chemical in soil, air and water; the human health consequences of exposure to the chemical; the experimental evidence that supported the human health consequences; typical background levels monitored in the environment; and, the major industrial sources that contributed to the environmental burden. For this paper we updated the regulations and guidelines that apply to levels of inorganics and organics in soil.

The procedures that we used in assessing the literature were based on guidelines that were developed for undertaking systematic reviews of research and effectiveness.¹⁵ Briefly, we reviewed all papers reported in English that were published in the 1990's, but we also reviewed key papers from earlier decades. Data sources included Medline, professional organizations, statutory organizations and the web.

Results

Recommended soil levels for 17 inorganic and organic chemicals were found in the literature (table 1). Some guidelines could not be found, for example the UK limits for antimony in soil; and some guidelines were somewhat old, for example copper (table 1). For those guidelines that are up to date and comprehensive it is clear that, between countries, there are wide variations in what is deemed acceptable. For instance the UK allows

soil lead in residential land to reach 450 mg/kg, whereas Canada sets 140 mg/kg as the maximum limit (table 1). There are also examples of the maximum soil values for residential land being set below levels that occur naturally as background. For example the UK guideline for arsenic in soil is 20 mg/kg yet in the south-west of England it occurs naturally at levels between 29-51 mg/kg (table 1).

Table 1 Recommended levels for selected inorganic and organic chemicals in soil

NB mg/kg is the same as µg/g and ppm

Substance	Acceptable levels for residential land		Background
	UK limit	Other (country) limit	
Antimony		20 mg/kg (Canada) ⁰ 20 mg/kg (Netherlands) ⁰ 100 mg/kg (France) ⁰ 20mg/kg (Denmark) ⁰	0.19-1.77 µg/g (World wide) ¹⁷ 3 mg/kg (mean Netherlands) ⁰ 1-8.8 ppm (mean=0.48 ppm) (USA) ⁰
Arsenic (inorganic)	20 mg/kg ⁰	12 mg/kg (Canada) ⁰ 50 mg/kg (Germany) ⁰ 55 mg/kg (Netherlands) ⁰ 37 mg/kg (France) ⁰ 15 mg/kg (Sweden) ⁰ 100 mg/kg (Australia) ⁰ 30 mg/kg (New Zealand) ⁰	29-51 mg/kg (south-west England) ⁰ 29 mg/kg (mean Netherlands) ⁰ 10 mg/kg (90 th percentile Sweden)* ⁰ 1-50 mg/kg (Australia) ⁰ 0.1-97 µg/g (mean=7.2) (USA) ⁰
Beryllium		4 mg/kg (Canada) ⁰ 500 mg/kg (France) ⁰ 20 mg/kg (Australia) ⁰	0-5 ppm (UK) ²⁰ 1.1 mg/kg (mean Netherlands) ⁰ 1.2-12.1 ppm (USA) ¹⁷ 1-15 mg/kg (mean=0.63) (USA) ⁰
Cadmium	1-8 mg/kg ⁰	10 mg/kg (Canada) ⁰ 20 mg/kg (Germany) ⁰ 12 mg/kg (Netherlands) ⁰ 20 mg/kg (France) ⁰ 0.5 mg/kg (Denmark) ⁰ 0.4 mg/kg (Sweden) ⁰ 20 mg/kg (Australia) ⁰	<0.2-5.9 (England) ⁰ 0.8 mg/kg (mean Netherlands) ⁰ 0.3 mg/kg (90 th percentile Sweden)* ⁰ 1 mg/kg (Australia) ⁰ 100 to 1000 µg/kg (USA) ²¹ 0.25 ppm (mean USA) ⁰
Chromium (total)	130 mg/kg ⁰	64 mg/kg (Canada) ⁰ 400 mg/kg (Germany) ⁰ 380 mg/kg (Netherlands) ⁰ 130 mg/kg (France) ⁰ 500 mg/kg (Denmark) ⁰ 120 mg/kg (Sweden) ⁰	0.2-838 mg/kg (UK) ²² 22-1297 (British Geological Survey) ²² 100 mg/kg (mean Netherlands) ⁰ 30 mg/kg (90 th percentile Sweden)* ⁰ 5-1000 mg/kg (Australia) ⁰ 1-2000 mg/kg (geom.mean = 37) (USA) ⁰
Cobalt		50 mg/kg (Canada) ⁰ 240 mg/kg (Netherlands) ⁰ 240 mg/kg (France) ⁰ 30 mg/kg (Sweden) ⁰ 100 mg/kg (Australia) ⁰	1.6-21.5 µg/g (World wide) ¹⁷ 10 µg/g (Canada) ²³ 9 mg/kg (mean Netherlands) ⁰ 10 mg/kg (90 th percentile Sweden)* ⁰ 1-40 mg/kg (Australia) ⁰ 7.2 mg/kg (mean USA) ⁰

ENVIRONMENT AND HEALTH INTERNATIONAL

Copper	130 mg/kg ²⁴	63 mg/kg (Canada) ⁰ 190 mg/kg (Netherlands) ⁰ 190 mg/kg (France) ⁰ 500 mg/kg (Denmark) ⁰ 100 mg/kg (Sweden) ⁰ 1000 mg/kg (Australia) ⁰	6-8 µg/g (World wide) ¹⁷ 0-100 ppm (UK) ²⁰ 30 µg/g (Canada) ²³ 36 mg/kg (mean Netherlands) ⁰ 30 mg/kg (90 th percentile Sweden)* ⁰ 2-100 mg/kg (Australia) ⁰ 14-41 mg/kg (USA) ⁰
Dioxins & Furans		4 ng TEQ/kg (Canada) ⁰ 1000 ng TEQ/kg (Germany) ⁰ 1000 ng TEQ/kg (Netherlands) ⁰ 1000 ng TEQ/kg (France) ⁰ 2 ng TEQ/kg (Finland) ⁰ 1500 ng TEQ/kg (New Zealand) ⁰ 1000 ng TEQ/kg (Japan) ⁰ 1000 ng TEQ/kg (USA) ⁰	1-64 ng TEQ/kg (Austria) ⁰ 2.1-8.9 ng TEQ/kg (Belgium) ⁰ 1-30 ng TEQ/kg (Germany) ⁰ 2-45 ng TEQ/kg (Greece) ⁰ 1-13 ng TEQ/kg (Ireland) ⁰ 1-43 ng TEQ/kg (Italy) ⁰ 1.4-20 ng TEQ/kg (Luxemburg) ⁰ 2.2-16 ng TEQ/kg (Netherlands) ⁰ 1-24.2 ng TEQ/kg (Spain) ⁰ < 1 ng TEQ/kg (Sweden) ⁰ 1-87 ng TEQ/kg (UK) ⁰ 6.5 pg/g (mean Japan) ⁰
Lead	450 mg/kg ²⁵	140 mg/kg (Canada) ⁰ 400 mg/kg (Germany) ⁰ 530 mg/kg (Netherlands) ⁰ 400 mg/kg (France) ⁰ 40 mg/kg (Denmark) ⁰ 80 mg/kg (Sweden) ⁰ 300 mg/kg (Australia) ⁰	10-84 µg/g (World wide) ¹⁷ 23 mg/kg (UK) ²⁵ 3-16,338 mg/kg (median=40) (UK) ²⁵ 25 µg/g (Canada) ²³ 85 mg/kg (mean Netherlands) ⁰ 25 (mg/kg) (90 th percentile Sweden)* ⁰ 2-200 mg/kg (Australia) ⁰
Manganese	0-500 ppm ²⁰	1500 mg/kg (Australia) ⁰	80-1300 µg/g (World wide) ¹⁷ 850 mg/kg (Australia) ⁰
Mercury	8 mg/kg ²⁶	6.6 mg/kg (Canada) ⁰ 20 mg/kg (Germany) ⁰ 10 mg/kg (Netherlands) ⁰ 7 mg/kg (France) ⁰ 1 mg/kg (Denmark) ⁰ 1 mg/kg (Sweden) ⁰ 15 mg/kg (Australia) ⁰	0.02-0.41 ppm (World wide) ¹⁷ 10-1800 µg/g (UK) ²⁶ 0.3 mg/kg (mean Netherlands) ⁰ 0.1 mg/kg (90 th percentile Sweden)* ⁰ 0.03 mg/kg (Australia) ⁰
Nickel	50 mg/kg ²⁸	50 mg/kg (Canada) ⁰ 140 mg/kg (Germany) ⁰ 210 mg/kg (Netherlands) ⁰ 140 mg/kg (France) ⁰ 30 mg/kg (Denmark) ⁰ 35 mg/kg (Sweden) ⁰ 600 mg/kg (Australia) ⁰	4-55 µg/g (World wide) ¹⁷ 40-80 mg/kg (England) ²⁸ 27 (mean Scotland) mg/kg ²⁸ 20 (mean England) mg/kg ²⁸ 35 mg/kg (mean Netherlands) ⁰ 20-25 mg/kg (90 th percentile Sweden)* ⁰ 5-500 mg/kg (Australia) ⁰ <5-700 ppm (geom.mean=13 ppm) (USA) ⁰
PAHs	50 mg/kg ²⁴	21.3 mg/kg (Canada) ⁰ 40 mg/kg (Netherlands) ⁰ 20.3 mg/kg (Sweden) ⁰ 20 mg/kg (Australia) ⁰	1 mg/kg (mean Netherlands) ⁰ 5 mg/kg (90 th percentile Sweden) ⁰

ENVIRONMENT AND HEALTH INTERNATIONAL

PCBs	1 mg/kg ²⁴	1.3 mg/kg (Canada) ⁰ 1.0 mg/kg (Netherlands) ⁰ 0.02 mg/kg (Sweden) ⁰ 10 mg/kg (Australia) ⁰	
Selenium	35 mg/kg ²⁹	1 mg/kg (Canada) ⁰	0.05-0.09 mg/kg (Worldwide) ⁰ 0.02 to 2 mg/kg (England & Wales) ²⁹ 0.7 mg/kg (mean Netherlands) ⁰ 0.01-0.2 mg/kg (USA) ⁰
Vanadium	0-100 ppm ²⁰	130 mg/kg (Canada) ⁰ 560 mg/kg (France) ⁰ 120 mg/kg (Sweden) ⁰	5-190 µg/g (World wide) ¹⁷ 42 mg/kg (mean Netherlands) ⁰ 40 mg/kg (90 th percentile Sweden)* ⁰ 20-50 mg/kg (Australia) ⁰ 200 mg/kg (mean USA) ⁰
Zinc	130 mg/kg ²⁴	200 mg/kg (Canada) ⁰ 720 mg/kg (Netherlands) ⁰ 9000 mg/kg (France) ⁰ 500 mg/kg (Denmark) ⁰ 350 mg/kg (Sweden) ⁰ 7000 mg/kg (Australia) ⁰	60 µg/g (Canada) ²³ 140 mg/kg (mean Netherlands) ⁰ 60-70 mg/kg (90 th percentile Sweden)* ⁰ 10-300 mg/kg (Australia) ⁰ <5-2900 mg/kg (mean=60 mg/kg) (USA) ⁰

* For the Swedish background levels, figures represent the 90th percentile value of the samples analysed

Discussion

There is concern that the guidelines for maximum levels of chemicals in soil, air and water are inadequate. This is exemplified by the controversy surrounding acceptable levels of dioxins and furans in soil. The Canadian guidelines¹⁶ set 4 ngTEQ/kg (ng toxic equivalent per kg of soil) as the maximum permissible for residential parkland, for agricultural soils and for industrial land; whereas Germany sets 1000 ngTEQ/kg for residential land and for parks and recreational areas, 10,000 ngTEQ/kg for industrial areas, and 100 ngTEQ/kg for playgrounds.¹⁹ A huge range of concentrations of dioxins and furans in the soil in the UK has been reported as typical of background concentrations. Scottish Power³⁰ report in a Department of the Environment report³¹ that a reasonable estimate for background TTEQ (total toxic equivalents) levels in the England, Wales and Lowland Scotland is 2.49 ng/kg. This contrasts to reported concentrations on industrial and urban land³² of 24 ng/kg, of 54 ng/kg³³ and various concentrations taken from urban sites ranging from 65 ng/kg for TCDD to 232 ng/kg for TCDF³⁴ and for rural sites of 10.3 ng/kg.³³ Interpretation of what is and what is not a high level of soil contamination is almost impossible using these guidelines.

The main purpose of adhering to guideline recommendations is the belief that the recommended maximum concentration specified by the guideline for any particular contaminant will not pose an unacceptable risk to health. Guideline recommendations are media-specific; that is, they are set independently for soil, for water and for air. From a public health perspective this is unsatisfactory because different chemicals contaminate human beings through different routes of exposure. For example it has been estimated, assuming a soil ingestion rate of 0.02 g per day, that exposure to TCDD might be apportioned as follows: 1.1% from air, 98.8% from food, 0.05% from soil and 0.01% from water.³⁵ Since direct ingestion of contaminated soil and water are not important routes for human exposure to TCDD, could higher guideline values for soil and water contamination be allowed for this chemical under certain circumstances? Naturally, this would change if householders on contaminated land consumed large quantities of home-grown vegetables, or home-reared livestock.

Establishing the maximum acceptable levels of these substances in soil (or air) is not straightforward. Regulations and guidelines in soil and the air do not exist for all of these

substances. The interpretation of standards and regulations for soil is complicated by the use of different units of measurement and the duration of sampling period. The units used for soil levels may be mg/kg of air dried soil, $\mu\text{g/g}$ of soil, g/ha/yr or parts per million (ppm). The durations of the sampling period used for determining levels in soil may be one-off (spot) measurements, a mean value derived from daily, weekly, monthly or annual measurements, or in many cases simply specified as long term, or short term.

Measurements made intermittently do not necessarily adequately represent the exposure of the population. An additional problem when interpreting the standards and regulations for soil lies in the typical daily use of the soil. Many of the standards and regulations are set assuming the soil is to be used for growing plants and crops. However, susceptible people such as children playing in gardens, gardeners and builders can consume appreciable quantities of soil through direct contact of the soil coupled with inadequate cleaning of the their hands.

Standards and regulations are not absolute, as shown by the large range seen between and even within countries. For instance, the guideline for the soil concentration of arsenic in residential land in the UK is 20 mg/kg² whereas in Canada it is 12 mg/kg.¹⁶ This contains some degree of uncertainty because of the lack of human toxicological data on which to base the standard. Different chemicals target different organs of the body;³⁶ toxicity can vary between species – for example had penicillin been tested on mice instead of guinea pigs it would never have been passed for human trials because the guinea pig is exceptionally sensitive to penicillin and its ingestion kills 50% of the sample.³⁷ Toxicity also varies between the sexes;³⁸ and the old, the immunocompromised and the young are generally most susceptible to the effects of toxicants.³⁹ Human data are preferred for the formation of standards but standards are often based only on animal studies because the relevant human studies are lacking. Even when human data are available interpretation is hampered as some investigate chronic exposure whilst other investigate acute exposure. The interpretation and application of standards is a balance between legal requirements on the one hand and local factors and conditions on the other.

Another important issue is the exposure pathway and the exposure conditions under which an

individual or a community come into contact with pollutants. Human exposure to toxicants may occur under several conditions depending on the environmental setting. Differences associated with occupational or residential environment; distance from the source of pollution; meteorological conditions; land use; consumption of locally-grown crops and local-breed livestock should be taken into account when interpreting results of environmental measurements. All these parameters, in association with the physicochemical properties of pollutants, lead to a different intake of pollutants by individuals. Guidelines attempt to reflect some of this variation and, for example, the Department for Environment, Food and Rural Affairs (DEFRA) of the UK Environment Agency provides guidelines for the upper acceptable concentrations of several pollutants in soil that are dependent upon the soil use. For instance the guidelines for mercury range from 8 mg/kg in residential land (with or without plant uptake) to 480 mg/kg for land used for commercial or industrial purposes.²⁶

A key goal for environmental epidemiology is the establishment of cause and effect between a (putative) pollution source and ill health. A major problem for achieving this is that chemicals are often produced by a variety of sources. For instance, although *all* of the chemicals described in table 1 are produced by municipal waste incineration, they are also produced by a variety of other sources. All of the chemicals are found in tobacco smoke, 10 of the 17 are liberated through burning coal, and 6 of the 17 are found in exhaust emissions from motor vehicles. Municipal waste incineration is the major contributor of 9 of the 17 chemicals. In addition all of these chemicals occur at background levels in the environment. Confirmation of an unequivocal association between an industrial source and an adverse environmental or human health impact may therefore be extremely difficult.

DEFRA report series on *Soil Guideline Values e.g. 2,18* suggest that any guidelines should be used by a risk assessor as “a component of an overall risk assessment and management strategy”, which implies that they constitute an indicative tool for risk assessment and not an absolute rule. The report points out that “the assessor should take into account site-specific circumstances” and that “a potentially significant risk might be present even though a soil guideline value is not exceeded.”

This 'open to interpretation' advice highlights the problems associated with implementing such a diversity of limits, recommended values and guidelines in the operational field. The different approaches may be exacerbated by the wide range of professionals who are left to try to interpret these values and to ensure compliance with statute. If the evidential base for such work is to be developed then the need for comprehensive and robust environmental studies is a prerequisite. Inherent in this aim is an assumption that the workforce carrying out the work is adequately resourced both in terms of personnel and budgets for the carrying out of investigative fieldwork. This resource is often not available and the resultant inconsistencies in duration, type and totality of sampling undoubtedly impedes the formation of an evidential base. Public bodies when faced with a potential public health incident surrounding for example a point pollution source may find resourcing of investigative work prohibitive and therefore opportunities to strengthen the evidential base maybe lost.

The current reliance by practitioners on environmental guidelines may be alleviated in part by the continued development and implementation of concepts such as the 'precautionary principle'. One commonly accepted definition of the precautionary principle is: 'The precautionary principle provides a framework, procedures and policy tools for public policy actions in situations of scientific complexity, uncertainty and ignorance, where there may be a need to act in order to avoid, or reduce, potentially serious or irreversible threats to health or the environment, using an appropriate level of scientific evidence, and taking into account the likely pros and cons of action and inaction.'⁴⁰ The adoption of such a principle would it is hoped assist the multidisciplinary public health workforce overcome the inherent difficulties in the use of environmental limits to protect human health by helping to 'foresee and forestall hazards'.⁴¹ The impact of such a process would be greatly enhanced if effective and comprehensive risk communication, education and awareness raising takes place with the affected local communities throughout the investigative process. Such active inclusion of the local population is essential if all health impacts including the psychosocial impacts of a particular site or project are to be truly addressed.

At the present time environmental limits for chemicals vary in terms of both their derivation and their application. Despite these inconsistencies there is still reliance by practitioners on using these values in the operational setting when trying to protect human health. This reliance may lead to an inaccurate picture of the true human health impact of a particular community based environmental exposure. The need for the development of a sound evidential base for such guidelines through adequate resourcing at both a research and operational level requires to be addressed as a matter of urgency. The further development of differing methods of dealing with environmental risks to human health such as the precautionary principle and risk communication are to be welcomed if this helps to reduce the current reliance on environmental guidelines.

PP undertook some of this work while in receipt of a State Scholarship Foundation of Greece. The work was part funded by the Dundee City Council.

Main messages and policy implications

Current guidelines and recommendations for levels of inorganics and organics in soil, water and air are published in a multitude of disparate journals, policy documents, governmental and statutory publications.

There is variation in guidelines and recommendations for levels of inorganics and organics in soil, water and air both within and between countries.

Guidelines and recommendations for levels of inorganics and organics in soil, water and air do not necessarily reflect accurately the hazard represented by chronic exposure to low levels of a 'cocktail' of chemicals.

The precautionary principle – which provides a framework, procedures and policy tools for public policy outcomes – may provide an alternative approach to evaluating the health impact in situations of putative contamination.

References

- BMA. Health and environmental impact assessment. An integrated approach. London: Earthscan publications. 1998.
- DEFRA. SGV soil guidelines values for arsenic contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv1_arsenic_676042.pdf accessed February 2006
- Ponka A. Asthma and low level air pollution in Helsinki. Archives of Environmental Health. 1991;46:262-267.
- Schwartz J, Spix C, Touloumi G, Bacharova L, Barumamdzadeh T, le Tertre A, Piekarski T, Ponce de Leon A, Ponka A, Rossi G, Saez M, Schouten JP. Methodological issues in studies of air pollution and daily counts of deaths or hospital admissions. Journal of Epidemiology and Community Health. 1996;50(Suppl 1):S3-S11.
- Schwartz J. Air pollution and daily mortality: a review and meta-analysis. Environmental Research. 1994;64:36-52.
- Schwartz J, Slater D, Larson TV, Pierson WE, Koenig JQ. Particulate air pollution and hospital emergency room visits for asthma in Seattle. American Reviews Respiratory Disease. 1993;147:826-831.
- Dockery DW, Pope CA, Xu X, Spengler JD, Ware JH, Fay ME, Ferris BG, Speizer FE. An association between air pollution and mortality in six US Cities. The New England Journal of Medicine. 1993;329:1753-1759.
- Holden C. Love Canal residents under stress. Science. 1980;208:1242-1244.
- Suter-Hofmann M, Schlatter C. Toxicity of particulate emissions from a municipal incinerator: critique of the concept of TCDD-equivalents. Chemosphere 1986; 15:1733-1743.
- Environment Agency. Processes subject to integrated pollution control. IPC Guidance Note. London HMSO. 1996.
- Houghton SJ. Royal Commission on environmental pollution: incineration of waste. 17th Report. London HMSO. 1993.
- Edujee GH. Organic micropollutant emissions from waste incineration. Issues in Environmental Science and Technology. 1994.
- Kelly KE. Health risk assessment of hazardous waste incinerator stack emissions. Hazardous Waste and Hazardous Materials. 1986;3:367-403.
- Williams FLR, Robertson R, Roworth M. Detailed profiles of 25 major organic and inorganic substances. Glasgow: Scottish Centre for Infection and Environmental Health. 1999.
- CRD. NHS Centre for reviews and dissemination. Undertaking systematic reviews of research on effectiveness. CRD guidelines for those carrying out or commissioning reviews. University of York. 1996.
- Canadian Council of Ministers of the Environment. Canadian soil quality guidelines for the protection of environmental and human health: update 2003. Winnipeg: CCME, 2003.
- McBride MB. Trace and toxic elements in soils. Environmental Chemistry of soils. Oxford: Oxford University Press. 1994:308-341.
- DEFRA. SGV soil guidelines values for cadmium contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv3_cadmium_676065.pdf accessed February 2006
- German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Federal soil protection and contaminated sites ordinance Annex 2. Bonn 1999.
- Society of the Chemistry Industry. Site investigation and materials problems. Proceedings: conference on reclamation of contaminated land. Eastbourne 1979.
- Barltrop D, Strehlow CD. Clinical and biochemical indices of cadmium exposure in the population of Shipman. Proceedings 3rd International Cadmium Conference. 1981.
- DEFRA. SGV soil guidelines values for chromium contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv4_chromium_676070.pdf accessed February 2006
- Canadian Council of Ministers of the Environment. Interim Canadian environmental quality criteria for contaminated sites. Winnipeg: CCME, 1991.
- ICRCL. Guidance on the assessment and redevelopment of contaminated land. London: Inter – departmental committee on the redevelopment of contaminated land 59/83, 1983.
- DEFRA. SGV soil guidelines values for lead contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv10_lead_676098.pdf accessed February 2006
- DEFRA. SGV soil guidelines values for inorganic mercury contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv5_inorg_mercury_676075.pdf accessed February 2006
- Circular on target values and intervention values for soil remediation. Ministerie van Volkshuising, Ruimtelijke Ordening en Milieubeheer (The Dutch Environment Ministry). The Hague. 4th February 2000. http://www2.minvrom.nl/Docs/internationaal/annexS_I2000.pdf accessed February 2006.
- DEFRA. SGV soil guidelines values for inorganic nickel contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv7_nickel_676082.pdf accessed February 2006
- DEFRA. SGV soil guidelines values for inorganic selenium contamination. DEFRA Report Series. Bristol March 2002. http://www.environment-agency.gov.uk/commondata/acrobat/sgv9_selenium_676091.pdf accessed February 2006
- Scottish Power. Ambient air and soil analysis. 1st survey. Dundee: Dundee Energy Recycling Limited. 1999: 1-10.
- Department of the Environment. Dioxins in the environment, Pollution Paper No 27. Central Directorate of Environmental Protection. London HMSO 1989.
- Fernandes AR, Timmis R, Dawes C. A survey of dioxin contents of solid waste in Walsall, UK. Stevenage: Warren Springs Laboratory, 1993.
- ENDS. High dioxin levels in soil and cattle around a Coalite plant. ENDS Report 1992:206:6.
- Creaser CS, Fernandes AR, AL-Haddad A, Harrad SJ, Homer RB, Skett PW, Cox EA. Survey of background levels of PCDD and PCDF's in urban British soils. Chemosphere 1990;21:931-938.
- Travis CC, Hattmer-Frey HA. Human exposure to dioxin. The Science of the Total Environment. 1991;104:97-127.

ENVIRONMENT AND HEALTH INTERNATIONAL

- Goyer RA. Toxic effects of metals. In: Klaassen CD, Amdur MO, Doull J (Edits). Casarett and Doull's Toxicology: The basic science of poisons. 3rd ed. New York: Macmillan Publishers. 1986:582-635.
- Wilson D. Penicillin in perspective. London Faber and Faber. 1976.
- Pesatori AC, Consonni D, Bachetti S, Zocchetti C, Bonzini M, Baccarelli A, Bertazzi PA. Short and long term morbidity and mortality in the population exposed to dioxin after the Seveso accident'. *Industrial Health* 2003;41:127-138.
- McConnell E. Acute and chronic toxicity, carcinogenesis, reproduction, teratogenesis and mutagenesis in animals. *Topics in environmental Health*. 1980;4:109-150.
- Harremo P, Gee D, MacGarvin M, Stirling A, Keys J, Wynne B, Guedes Vaz S (Edits). Late lessons from early warnings: the precautionary principle 1896-2000. Environmental issue report No 22, European Environment Agency: Luxembourg: Office for Official Publications of the European Communities. 2002
http://reports.eea.eu.int/environmental_issue_report_2001_22/en/tab_abstract_RLR accessed February 2006
- SNIFFER. Application of the precautionary principle. Report of workshop held at the Corus Hotel Edinburgh North, North Queensferry. 18th and 19th of May, 2004.
- Darmendra D. The French approach to contaminated land management. 2001.
<http://www.sanaterre.com/guidelines/french.htm> accessed February 2006
- Sanaterre Environmental. Soil Plan Zealand. July 2001.
<http://www.sanaterre.com/guidelines/zealand.htm> accessed February 2006
- Swedish Environment Protection Agency. Swedish Environment Quality Criteria for Contaminated Sites: Assessment of Contamination Level. 30 September 2002.
<http://www.internat.envron.se/index.php3?main=/documents/legal/assess/assedoc/cont.htm> accessed February 2006
- Australian National Environment Protection Council. Guidelines on the Investigation Levels for Soil and Groundwater. 1999.
http://www.ephc.gov.au/pdf/cs/cs_01_inv_levels.pdf accessed February 2006
- New Zealand Ministry of the Environment. Health and Environmental Guidelines for selected Timber Treatment Chemicals: Chapter 5 Soil Acceptance Criteria. Wellington, June 1997.
<http://www.mfe.govt.nz/publications/hazardous/timber-guide-jun97/chapter-5-jun97.pdf> accessed February 2006
- Petersen A. Compilation of EU Dioxin Exposure and Health Data: Task 1 – Review of Member State Legislation and Programmes. AEA Technology plc: Abingdon, Oxfordshire, October 1999.
<http://europa.eu.int/comm/environment/dioxin/download.htm#CompilationofEUDioxinexposureandhealthdata> accessed February 2006
- Japanese Ministry of the Environment. Informational Brochure – Dioxins. Tokyo 2003.
<http://www.env.go.jp/en/topic/dioxin/brochure2003.pdf> accessed February 2006
- Pattle Delamore Partners Ltd. Dioxin Concentrations in Residential Soil, Paritutu, New Plymouth, Appendix D: Summary of NZ and Overseas Soil Guidelines for Dioxin. Wellington, 2002
<http://www.mfe.govt.nz/publications/hazardous/taranaki-dioxin-report-sep02/appendix-d-sep02.pdf> accessed February 2006
- Fiedler H. Compilation of EU Dioxin Exposure and Health Data: Task 2 – Environmental Levels. AEA Technology plc: Abingdon, Oxfordshire, October 1999.
<http://europa.eu.int/comm/environment/dioxin/download.htm#CompilationofEUDioxinexposureandhealthdata> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Antimony and Compounds. Atlanta, 1992.
<http://www.atsdr.cdc.gov/toxprofiles/tp23.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Arsenic. Atlanta 2005.
<http://www.atsdr.cdc.gov/toxprofiles/tp2.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Beryllium. Atlanta 2002.
<http://www.atsdr.cdc.gov/toxprofiles/tp4.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium. Atlanta 1999.
<http://www.atsdr.cdc.gov/toxprofiles/tp5.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chromium. Atlanta 1999.
<http://www.atsdr.cdc.gov/toxprofiles/tp7.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cobalt. Atlanta 2004.
<http://www.atsdr.cdc.gov/toxprofiles/tp33.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Copper. Atlanta 2004.
<http://www.atsdr.cdc.gov/toxprofiles/tp132.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Nickel. Atlanta 2003.
<http://www.atsdr.cdc.gov/toxprofiles/tp15.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Selenium. Atlanta 2003.
<http://www.atsdr.cdc.gov/toxprofiles/tp92.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Toxicological Profile for Vanadium and Compounds. Atlanta 1992.
<http://www.atsdr.cdc.gov/toxprofiles/tp58.html> accessed February 2006
- Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Zinc. Atlanta 2003.
<http://www.atsdr.cdc.gov/toxprofiles/tp60.html> accessed February 2006

An Assessment of Air Quality in an Enclosed Multi-Storey Car Park

Mark Lyne,
School of Population Health, University of
Auckland and Division of Applied Sciences,
Auckland University of Technology, New Zealand

Michael Morrice,
Division of Applied Sciences, Auckland University
of Technology, New Zealand



Introduction

There is very little research that has been done in New Zealand regarding air quality within enclosed car parking buildings. However research shows that an estimated 400 premature deaths occur each year in New Zealand due to motor vehicle emissions.ⁱ In addition to premature deaths, acute and chronic

health effects including asthma, heart disease and bronchitis, as well as increased hospitalisations and restricted activity (sick days) are also attributable to vehicle emissions.ⁱⁱ

Estimates of the contribution of motor vehicle emissions to air pollution in Auckland are in the order of 70 to 90% for carbon monoxide and nitrogen oxides.ⁱⁱⁱ

The aim of this study was to;

- Measure levels of motor vehicle emissions within an enclosed multi-storey car park;
- Compare results with standard and guideline values; and
- Identify potential health risks and impacts of motor vehicle emissions.

The car park monitored was the busiest enclosed multi-storey car park in the Auckland region, based upon the number of cars that visit the site daily. It has two levels and provides parking for a large retail shopping mall and supermarket.

ENVIRONMENT AND HEALTH INTERNATIONAL

Carbon monoxide, nitrogen oxides and nitrogen dioxide levels were monitored at four sites within the car park, two on each level. Both instant testing gas detector tubes and diffusion tube passive samplers were used to monitor the sites over a three- month period.

Background

The health effects of motor vehicle emissions and ambient air pollution are known but due to the nature of enclosed multi-storey car parks it is anticipated that these health risks may be amplified.^{iv} This is of particular concern since it may be possible that it will have a cumulative effect and also because employees and subcontractors that provide security, maintenance and other various services may be subjected to work in these environments for a substantial period of time.

Carbon monoxide is the end result of incomplete combustion of fossil fuels, usually by petrol and diesel engines. It is an odourless, colourless gas, heavier than air, which means that it may collect and accumulate in confined spaces. At risk human population groups include children, pregnant women and their developing foetuses and people with pre-existing respiratory and heart conditions.²

Carbon Monoxide reduces the ability of haemoglobin in the bloodstream to carry oxygen such that the blood is unable to release enough oxygen into the body's tissues and other sensitive organs such as the brain and heart. It does not directly affect the lung tissue except at extremely high concentrations that are unlikely to be experienced in normal circumstances. Poisoning can cause short-term neurological deficits that are reversible and severe, often delayed, neurological damage. Low concentration poisoning is characterised by headaches, but as concentrations increase, symptoms include dizziness, nausea and vomiting.^v

The primary source of anthropogenic nitrogen oxides is from the combustion of fossil fuels from motor vehicles. Nitrogen oxides readily form nitric acid when they come into contact with water within the body; the most effected parts are the eyes, lungs, mucous membranes and skin. The most susceptible groups are young children, asthmatics, and people with chronic bronchitis and other related conditions.¹

ENVIRONMENT AND HEALTH INTERNATIONAL

Nitrogen dioxide can significantly contribute to morbidity and mortality, particularly in the previous susceptible groups. When exposed to relatively high concentrations of nitrogen dioxide lung irritation and potentially long-term lung damage may occur.¹

Method

For the purpose of this study the sampling of carbon monoxide, nitrogen oxides and nitrogen dioxide was carried out. Nitrogen dioxide was

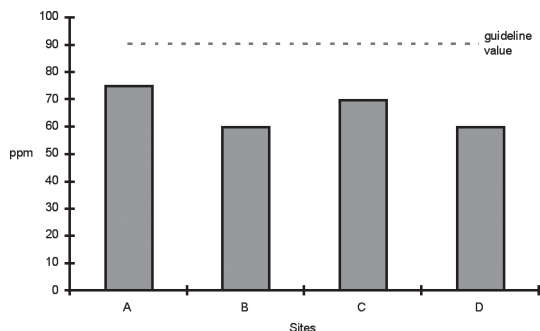
monitored constantly over the three-month period at each site using diffusion tube passive samplers (average fortnightly levels). Carbon monoxide and nitrogen oxides were both monitored using Gastec gas detector tubes (instant levels). Carbon monoxide was also monitored using Gastec 8 hour diffusion tube passive samplers (average 8 hour levels).

Results

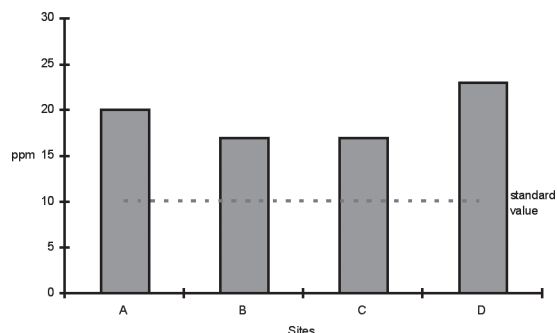
Carbon Monoxide (instant levels)

Site	Highest level	Mean	Lowest	Guideline	No. of readings taken	No. of exceedences of Guideline
A	75ppm	50ppm	20ppm	90ppm (15min)	9	0
B	60ppm	38ppm	15ppm	90ppm (15min)	9	0
C	70ppm	37ppm	15ppm	90ppm (15min)	9	0
D	60ppm	39ppm	20ppm	90ppm (15min)	9	0

Carbon Monoxide highest instant levels



Carbon Monoxide highest 8 hour levels



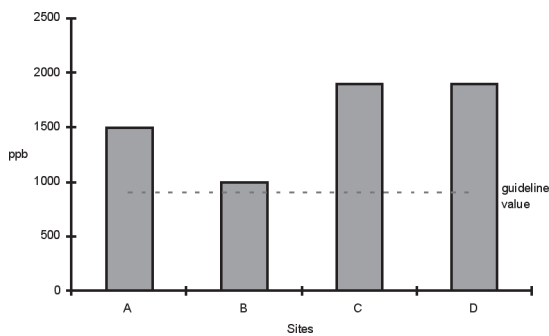
Carbon Monoxide (8 hour levels)

Site	Highest level	Mean	Lowest	Standard	No. of readings taken	No. of exceedences of Standard
A	20ppm	17ppm	14ppm	10ppm (8 hour)	5	5
B	17ppm	14ppm	11ppm	10ppm (8 hour)	6	6
C	17ppm	13ppm	9ppm	10ppm (8 hour)	6	4
D	23ppm	16ppm	11ppm	10ppm (8 hour)	5	5

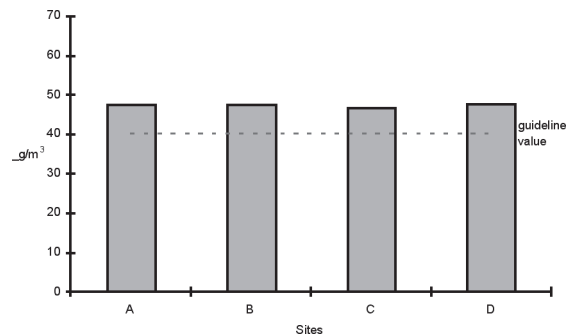
Nitrogen Oxides(instant levels)

Site	Highest level	Mean	Lowest	Guideline	No. of readings taken	No. of exceedences of Standard
A	1500ppm	1075ppb	400ppb	900ppb (instant)	8	6
B	1000ppm	706ppb	400ppb	900ppb (instant)	8	3
C	1900ppm	700ppb	200ppb	900ppb (instant)	8	2
D	1900ppm	888ppb	400ppb	900ppb (instant)	8	4

Nitrogen Oxides highest levels



Nitrogen Dioxide highest levels



Nitrogen Dioxide (fortnightly levels)

Site	Highest level	Mean	Lowest	Guideline	No. of readings taken	No. of exceedences of Standard
A	47.5µg/m³	42.2µg/m³	37.2µg/m³	40µg/m³ (annual)	5	3
B	47.5µg/m³	41.2µg/m³	38.2µg/m³	40µg/m³ (annual)	5	3
C	46.8µg/m³	42.0µg/m³	34.8µg/m³	40µg/m³ (annual)	5	3
D	47.8µg/m³	42.5µg/m³	36.1µg/m³	40µg/m³ (annual)	5	3

Discussion

While all the instant carbon monoxide levels fell within the guideline value, almost all of the 8 hour carbon monoxide levels exceeded the standard value, although a 15 minute guideline set by the World Health Organisation was used for the comparison of the former due to a lack of any instant guideline or standard value. The standard used for 8 hourly carbon monoxide levels is set by the Ministry for the Environment (New Zealand).

Of the 32 instant readings that were taken for nitrogen oxides, 15 exceeded the guideline value. There are no guideline or standard values set for nitrogen oxides in New Zealand and for this

comparison a guideline set by the Department of the Environmental Affairs and Tourism (South Africa) was used.

12 of the 24 fortnightly nitrogen dioxide levels exceeded the guideline value. An annual guideline value set by the World Health Organisation was used for comparison since no similar guideline or standard values are set in New Zealand for annual levels.

Since levels of carbon monoxide, nitrogen oxide and nitrogen dioxide monitored within the enclosed multi-storey car park exceeded guideline and standard levels set to protect human health, it

suggests that there is the potential for health risks caused by motor vehicle emissions.

Limitations

Due to practicability, only carbon monoxide, nitrogen oxides and nitrogen dioxide were monitored. Other pollutants (e.g. particulates, and volatile organic compounds etc.) which are also emitted from vehicles and harmful to health were not monitored. However, those gases which were monitored give an indication of the general air quality within the enclosed multi-story car park and provide the basis for further research and more detailed monitoring.

It is accepted that the monitoring methods used are not as accurate and precise as real-time monitoring. However, taking into consideration coefficients of variation and standard deviations for the monitoring methods used, results still suggest the potential for health risks due to elevated levels of those pollutants monitored.

For further information contact Mark Lyne at m.lyne@auckland.ac.nz

References

Fisher, G., et al., *Health Effects Due to Motor Vehicle Air Pollution in New Zealand*, Report to the Ministry of Transport, January 2002.

Ministry of Transport, *The New Zealand Vehicle Emissions Screening Programme*, 2004, 1-28.

Ministry for the Environment, and Ministry of Transport, *Ambient Air Quality and Pollution Levels in New Zealand: Targets for Vehicle Emissions Control*, Air Quality report No.9, December 1998.

Burnett, J., and Chan, M.Y., *Criteria for Air Quality in Enclosed Car Parks*, Proc. Instn Civ. Engrs, Transp., 1997, 123, May, 102-110.

World Health Organisation (WHO), *Air Quality Guidelines, Second Edition*. WHO Regional Office for Europe, Copenhagen, Denmark, 2000.

A presentation by Marius Urbonas, Head of Department of Public Health Safety Expertise, State Environmental Health Centre, Lithuania (Chairman of Lithuanian Union of Hygienists and Epidemiologists) on the IFEH Website www.ifeh.org

The presentation is entitled 83/477/EEC, 91/382/EEC and 2003/18/EC: Protection of Workers from Risks related to the Exposure to Asbestos – Problems and Experience from Lithuania – and was given at the Seminar on OHS Prevention Culture, OHS Management System.

ASBESTOS – FUTURE RISKS?

Robin Howie, Robin Howie Associates

Exposure to asbestos can cause, in order of increasing severity: pleural plaques, benign pleurisy, diffuse pleural thickening, asbestosis, asbestos-induced lung cancer and mesothelioma. Of the above diseases, the most critical are asbestos-induced lung cancer and mesothelioma, as both are fatal. About 93% of patients with lung cancer die within 5 years of diagnosis and the average survival from diagnosis in patients with mesothelioma is about 8 months. Mesothelioma is a cancer of the pleura (the lining of the lungs) the peritoneum (the lining of the gut) or the pericardium (the lining of the heart). About 90% of mesotheliomas occur in the pleura.

There is a “latent period” of generally about 20-30 years between first exposure to asbestos and development of asbestos-induced lung cancer. The lung cancer risk with asbestos is synergistic with smoking: a smoker who is exposed to asbestos has about a fifteen times greater risk of developing lung cancer than an equally exposed non-smoker. This multiplicable effect also applies if the exposed person subsequently smokes, e.g. if young child who has been exposed to asbestos subsequently smokes. Conversely, for a smoker who has been exposed to asbestos, the lung cancer risk can be reduced if the smoker stops smoking or reduces his consumption of tobacco. There is also a latent period with mesothelioma, generally about 40 years, but can range from 5 to 80 years. However, latent periods of less than 10 years are rare.

The risk of developing mesothelioma increases as the time since exposure to asbestos to the power 3-4, e.g. Doll and Peto (1985). For example, the mesothelioma risk to age 80 for someone first exposed at age 20 is about twice as high as for someone similarly exposed from age 30. If a child is exposed to asbestos from birth, the mesothelioma risk is about a factor of 2.5 higher than from age 20, from Doll and Peto (1985). Age at the time of exposure is therefore particularly important for children as they have a higher probability than adults of living long enough to develop mesothelioma. A further problem is that if children are exposed to asbestos in the home, they may be exposed for up to 20 hours/day, ~350 days/year. For a given airborne fibre concentration, a pre-school child may therefore

have an about 4 times higher cumulative exposure than an adult occupationally exposed for 40 hours/week for 45 weeks/year. This extended exposure effect is multiplicative with the age effect: a pre-school child exposed in the home for 20 hours/day for 5 years is therefore at a 10 times higher risk of developing mesothelioma by age 80 than an equally exposed 20 year-old adult at work.

There are two different classes of asbestos, serpentine and amphibole, and six different types of asbestos, chrysotile – “white asbestos” is a serpentine, and crocidolite – “blue asbestos”, amosite – “brown asbestos”, anthophyllite, also sometimes called “white asbestos”, fibrous tremolite and fibrous actinolite are all amphiboles. Note that non-fibrous tremolite and actinolite are common minerals.

Not all types of asbestos are equally hazardous. For a given exposure, the asbestosis risk is greater with crocidolite and amosite than with chrysotile. The mesothelioma risk with crocidolite is about 5 times greater than with amosite and about 500 times greater than with chrysotile. The asbestos-induced lung cancer risks with crocidolite and amosite are 10-50 times greater than with chrysotile, Hodgson and Darnton (2000). Fibrous tremolite and fibrous actinolite can be considered as having the same potency for causing mesothelioma as crocidolite.

All asbestos used in the UK was imported. Total imports of asbestos into the UK were about 150,000 tonnes of crocidolite, about 600,000 tonnes of amosite and about 6? million tonnes of chrysotile. A small quantity of anthophyllite was also imported. Fibrous tremolite and actinolite were not commercially used in the UK but were present as naturally occurring contaminants in chrysotile from some sources, e.g. chrysotile from Quebec could contain up to about 4% by weight of tremolite. Fibrous tremolite is also present as a natural contaminant of talcum powder and vermiculite from some mines and has caused numerous mesotheliomas in such areas.

Crocidolite was used in thermal and acoustic insulation products in sprayed or bulk form, in mattress, (bags with crocidolite or chrysotile textile covers and generally filled with crocidolite or amosite fibres), in building boards, in high-pressure water and sewerage pipes and in wartime and post-war military gas mask filters. Amosite

was used in similar products as crocidolite but was also used in preformed insulation sections and slabs and in Asbestos Insulation Boards (AIB). It can be estimated that about 140 million square metres of AIB were manufactured in the UK between about 1950 and about 1980. Such boards contained 15-50% by weight of amosite and some pre-formed pipe sections and slabs contained up to about 80% by weight of amosite. Chrysotile was primarily used in asbestos cement products, which can contain up to about 15% by weight of asbestos, and in low-density fire resistant boards, which were widely incorporated in fire doors and other fire resistant panels. From the latter 1950s through the 1960s crocidolite was added to asbestos cement products at 1-3% of fibre content to increase production. Given the 500-fold higher mesothelioma risk with crocidolite compared with chrysotile, a 1% crocidolite content of the fibre content in asbestos cement products increases the mesothelioma risk by about a factor of 6 as compared with crocidolite-free products. Asbestos cement products should therefore always be assumed to contain crocidolite unless it is known that the dates of manufacture post-date about 1975 or proper analysis has confirmed that such products contain chrysotile only.

Sprayed materials containing crocidolite and/or amosite are very friable and can readily release fibres. Bulk thermal insulation is commonly called “monkey dung” or “plastic” and generally contains crocidolite and/or amosite, magnesium carbonate or calcium silicate and a binder, such as Portland cement. Poorly controlled removal of sprayed crocidolite or amosite materials can generate upwards of 3,000 fibres/ml and the use of power tools on inadequately wetted crocidolite can generate up to about 1,000 fibres/ml, Howie et al (1996). A short study by this author revealed that the dry breakout of a single 4-foot by 8-foot sheet of AIB and sweeping up the dry debris could generate personal exposures of 50-75 fibres/ml of amosite and could cause the release of 9,000,000,000 respirable airborne amosite fibres. Even “trivial” activities such as sticking drawing pins in AIB can release numerous airborne fibres: one drawing pin insertion and removal can generate 2,000-6,000 respirable fibres.

HSE (2003) estimated that there had been about 25,800 male mesothelioma deaths in Great Britain during 1968-2001 and that between 2002 and

2050 there will be a further 55,000 male deaths. Assuming that female deaths occur at about 15% of the rate of male deaths, total mesothelioma deaths to 2001 will have been about 30,000 with a further about 63,000 between 2002 and 2050.

HSE's above estimate is based on the assumption that current and future exposures to airborne fibres are very low. However, it must be appreciated that at the incoming Control Limit of 0.1 fibres/ml for all types of asbestos, the risks are very substantial. For example, the lung cancer and mesothelioma consequences of exposure to 0.1 fibres/ml of asbestos over a 20-year working period from age 20 will be as below, from Hodgson and Darnton (2000):

Excess deaths per million to age 80 from 20 year exposure to 0.1 f/ml from age 20

Asbestos type	Mesothelioma	Lung cancer	Total
Crocidolite	19,400	1,300	21,000
Amosite	2,700	1,300	4,000
Chrysotile	150	450	600

HSE (1989) assessed the social acceptability of excess deaths risks and concluded that a death risk of 1 in 1,000 per annum (1/million/yr) "is about the most that is ordinarily accepted under modern conditions for workers in the UK and it seems reasonable to adopt it as the dividing line between what is just tolerable and what is intolerable." HSE (1989) introduced the concept of a "tolerable" risk as a risk arising from a process from which there is a benefit, e.g. as we all use electricity, we must therefore all accept a level of risk in return. The upper boundary for "tolerable" risk was set at 10/million/yr and the boundary for "acceptable" risk was set at 1/million/yr.

Philosophically, it seems of extremely dubious morality for anyone to define as "just tolerable" a level of risk to which he is not himself exposed. It is therefore herein considered that no worker should be exposed to an occupational risk of more than 10/million/yr.

If annual risk is taken as being the total risk divided by the period over which that risk is accumulated, i.e. the period of exposure, the annual risks for 5-year exposures from age 20 at 0.1 fibres/ml are 5,300/million/year with crocidolite, 800/million/year with amosite and 120/million/year with chrysotile. That is, all above

risks are very substantially in excess of the "tolerable" boundary of 10/million/year.

From the above figures it is essential that all personal exposures be reduced to the lowest technically feasible level, and certainly to substantially less than 10% of the new Control Limit of 0.1 fibres/ml, particularly for exposures to crocidolite or amosite.

Limiting personal exposures to consistently less than 10% of the Control Limit will require scrupulous adherence to new working methods and rigorous enforcement of the incoming Control of Asbestos at Work Regulations.

There are many situations where "Reassurance Samples" are taken to assess airborne asbestos exposure levels in offices, schools and homes. Great Britain currently does not have an environmental limit for asbestos. However, HSE (2005) states that the Clearance Indicator criterion of 0.01 fibres/ml may "... also be used in the interpretation of reassurance and background samples". The Clearance Indicator is the airborne fibre concentration which must not be exceeded if an asbestos enclosure is to be removed. This use of the Clearance Indicator is in direct contradiction to the Approved Code of Practice, HSE (2002), which states that: "The threshold of less than 0.010 fibres/ml should be taken only as a transient indication of site cleanliness, in conjunction with visual inspection, *and not as an acceptable permanent environmental level*" (my italics).

As the concentrations measured during Reassurance Sampling are effectively the permanent exposure levels within the building, it is useful to assess the risks for adults and pre-school children exposed to this concentration for five years on the assumption that the adults are exposed occupationally for about 1,800 hours per year from age 20 and that pre-school children may be exposed in the home for about 7,200 hours per year from birth.

The mesothelioma and lung cancer risks from such exposures are shown below, from Hodgson and Darnton (2000) and Doll and Peto (1985):

Excess death risks per million to age 80 from 5-year exposures to 0.01 f/ml

Exposures	Asbestos type	Mesothelioma	Lung cancer	Total	Risk/ million/yr
Adults	Crocidolite	1,240	15	1,260	255
	Amosite	186	15	200	40
	Chrysotile	50	–	50	10
Pre-school children	Crocidolite	8,160	104	8,260	1,650
	Amosite	1,224	104	1,330	266
	Chrysotile	–	–	326	65

From the above it will be seen that the consequences of residential exposure to 0.01 fibres/ml for pre-school children are about a factor of 6 higher than for adults occupationally exposed at the same concentration and very substantially in excess of the “tolerable” level of 10/million/yr for exposures to all types of asbestos.

It is concluded that unless occupational personal exposures are reduced to less than about 10% of the incoming Control Limit of 0.1 fibres/ml and residential exposures for pre-school children are reduced to below less than 10% of the Clearance Indicator of 0.01 fibres/ml, particularly for crocidolite and amosite, the excess death risks will be very substantially in excess of the “tolerable” level of 10/million/yr for exposures to all types of asbestos and HSE’s assumed mesothelioma deaths to 2050 will be an underestimate.

REFERENCES

- Doll R and Peto J (1985) Asbestos Effects on health of exposure to asbestos. Health and Safety Commission: London.
- Health and Safety Executive (2005) Asbestos: The analysts’ guide for sampling, analysis and clearance procedures. HSG 248. HSE Books: Sudbury.
- Health and Safety Executive (2003) Mesothelioma mortality in Great Britain: estimating the future burden. HSE: Bootle.
- Health and Safety Executive (2002) Approved Code of Practice: Work with asbestos insulation, asbestos coating and asbestos insulating board”. Fourth Edition, L28. HSE Books: Sudbury.
- Health and Safety Executive (1989) Risk criteria for land-use planning in the vicinity of major industrial hazards. HMSO: London.
- Hodgson JT and Darnton A (2000) Quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure. *Annals of Occupational Hygiene*, 44: 565-602.
- Howie RM, Johnstone JBG, Weston P, Aitken RJ, Groat S (1996) Effectiveness of RPE during asbestos removal work. HSE Contract Research Report No. 112/1996. HSE Books: Sudbury.

GROUNDWATER QUALITY AND HEALTH RISKS IN ONNE COMMUNITY NEAR A FERTILIZER COMPLEX IN SOUTHERN NIGERIA

G. R .E .E Ana and M.K.C Sridhar

Department of Epidemiology, Medical Statistics and Environmental Health,
Faculty of Public Health, College of Medicine,
University of Ibadan,
Ibadan, Nigeria

E-mail <anagrow@yahoo.com>

Phone 08037146436

ABSTRACT

The quality of groundwater sources around the vicinity of a chemical fertilizer industry located in Onne about 30km from Port Harcourt was assessed. The objective of this study was to determine the extent of contamination of groundwater sources and their associated health risks in the host communities to the fertilizer Industry. This was carried out by assessing the levels of some physicochemical parameters using methods recommended by the American Public Health Association (APHA). Eight samples with appropriate controls were randomly obtained and analyzed for parameters including pH, conductivity, phosphate, nitrate and total hardness. In addition, 100 human subjects selected randomly were subjected to in-depth interview on their health conditions within the communities. The laboratory results indicated the highest conductivity value of 582.0µs and an undetectable free ammonia level for one of the control samples. Also there was relatively higher levels of nitrate (>1.0mg/l), phosphate (2.22mg/l) and total hardness (111.3mg/l) among some ground water samples even though they were within acceptable guideline values .The survey results indicated that

apart from malaria, which recorded the highest incidence, GIT disorders 20(20%) and skin irritation 16 (16%) were the most reported health problems in the communities. This study indicates that present level of groundwater pollution with nitrogenous substances is minimal. However, other contaminants such as ionic species may be associated with the high incidence of GIT and Skin disorders recorded in the communities.

Key Words: 'Fertilizer Industry', 'Groundwater Pollution', 'GIT Disorders', Onne and Nigeria.

INTRODUCTION

Groundwater constitutes nature's largest and most valuable source of drinking water. However, its potability and availability remain very serious area of concerns for many great nations especially the industrialized ones. The composition of groundwater is dependent on the kind of soils and geological materials rich in minerals. The amount of these substances makes it potable or hardly potable (Patrick and Ford, 1990)

Often, a number of anthropogenic activities contribute to the adverse changes in the composition of groundwater sources. Some of these include increase in nitrate and phosphate concentration arising from extensive fertilization (Gazela et al, 1974); large number of coliforms, high concentration of nitrates, chloride and phosphate resulting from sewage infiltration (Sridhar and Pillai, 1973). Sometimes, industrial effluents also constitute potential source of contamination of groundwater sources. Recently, studies on ground water contamination have elucidated implicitly inputs from non-industrial and industrial sources with the latter accounting for more than 40% of these cases.

In Nigeria, limited evidence abound as to the status of ground water supplies especially those bordering industrial communities. The ground water sources that serve the host communities to Nigeria's most complex chemical fertilizer industry are in no way any exception.

These water sources though complementary to the more abundant and readily utilized surface water sources could pose public health risk if their quality is of modicum standards. The overall objective of this study is underscored by the need to assess the quality of the available ground water sources and the attendant health risks in the host communities to the fertilizer industry.

METHODOLOGY

The Study Area

The study was conducted within the vicinity of the ultra-modern fertilizer complex at Onne, located in the southern part of Nigeria between 4.49° and 4.5° North and about 6.59° and 7.0° east of the Greenwich Meridian and about 30km from Port Harcourt, Rivers State. The fertilizer complex is bounded on the west by Okrika creek, which is the major receiving water body for the plant effluents which are rich in nitrogenous and phosphorous compounds, Okrika communities and mangrove swamps; on the east by Onne communities and farmlands where most of the samples were obtained; and on the south by the Federal Ocean terminal, Ele and Owuogono.

Materials

Eight ground water samples were collected cross-sectionally from eight points distributed randomly around the fertilizer complex within a radius of 5km. Two of the samples, from bore holes, were collected from the plant complex and staff village about 1km apart, while four samples from three hand dug wells and one bore hole were collected from Alegeor, Agbeta and Ogoloma Villages of Onne town (each about 500m apart). Two control samples were collected from Diobu area of Port Harcourt, 30km away from the study area.

Methods

Methods used in assessing the ground water quality were classified into physical and chemical methods. Prior to this, the general features of the various water sources were documented. For the physical methods, parameters such as colour, odour, temperature, pH and conductivity were determined. Colour and odour determination were carried out according to standard methods. Temperature was measured in-situ using standard laboratory size thermometer graduated in degrees Celsius (°C). Measurement of pH value was carried out by probe method with a standard calibrated pH meter model 3020 made by Jenway, U.K Conductivity was measured using a conductivity meter model 4010 made by Jenway, U.K.

The following chemical parameters were measured: dissolved oxygen (DO), urea, free ammonia, chloride, nitrate, phosphate, total hardness, iron and zinc. The dissolved oxygen was determined by using a calibrated standard DO meter model 50B made by YSI, U.K The chloride, nitrate and phosphate levels were determined

spectrophotometrically according to mercuric nitrate, phenoldisulfonic acid and sulphate digestion standard methods, respectively. The total (calcium) hardness level was determined using EDTA titrimetric method while the zinc and iron concentration were determined spectrophotometrically using zincon and phenanthroline methods respectively as described by standard methods (APHA,1992)

In addition to these laboratory methods, a health survey involving in-depth interview with 100 human subjects randomly chosen in the community was carried out .This interview focused primarily on sources of water, uses of water and prevailing health conditions and outcomes among individuals in the community. Data obtained was processed and subjected to descriptive statistical analysis.

RESULTS AND DISCUSSION

The general features for the groundwater sources

are given in Table 1.0.The results of the physical and chemical analyses as shown in Table 2.0 indicate that with the exception of samples 4 and 5 that were slightly turbid and brownish all other samples were colourless. Odour was not perceived in most of the samples except for samples 4 and 5, which were slightly rusty and rusty respectively. The control sample 2 from Port Harcourt town recorded the highest conductivity value of 582.0µs. Free ammonia was not detectable in any of the samples. Only samples 7 and 8 from the neighbouring villages recorded nitrate levels above 1.0mg/l. Sample 7 recorded the highest phosphate level of 2.39mg/l. The highest concentration of calcium hardness was recorded for sample 5 from the village. The health survey indicated that although malaria recorded the highest incidence, other cases such as skin and GIT infections were significantly high in the communities based on the reports of the respondents as shown in Figure 1.

Table 1.0: General Features of Groundwater sources:

Sample sources	Location	Nature of sources	Remarks
1	Port Harcourt Town (30km)	Bore hole	Good sanitary condition
2.	Port Harcourt Town (32km)	Shallow well Cover present Depth 3.9m Width 0.9m Parapet 1.0 Apron present	Fair Sanitary condition
3.	Plant Complex (1km)	Bore hole	Very good sanitary condition
4.	Estate (2km)	Bore hole	Very good sanitary condition
5.	Ogoloma village (4km)	Bore hole (Hand pump)	Water was brownish in colour
6.	Ogoloma village(3.5km)	Shallow well Cover present Depth 7.25m Width 1 m Parapet 0.5m Apron present	Algal growths on the upper Linning of the well
7.	Alegeor village(3km)	Shallow well Cover present Depth 6.481m Width 0.81m Parapet 0.45m Apron present	No algal growths on the side of the well
8.	Aleta village (2.5km)	Shallow well Cover present Depth 6.48m Width 0.81m Parapet 0.45m Apron present	No algal growths on the sides of the well

Table 2.0 Physicochemical Parameters for Groundwater Sources

Sampling Point Parameters	1 P.H Town Bore Hole (control 1)	2 P.H Town Bore hole (control 2)	3 Plant Bore hole	4 Plant Estate Bore hole	5 Village Shallow well	6 Village Shallow well	7 Village Shallow well	8 Village Shallow well	WHO Guideline Value
Colour	C	C	C	ST	B	C	C	C	5 units
Odour	ND	ND	ND	SR	R	ND	ND	ND	Unobjectionable
Temperature(°C)	26.0	26.3	26.0	28.5	28.0	28.5	28.0	28.5	<40°C
pH value 5.24	5.24	6.85	6.85	6.55	6.90	7.44	7.38	6.79	7-8.5
Conductivity(ms)	146.6	582.0	22.8	13.5	16.2	347.2	222.7	72.5	–
DO (mg/l) 6.60	6.60	6.88	6.40	7.20	6.60	7.07	6.60	6.63	8mg/l
Chloride (mg/l)	30.3	126	3.08	2.56	ND	25.64	9.74	7.69	200mg/l
Nitrate (mg/l)	0.551	0.551	0.735	0.857	ND	0.673	1.591	1.071	50mg/l
Phosphate (mg/l)	1.51	1.62	0.366	0.937	ND	0.427	2.391	2.22	–
Free Ammonia	ND	ND	ND	ND	ND	ND	ND	ND	–
Total Hardness (mg/l)	18.87	2.97	2.81	9.037	15.94	0.427	2.391	2.22	100mg/l
Iron (mg/l)	0.037	0.141	0.005	0.065	0.297	111.3	82.98	11.22	0.1mg/l
Zinc (mg/l)	1.139	0.853	1.07	1.134	0.295	1.79	1.323	1.257	5.0mg/l

Port Harcourt (PH); Brownish (B); Clear (C); Slightly Turbid (ST); Slightly Rusty (SR); Rusty(R); Not Detectable (ND)

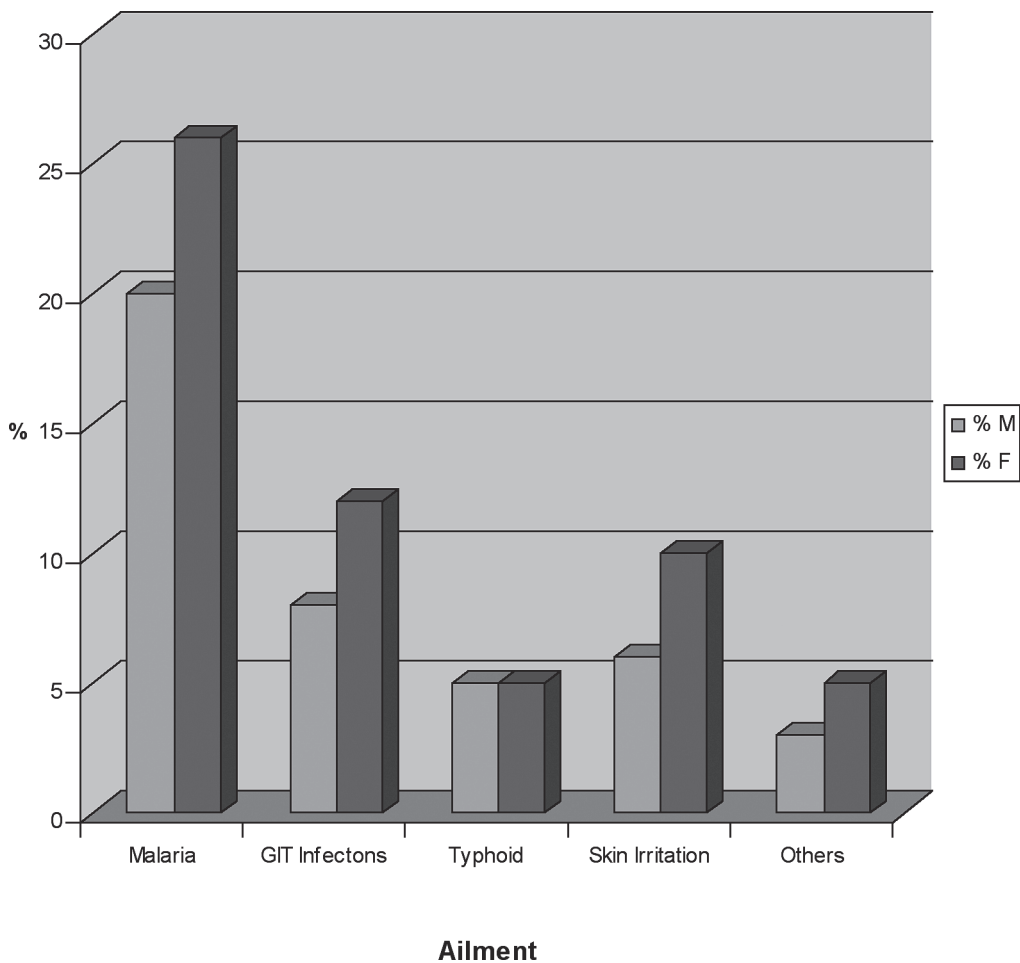


Fig 1.0 Health Status of communities

The assessment of quality of ground waters obtained near the fertilizer industry showed that all the samples including controls had clear appearance except for the borehole samples in the estate and the village, which were slightly coloured. This condition was found to be associated with the rusty pipes. Odour, temperature and pH values for all the samples were within the WHO permissible limits. However, the high conductivity values recorded for control sample 2 and some of the village samples were an indication of probable intrusion of salts from the brackish aquatic ecosystem surrounding the Onne and Port Harcourt environments respectively. This may have had direct bearing with the GIT infections and skin morbidities recorded in the community.

Also results indicated appreciable DO values ranging from 6.60mg/l to 7.20mg/l when compared to WHO's recommended level of 8.0mg/l for potable water (WHO, 1995). The free ammonia levels were not detectable in any of the samples. Nitrate levels were within WHO permissible level but were comparatively higher in the village samples suggesting nitrogenous inputs from either domestic activities and/or a combination of that with the industrial discharges. This implies that though ammonia nitrogen is not present, the current level of nitrate contamination does not pose any health hazard thus allaying any fears of possible nitrate poisoning in the community (Jackson et al 1990). Nevertheless, it is not unlikely that the risk of such a condition may not occur if the pollution load increases and sustainable environmental practices diminish in future.

Furthermore, the values for chloride, total hardness and phosphate levels were not significant when compared to WHO's highest desirable level of 200mg/l for chloride and 100mg/l for total hardness respectively. The levels of metals like zinc were very low in comparison with WHO's highest desirable level of 0.1mg in contrast to highly significant levels of zinc in some samples as compared with WHO's highest desirable level of 5.0mg/l.

The high malaria incidence in the community is typical of any tropical environment. However, the high incidence of skin and GIT morbidities may have been attributed to exposure to water sources, whose quality has been eroded due to presence of some inorganic contaminants. Other minor

morbidity conditions such as arthritis and sexually transmitted diseases (STD's) were also reported and these were higher among women.

CONCLUSION

This study reveals that most of the water sources in Onne are potable with very minimal impact from nitrogenous substances. Nevertheless, there are strong indications that apart from malaria, which recorded the highest incidence in the community, other highly reported morbidities associated with skin and GIT may have been associated with the presence of inorganic-based contaminants in the groundwater. This constitutes an area for in-depth research in the future.

REFERENCES

- American Public Health Association(1992)Standard methods for the examination of water and waste water., 17th edition.
- Gazela, S; Melioris, L and Probity, A. (1974) "Hydrogeology and Environmental protection: Mineral Solvac; 6 (3) 239-48.
- Jackson, M.H, Morris G.P.; Smith, P.G. and Crawford, J.F. (1989) "environmental Health Reference Book" By Butterworth-Heinemann, Printed and rolled by Hartnolls Ltd Bodmin Cornwall pp 8/3-11/20.
- Patrick, R.E and Ford, J.Q (1990): "Groundwater contamination in the United State, second edition, Philadelphia. A Publication of UNEP-Industry and Environment, pp 29-30
- Smith, G.E (1967) "Fertilizer Nutrients as contaminants in water supplies" published in America. As advance sci (85). 173-86.
- Sridhar, M.K.C and Pillai, S.C. (1973) "Pollution of ground water at Bangalore": Proceedings of the Seminar on Environmental Pollution Central Public Health Engineering Research Institute, Nagpur, 59-70.
- World Health Organisation (WHO (1995): "Guidelines for Drinking Quality Water "2nd edition. Vol. 1. Geneva, pp 174-180..

ACKNOWLEDGEMENTS

We express our sincere gratitude to the management of National Fertilizer Company of Nigeria (NAFCON) limited for granting us access to its facility for the purpose of conducting this research.

Assessment and Monitoring of Chemical Water Quality Parameters in the Mbabane River: Swaziland

S.J. NKAMBULE (Dipl., B.Sc. (Hons), M.Sc.)
University of Swaziland
Faculty of Health Sciences Department of
Environmental Health Sciences



ABSTRACT:

A preliminary assessment and monitoring of Mbabane river water quality was done between January and December 2002. The river flows throughout Mbabane collecting surface run-offs from residential, urban and different type of industrial sites. Concentration and level of chemical water quality parameters namely, Biochemical Oxygen Demand (BOD), ortho-phosphates, nitrates, sulphates, ammonia, chlorides and dissolved oxygen were monitored at four different sites which were identified along the river. Site one upstream as a control site, site two at the industrial site, site three downstream of waste stabilisation ponds discharge and site four 10km downstream, to assess the recovery rate of the river.

The study shows that during the period of sampling, the concentration levels of chemical parameters eg. ammonia at 1.8mg/l and BOD at 9.2 mg/l exceeded levels stipulated in The Water Act, Water Quality Standards. This pollution may have been attributed to leaks and overflow in the sewerage networks along the river. The concentration of the other parameters had not reached alarming proportion but showed steady rising level, which is a cause for concern, thus

discharges from nearby industries need to be closely and continuously monitored.

This study shows that chemical pollution in the Mbabane river poses a threat to the environment especially the aquatic life and is a health hazard to the people who depend on the river for their daily activities.

INTRODUCTION AND LITERATURE REVIEW.

A normal healthy river has a balance of plants and animal life presented by great diversity of species. Water is critical to the survival of life including plants and animals and man is no exception. If the water is polluted aquatic life will not survive, humans will also be affected due to toxic and hazardous pollutants in the water systems when used for domestic, habitations, agricultural activities etc. Water-borne and other water related diseases will affect water users down stream (Vissman and Hammer, 1998).

History shows many occasion where agricultural development has been hindered by lack of water supplies due to conflicts between landowners and settlers, which has occurred in numerous parts of the world and other conflicts in relation to water supplied can arise because of effects which human and industrial wastes can have on the water (Tebbutt, 1998). This means that the importance of water as a natural resource, which requires careful management and monitoring, must be universally recognised. Although Nature often has great ability to recover from environmental damage, the growing demands on water resources necessitate the professional application of fundamental knowledge about the water cycle to ensure maintenance of quality and quantity.

Rivers are a major source of water supply for domestic and other municipal activities. Industries also rely on water to remove excess heat and satisfy their manufacturing process needs. Unfortunately, the water that has been used in all these activities will find its way back into the river as their principal disposal pathway for waste materials. The propagation of fish, shell fish and other aquatic life does not normally require withdrawal of water from the source but is based on utilisation in place (Lamb 1985). As societies become more industrialised, the variety of waste material increases and problems of water quality become more difficult and demanding. The natural ability of the river to deal with a

certain degree of inevitably organic pollution from its catchment is reduced. This may reduce the value of the water, or even make its use for certain purposes impossible without substantial prior treatment. This situation may develop, for example, when discharged waste waters diminish aesthetic benefits and reduce or eliminate downstream fisheries. It may also create less acceptable raw water quality for municipal or industrial supplies, or reduce the ability of the stream to assimilate potential pollutants from other discharges.

In order to understand the river system and its influence on water quality, it is essential that the mechanism governing pollution and self-purification processes are also understood. In this study chemical parameters were investigated in an effort to evaluate their concentration and effect upon quality status of the river. Sources of pollution into rivers, legislation and other documentary sources to control pollution were also studied.

Associated with the increase in population size, is the increase in industries. Studies have shown that in industries there are by-products wastes or effluent, which are discharged to rivers. With the widespread use of organic and inorganic chemicals such as herbicides and insecticides in agriculture, it is inevitable that some of these find their way into fresh water systems (Miller, 2000). Some pollutants do not break down readily in the natural environment, such that once taken by a plant or animal in a food chain, they pass and accumulate in the highest members of the chain (Willoughby, 1976). As Swaziland is a growing country, there are also industries that have been established and developed. These industries generate effluent and excessive discharges of effluent into a river cause deterioration in its quality. These are manifest in the loss of dissolved oxygen, increased turbidity and change in the flora and fauna, occurrence of smell; as a result of river pollution.

River and environmental pollution by heavy metals became widely recognised with the Minamata disaster in Japan, when between 1953 and 1960 several thousands of people suffered mercury poisoning from eating fish caught from Minamata Bay, which was receiving mercury from a vinyl chloride plant (Mason, 1981). A river is considered to be polluted when it contains such a large amount of organic matter that the oxygen in

the water is greatly depleted, due to microbial activity. The discharge of effluent at one point into a river can lead to such conditions.

There are several sources from which potential pollutants may enter watercourses and these can be categorised into two main groups namely:

- a) Point Sources &
- b) Non- Point Sources (diffuse)

For effective control and monitoring of pollution, a clear understanding of these sources as well as the type of material they may contribute into fresh water is essential. Point sources are characterised by the fact that effluent is conveyed in a defined channel. They possess the property that the total load of pollutants can be determined by sampling and flow measurement at the point of entry to a receiving watercourse (Kaldeman, 2000). The diffuse or non-point sources discharges are mainly through run-off where the total flow cannot be measured or sampled directly or even readily observed at a single point. It also makes it difficult to apply treatment, or monitoring and suitable for regulation by the effluent limitations approach (Nemerous and Avijit, 1991). For this reason regulation must centre on the means of control and prevention measures.

Water in rivers is the usual recipient of industrial pollution because disposal of wastes into the bodies is cheap and convenient. Eventually these wastes may accumulate to a point where they become dangerous. The Peleng river in Botswana for example, has been polluted with liquid waste to the point where fish and reeds disappeared and boreholes, which provided drinking water for Peleng Village had to be closed (Segosebe and Van der Post, 1991).

Industrial waste may also be dumped on factory properties, where they can wash into surface water supplies especially rivers or into groundwater. Because of this kind of surface run-off from factories and laundries in Lesotho, Maseru's main water supply is contaminated with lead six times above WHO Standards (Gentler and Ambrose, 1992).

Pulp and paper mills are among the worst industrial polluters. Production of pulp and paper requires large quantities of water. Pulp mills use strong chemicals such as chlorine, to soften wood pulp and bleach it white. Treatment of the effluent does not remove all the contaminants (Vissman and Hammer, 1998).

Treatment of wastewater at the Swazi Paper Mills (SPM) on the Great Usuthu river in Swaziland, is well below standard according to the Swazi Government. Phenols, which are by-products of pulp production, have increased steadily since 1998 and now average about four times above standard. Phenols accumulate rapidly in fish, giving them a strong odour and taste. Paper fibres are discharged into the river together with the effluent and now carpet the bottom of the river where they will continue to rot and rob the water of oxygen (Mtetwa, 1992).

Even much a simple matter as blockage of water passages in the bottom gravel by decaying debris can reduce the survival of young fish and fish eggs (Mhlanga 1994).

The overall impact of pollution on environment and human health in Swaziland is difficult to judge because there is no baseline information. No long-term studies of pollutants have been undertaken at national level, and appropriate control and monitoring mechanism are not in place or are poorly enforced. In some cases, pollution is not monitored. However, a review of some individual sources of pollution and their river impacts is being done and provides a starting point for assessment.

METHODOLOGY

The following parameters, namely biochemical oxygen demand, orthophosphates, nitrates, sulphates, ammonia, chlorides and dissolved oxygen were monitored at four (4) sampling points along the river basin.

Sampling Points

This site in approximately 4 km upstream of Mbabane city, before the river reaches the industrial site. Water samples were taken at a low level bridge. This site was used as a control point for the experiment since at this point no effluent has been discharged into the river.

Site I

This site is approximately 4 km upstream of Mbabane City, before the river reaches the industrial site. Water samples were taken at a low level bridge. This site was used as a control point for the experiment since at this point no effluent has been discharged into the river.

Site 2.

This sampling point is located after the river has passed all the possible sources of pollution after the industrial areas. The site was to assess the concentrations of the chemical parameters and it was the main point of the experiment.

Site 3

This sampling station is located 3km downstream of the industrial site. This point was to assess the discharge effluent from waste stabilisation ponds which service the whole of Mbabane city and peri-urban area.

Site 4

This site is about 18km downstream and samples were taken below a bridge where there is a gauging station though was not functioning during the study period. The reason for this site was on the understanding that effluent from the industrial site and ponds would have mixed well with the river water and that the distance was considered to have allowed recovery of the river and some tributaries joining the river would have some dilution effect on the water to reduce the burden of the pollution.

Sampling Procedure

Water samples were collected using 1-litre polyethylene plastic bottles, which were pre-washed and rinsed with de-ionised water, and during sampling the bottles were thoroughly washed and rinsed with water to be sampled. Samples were collected and analysed the same day; if not finished they were stored at 4°C refrigeration and analysed the following day.

The samples were collected over a period of 12 months from January to December 2002 at regular interval and sampling was done between 9:00 am and 12noon as this was the peak operational period for all the industries. In each sampling point, three samples were collected (triplicate) in case there were errors and mistakes

Laboratory Analysis:

The standard methods for the examination of water and waste water, 19th edition Washington, American Public Health Association were used for the analysis.

The table below shows the methods which were used.

Table 1: Methods for Chemical Analysis

Parameter	Units	Standards methods for Examination of water and wastewater (ALPHA 19 TH Ed)
Biochemical Oxygen demand	Mg/l	Incubation for 5 days @20°C
Orthophosphate	Mg/l	Modified Hach Calorimetric Method (CSIR, SA)
Dissolved Oxygen	Mg/l	DD Meter
Nitrates	Mg/l	UV Spectrophotometer at 220nm
Sulphate	Mg/l	Turbid metric Method
Chlorides	Mg/l	Argentometric Method
Ammonia	Mg/l	Nesslerization Method (Direct and Following Distillation)

RESULTS AND DISCUSSION:

The discussion is based on the average values(per sampling site) of the determined parameter. Table 2: below shows the average values.

Parameter	Unit	Site 1	Site 2	Site 3	Site 4
BOD	Mg/l	2.75	3.97	9.17	4.57
Orthophosphate	Mg/l	0.35	2.22	4.0	1.2
Dissolved Oxygen	Mg/l	6.54	6.83	3.81	5.8
Nitrates	Mg/l	0.9	6.95	13.26	3.16
Sulphate	Mg/l	0.20	5.98	1.40	10.48
Ammonia	Mg/l	0	0.18	1.78	0.75
Chlorides	Mg/L	2.72	10.23	12.05	2.54

Spatial water quality variations.

The results in respect to the spatial water quality variation are shown on Figures 2 and 3. Site 3 was located on a small tributary of the river, and represents the impact of the wastewater treatment plant discharge. The magnitude of pollution at this point is considerably higher than in Mbabane River. This could be explained not only by the influence of the plant but also because of the relatively low water quantity in this tributary, which does not allow for considerable dilution of the effluent. The discharge from the plant could not be considered as a well defined point source of pollution. The ponds are full with sediments and vegetation has grown at separated spots.

Wastewater is flowing along naturally formed channels and small ponds, the banks of the ponds are not well defined, and the inlet and outlet facilities are clogged and do not function properly. Due to this, the effluent finds its way to the stream at several, naturally formed locations, but not only at the discharge outlet. As a result, the treatment

effect in the ponds is limited to partial sedimentation and retention of the coarse material and a fraction of the suspended solids. It could be expected that the washout of pollutants constituents during peak flow rates would be high.

The high values of ammonia, BOD₅, and the low DO values could be explained by the contribution from the pond effluent where anaerobic conditions exit most probably. Additional measurements in respect to this parameter, could clarify this contradiction. Most probably, it could be explained by a human error during the results' processing stage, because the chlorides and sulfates variation (Fig. 2) show a completely different trend. Chlorides concentrations show considerable increase at sites 2 and 3, with a maximum concentration at site 3. Chloride, being a conservative constituent, could reduce its value from site 3 to site 4 due to dilution only. Sulfates show a similar trend, however the maximum concentration was found at site 2, which could be associated with industrial discharges.

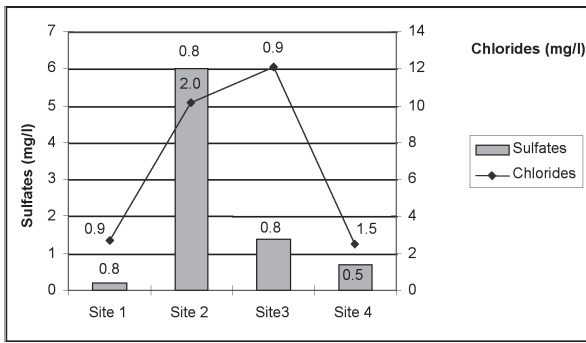


Figure 2. Spatial variation of general pollutant constituents in Mbabane River (mean values with Standard deviation shown as numerical value for n = 8)

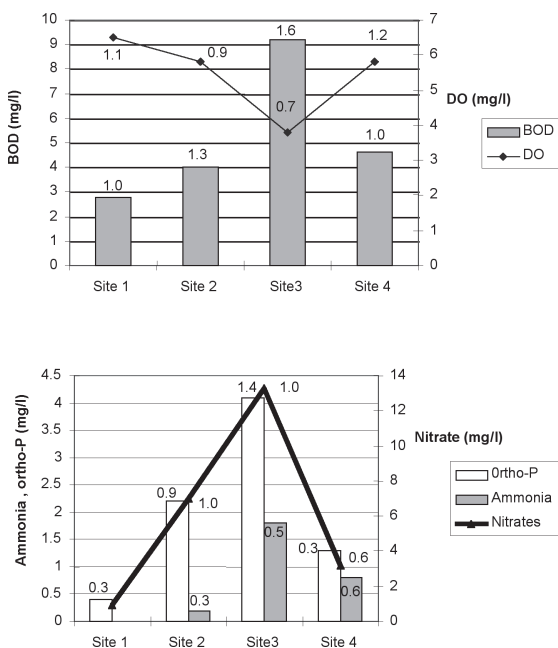


Figure 3. Spatial variation of DO, nutrients and bacteriological contamination in Mbabane River (mean values with Standard deviation shown as numerical value for n = 8)

The results of the Duncan’s test for statistically significant difference of the mean values among the different sampling locations are presented in Table 2. The test is performed based on 8 observations for all sampling locations and parameters, at a “ α ” value of 0.05. The ranking of the mean values is presented with capital letters from A to D in decreasing order. Mean values denominated with the same letter are not significantly different.

Table 3: Results of test for significant difference of mean water quality concentrations and ranking.

Parameter	Site 1	Site 2	Site 3	Site 4
DO (mg/l)	AB	A	C	B
BOD ₅ (mg/l)	C	BC	A	B
Nitrate (mg/l)	D	B	A	C
Ammonia (mg/l)	C	C	A	B
Ortho-P (mg/l)	D	B	A	C
Chlorides (mg/l)	B	A	A	B
Sulfates (mg/l)	C	A	B	C

In respect to organic pollution, the spatial variation is similar with a well-pronounced influence of the ponds effluent. The spatial variation of DO confirms this trend, with the lowest concentrations measured at site 3. In general, it was found that the urban runoff does not influence significantly the river water quality in terms of organic pollution. As the City is located in a hilly mountainous area, the river flow is relatively rapid, which allows for good aeration, and this explains the relatively high DO concentrations, and indicates to a potentially high self-purification capacity.

Nutrients variations follow the trend with the highest concentrations of the three observed parameters at site 3. The significantly increased concentrations of nutrients at site 2 could be associated with informal discharges from blocked sewer systems. It is also possible that some of the industries are contributing as well. The highest concentration, observed at site 3, has alarming value and is attributed to the malfunctioning of the treatment plant. The observed nitrate concentrations are very high, compared to other similar cases, and are difficult to explain. It could be expected that with prevailing anaerobic conditions at the treatment plant, nitrification processes would be suppressed, leading to lower nitrate concentrations. It is possible that the generally high DO concentrations due to the steep slope, could help in boosting this process. Additional investigations should be performed to determine the source of the nitrates observed during this study.

In general, significant increase in the water quality concentrations between the control point and sites 2 and 3 was found in respect to almost all measured parameters, showing the presence of diffuse pollution from urban runoff. The relatively low pollutant constituents at site 4 could be associated with dilution from additional tributaries and partial self purification due to the high DO values.

Assessing and Managing diffuse pollution of Mbabane River

During the period of study the water quality legislation of the country was under revision. Comparison with the suggested draft river water quality standards shows high level of pollution of the stream, which receives the effluents from the treatment plant. The BOD₅ limiting value of 5 mg/l was exceeded at site 3 only. In respect to ammonia, the stipulated limit was 0.08 mg/l and it was exceeded at sites 3 and 4. Ortho-P values were exceeded at sites 2 and 3.

Nitrate limiting value (50 mg/l) is higher compared to other regulatory instruments, which recommend a 10-mg/l threshold (WHO 1984, Viljoen 1992, WWEDR 2000), and was not exceeded at any of the tested locations. It could be stated that at site 4, where river water could be used directly for domestic purposes, the water quality was not exceeding the maximum permissible values in respect to the tested parameters, except for ammonia.

The results of this study shows that the major sources associated with diffuse pollution of Mbabane River (site 2) are associated with urban runoff from industrial sites, residential areas (in terms of informal sewage discharges) and solid wastes depositions along the river bed and banks. Comparing with regulatory documents, it could be stated that the extent of the pollution is not alarming and is pronounced in respect to ortho-P. The major source of pollution in respect to the organic and bacteriological pollution and nutrients has been contributed by the malfunctioning of the treatment plant (site 3).

The enforcement of the new regulatory instruments would require the implementation of a regular and continuous monitoring program, in order to control the river water quality status and to enforce them. This study could be regarded as a preliminary survey for the establishment of such program. In this aspect, the following recommendations could be made:

Considering the fact that Mbabane River downstream the City use its water for domestic purposes without pretreatment a stringent monitoring program should be implemented in order to control river water quality in terms of seasonal variations and long-term trends. Careful consideration of different possible pollution sources, from industrial enterprises could help to

develop an optimal choice of parameters (Ongeley, 1998). The information collected could serve to justify management decisions in respect to pollution prevention and provide warning to downstream users in cases of high concentrations of selected pollutants.

Monitoring network – in addition to the locations in this study, sampling sites could be established along the Pholinjane stream (after the industrial site and the City center) and on Mbabane River after the confluence of the stream collecting the discharge of the treatment plant.

Parameters tested- additional parameters in respect to toxic substances should be included in the monitoring program, such as toxic metals, grease and oil, selected synthetic organic compounds and trace elements.

Laboratory backup – the proposed extended monitoring program would require corresponding back up in terms of laboratory facilities, equipment and trained personnel.

Quality assurance and records – these two aspects need to be given specific emphasis in order to obtain reliable data and to store it correspondingly in an easy to use and comprehensive way.

The management aspects related to the diffuse pollution problems of Mbabane River require a multi-disciplinary approach and the implementation of technical, social and educational activities. The following problems require specific and urgent attention:

The status of the treatment plant – it should be given priority, as it is the major source of pollution of Mbabane River. During the period of study the reconstruction of this facility was envisaged. The plant is located in a narrow valley, with very steep slopes of the surrounding hills. The original choice of a stabilization pond system could not be evaluated as very appropriate, as the place is difficult to access and in addition there is not enough space for expansion. The reconstruction of the plant should look at the provision of a more compact treatment scheme, where the existing ponds could be cleaned and transformed into a wetland system for effluent polishing. Special attention should be given to a proper access road in order to provide for the smooth operation and maintenance of the plant. The implementation of such a management

decision would require the provision of the necessary funding, for the completion of the whole project including the design, construction and initial operation phases, together with the proper training of the required human resources for the plant operation.

The status of the solid waste management – this could be classified as other serious source of diffuse pollution. The proper organization of the refuse collection, provisions for refuse containers at all important public places, and the proper disposal and treatment of the collected solid waste forms the technical base for a successful solution. However, this problem has a social aspect as well, and needs to be backed-up by a well-organized educational and public awareness program.

Informal discharges from industrial sites, residential, institutional and commercial areas – the technical solutions of this aspect include regular inspections and control of water quality, which could help to identify the most important polluters. Existing municipal by-laws should make provision and basis for such activities and should be supported by the necessary institutional set-up and laboratory facilities. However, no technical or managerial solution could succeed if there is no appropriate social behaviour, awareness and understanding about the risks of informal discharges and the possible effects on the whole of society. Therefore, the parallel development and implementation of such programs is an important requirement for successful solutions of the problems associated with diffuse pollution of Mbabane River.

Conclusions

The study presented shows that the diffuse pollution problems of river water quality have common grounds and sources. Therefore, pollution management and abatement measures could have common bases for solutions as well, in terms of general approaches, methods and regulatory instruments.

The study focused on the stretch of the River passing through the City of Mbabane and receiving all urban runoff and effluent discharges. The major pollution source was associated with the effluents from the malfunctioning treatment plant in terms of all tested nutrients, organic pollution and bacteriological contamination. Urban runoff, spreading of solid wastes along the river banks and possible informal discharges from

the City have adverse impact of river water quality, which is less pronounced, but is noticeable in terms of ortho-P, nitrate and bacteriological contamination. About 20 km downstream the City, the river water quality did not show considerable pollution, which could be explained by dilution from tributaries and partial self-purification.

The results of both studies should be considered in the light of the mentioned limitations and as an evaluation of the spatial variation in respect to selected parameters only, given the available resource at the time of the study. The presence of industrial discharges (usually without treatment or with limited treatment) would require a more extensive and regular monitoring program in respect to some toxic elements, which might create health problems for downstream users.

Acknowledgements

The author would like to thank the management of the WREM program, through the “Collaborative Programme for Capacity Building in the Water Sector in Zimbabwe and the Southern Africa Region”, jointly executed by the Civil Engineering Department -UZ, IWSD and IHE- Delft, for the financial support offered during this study. To the technical staff and the management of all laboratories involved – thanks for their support and understanding.

REFERENCES:

- Guenter, W. and Ambrose, D. (1992) Lesotho Environment and Environment Law, National University of Lesotho, Roma, p. 211.
- Kelderman, P. (2000) Water Quality Monitoring, IHE Delft / University of Zimbabwe Lecture notes.
- Lamb, J.C. (1995) *Water Quality and its Control*: John and Wiley and Sons (ISBN 0471800473).
- Mason C.F. (1981) *Biology of Freshwater Pollution*. Longman Scientific and Technical, London, England.
- Ongeley, E.D. (1998). Modernization of water quality programs in developing countries: issues of relevancy and cost efficiency. *Water Quality International*, Sept./Oct.: 37-42.
- Standard methods for the examination of water and wastewater (1994). 19th ed. *American Public Health Association/ American Water Works Association/ Water Environment federation*, Washington DC, USA.
- Miller, G.T. (2004) *Living in the Environment*, Thompson Books/ Cole, 13th edition.
- Mhlanga, A. (1994) HCH and DDT Residue in the Freshwater Sardine (Kapenta) at the Ume River mouth,

Kariba, The Zimbabwe Science News, March/April, Vol.20, p 46-49.

Mtewa, V.S.B. (1992) River Pollution Studies in Swaziland: Assessment and Monitoring of Water Quality Parameters of Usushwana (Little Usuthu) River, Unpublished report, University of Swaziland.

Nemerow, N.L. and Avijit, D. (1991) *Industrial and Hazardous Waste Treatment*: Van Nostrand and Reinhold, New York (ISBN 0442319347)

Segosebe, E.M. and van der Post, C. (1991) Urban Industrial Solid Waste Pollution in Botswana: Practice, Attitude and Policy Recommendation, University of Botswana.

Tebbutt, T.H.Y. (1998) Principles of Water Quality Control, 5th Edition. Butterworth/Heinemann.

Willoughby, A. (1976) Treatment of industrial Effluents, Hodder and Stoughton (LTD) London, United Kingdom.

WWEDR (2000) *Water (Waste and Effluent Disposal) Regulations*, Statutory Instrument 274 of 2000, Republic of Zimbabwe.

World Health Organization (WHO). 1984 *Guidelines for drinking water, health criteria and other supporting information*. Vol.2, Geneva: WHO.

Viljoen, F. C. 1992. Risks, Criteria and Water Quality. *Municipal Engineer*

NEHA OFFERS AVIAN-FLU-PANDEMIC ONLINE COURSE

To assist public and environmental health professionals preparing for a possible flu pandemic, NEHA has partnered with NexPort Solutions to develop and deliver two online-training courses on avian influenza, Avian Flu Pandemic: Awareness for the Public Health professional and Avian Flu Pandemic: Preventive Measures Awareness.

Over the past several months H5N1 has moved along migratory bird flyways, from China and Southeast Asia to over 25 countries across Central Asia, Europe, Africa, and India. The virus is also changing, and its presence in Africa is increasing the likelihood that the virus may become transmissible between humans, leading to a global pandemic on the order of the 1918 Spanish Flu Pandemic that killed over 50 million people.

Avian flu has the potential to not only trigger a global pandemic but also become a major, if not catastrophic, public and environmental health issue. For these reasons, NEHA has worked to develop two online-learning courses that serve to provide the student with a comprehensive understanding of why the threat of a pandemic flu is of such concern. In addition, NEHA's interactions with both public and environmental health professionals have indicated that a limited understanding of this issue exists despite the significant role that these professionals will almost surely play in any pandemic-flu response. The two courses will help to develop the awareness and understanding that is needed in order for this workforce to properly prepare for this serious challenge.

Individuals who successfully pass the test at the conclusion of each course will receive 1.5 continuing-education contact hours, 1.5 for each course.

The availability of these two courses also serves to inaugurate NEHA's new online-learning university. Through this new online university, visitors will be able to access courses such as this one. In addition, they also will have access to an online library of resources, information streams of current events, and other resources.

To purchase the course and enter the NEHA online university visit www.neha.org.

Note: While aimed at the public and environmental health profession, this course is of value to anyone interested in learning more about pandemic flu.

**NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION
720 S. Colorado Blvd., Suite 970-S, Denver, CO 80246-1925
Phone: (303) 756-9090 Fax: (303) 691-9490 E-mail: staff@neha.org**

www.ifeh.org

The new IFEH website
it's all yours – designed by IFEH
to be used by all members and other interested parties



International Federation of Environmental Health

Find

[Home](#) [News](#) [Publications](#) [IFEH Forum](#) [Events](#) [Sitemap](#) [Links](#) [Contact IFEH](#)

[About IFEH](#) [Member Organisations](#) [IFEH Regional groups](#) [Meetings](#) [IFEH World Congress](#) [Activities & Projects](#)

SPOTLIGHT ON

LATEST NEWS

HIGH LIGHTS

Spotlight on Ireland

Each month the IFEH gives one of its member organisation the opportunity to give a brief presentaion of how environmental health is conducted in its home country - which main challenges there are to overcome - and where the organisation finds that special efforts should be allocated. These statements are solely the views of the individual member organisation.

This month you can read about Ireland:
>> [Link](#)



New IFEH website

The IFEH has designed a totally new web site. Lots of new features have been added. As this is the first release you may for a few days experience a lack of information on some of the pages.
>> [Link](#)

02.04.2006

IFEH Magazine

The latest edition of the IFEH Magazine: Environment and Health International is now available
>> [Link](#)

28.12.2005

>> [More news...](#)

IFEH World Congress 2006

In June 2006, the Environmental Health Officers' Association Ireland will host the 9th IFEH World Congress on Environmental Health.
>> [Link](#)

18-23 June 2006 - Dublin

9th World Congress
on Environmental
Health
www.ifeh2006.org



IFEH Magazine

Read the latest edition of the IFEH Magazine: Environment and Health International
>> [Link](#)

International Federation of Environmental Health
Chadwick Court, 15 Hatfields, London SE1 8DJ, UK

Email: secretary@ifeh.org
Further contact information