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Harmonised assessment of risk and risk management for water-related infectious disease: an overview

Jamie Bartram, Lorna Fewtrell and Thor-Axel Stenström

This chapter examines the need for a harmonised framework for the development of guidelines and standards in terms of water-related microbiological hazards. It outlines the proposed framework and details the recommendations derived from an expert meeting held to examine these issues. In its simplest form the framework consists of an iterative cycle, comprising an assessment of public health, an assessment of risk, health targets and risk management, with these components being informed by aspects of environmental exposure and acceptable risk.

1.1 INTRODUCTION

In both developing and developed countries worldwide principal starting points for the setting of water quality standards, including microbiological standards, are World Health Organization Guidelines (Box 1.1).

These guidelines are, in large part, health risk assessments and are based upon scientific consensus, best available evidence and broad expert participation. The use of the term 'guidelines' is deliberate since they are not international standards. Rather, the intention is to provide a scientific, rational basis from which national standards are developed. It is specifically recognised that the process of adaptation requires that account be taken of social, economic and environmental factors and that the resulting standards may differ, sometimes appreciably, from the original guidelines. The guidelines advocate that a risk-benefit approach, whether quantitative or qualitative, be taken to the control of public health hazards associated with water.

Box 1.1. World Health Organization guidelines concerned with water quality

Guidelines for Drinking-water Quality

First published in 1984 in three volumes to replace earlier international standards. The guidelines are divided into three volumes:

Volume 1: Recommendations

Volume 2: Health Criteria and other Supporting Information

Volume 3: Surveillance and Control of Community Supplies.

Second editions of the three volumes were released in 1993, 1996 and 1997.

Addenda to volumes 1 and 2 covering selected chemicals were released in 1998 and 1999 and a microbiological addendum is expected in 2001.

Guidelines for the Safe use of Wastewater and Excreta in Agriculture and Aquaculture

These were published in 1989 based upon the Engelberg guidelines and associated consultations and consensus. They replaced an earlier technical note (1973).

Guidelines for Safe Recreational Water Environments

These have been prepared progressively from 1994. Volume 1: Coastal and Freshwaters was released as a draft to the public domain for comment in 1998 and Volume 2: Swimming pools, spas and similar recreational water environments was released to the public domain for comment in 2000. Finalisation is envisaged in 2001. Volume 1 of the guidelines *per se* is supported by the text 'Monitoring Bathing Waters'.

In relation to chemical hazards, the guidelines for drinking-water quality (which provide the clearest example) are principally hazard characterisations in the context of the now 'classic' conception of risk assessment and risk management applied to chemical hazards. Delimiting the position of the guidelines to the rational scientific component of standard setting and advocating the role of national authorities in adapting guidelines to specific circumstances has proven a valuable means of supporting countries at all levels of socio-economic development and also a means of providing a common basis among them for activities protective of public health. While the guidelines are not international standards they are frequently referred to in international fora (such as the Codex Alimentarius Commission) as international points of reference for water quality, as well as supporting national standard setting.

In relation to microbiological hazards the sharp distinction between risk assessment and risk management that characterises approaches to chemical hazard is not maintained. This reflects a series of factors, most important among which are:

- The recognition that the hazards of greatest concern are multiple and share a common source - human excreta (and indeed that unrecognised hazards from the same source exist).
- The recognition that important health effects (both acute and delayed) may occur as a result of short-term exposure.
- The approach (derived from traditional 'hygiene' but reflected in modern risk management such as the hazard analysis and critical control point (HACCP) principles used in the food industry) that because the pathogens of concern are widespread and because their occurrence varies widely and rapidly in time and space, the absence of (a) safeguard(s) in itself constitutes a hazard.

As a result, all three of the WHO water quality-related guidelines include requirements for what may loosely be described as 'adequate safeguards' or 'good practice', in addition to stipulating numerical values for water quality measures. Whereas in the case of chemical hazards, the principal outcome is a guideline value expressed as a concentration of the substance of concern (i.e. a direct measurement of the human health hazard), in the case of microbiological hazards, the guideline is expressed in terms of measures not of the hazard itself, but of indicators that would assist in confirming that adequate safeguards were in place and operating within reasonable performance requirements (Table 1.1). Such measures include both analytical measurements and inspection-based procedures.

Table 1.1. Indicators and good practice requirements by guideline area

Guideline area	Indicators	Good practice requirements
Drinking-water quality	Value stipulated for faecal coliforms, with recommendations on turbidity, pH and disinfection (chlorination)	Groundwater source protection Treatment proportional to (surface) water quality Sanitary inspection as part of surveillance and control
Safe use of wastewater and excreta in agriculture and aquaculture	Faecal coliforms (unrestricted irrigation) Intestinal helminth counts (restricted and unrestricted irrigation) Trematode egg counts (aquaculture)	Involvement of adequate treatment chains
Safe recreational water environments	Numerical values for indicators (faecal streptococci/enterococci) related to defined levels of risk	'Annapolis Protocol' proposes a series of interventions

The three guidelines differ appreciably from one another, reflecting the state of scientific advance in the three distinct areas that they cover at the time they were produced (see Chapter 2). As a result, it is unlikely that they provide equivalence in terms of the degree of health protection provided by each.

1.2 THE NEED FOR A HARMONISED FRAMEWORK

In the areas of drinking water and wastewater and excreta reuse substantial new epidemiological evidence has become available since the time of the original development of the corresponding WHO guidelines. In parallel, the science of microbiological risk assessment has advanced and continues to advance rapidly, and substantial developments have occurred in the science and application of integrated water resource management. In the broader sphere of public health:

- There has been increasing acceptance that hazards previously managed in isolation should be understood as aspects of a whole.
- There has been an increasing demand for evidence-based decision making.
- There has been an increasing demand for information to support cost-benefit analysis.

In relation to microbiological aspects of water quality it is clear that the three areas of guidelines discussed here are joined by a common source of the hazard of primary concern – human (and to a lesser extent animal) excreta. They are therefore inseparable from the issue of adequate sanitation to contain, inactivate and control the pathogens derived from such excreta (Chapter 5). Dealing with the three aspects in isolation will tend to discriminate against interventions close to the source of the hazard (which is therefore contrary to the general principle of containing and treating pollution close to source).

Demands for an improved environment and health evidence base have tended to focus on the need to describe the response of communities (and individuals) to specific exposures to pollutants of concern. The evidence base for what is in effect ‘population dose–response’ is often weak. It is derived, directly or indirectly, from four principal sources of information:

- Epidemiological study of disease occurring under ‘normal’ situations of exposure. (Such studies may be better or worse controlled; exposure may be reasonably described. The study size is limited principally by financial considerations and the ability to define suitable study groups. Such studies reflect real populations under real conditions of exposure and are therefore of unique value.)
- Study of outbreaks of disease. (Such studies also reflect real populations under real conditions of exposure but the utility of information generated is often constrained by the inability to retrospectively estimate exposure and the physical constraints of the natural event and by necessarily reactive investigation.)
- Human volunteer studies (highly controlled but artificial exposures amongst real human populations).
- Microbiological risk assessment (which provides a framework through which data from multiple sources may be combined and used more effectively than in isolation).

It should be noted that the first two of these provide not only information concerning population dose–response but also information concerning the effectiveness of preventive measures.

When considering only health-related outcomes of environmental interventions, difficult choices have to be made regarding the relative priority that should be given to multiple interventions competing for limited available resourcing (even where the financial resourcing for the intervention is outside the health sector *per se*, as is commonly the case). During the earlier part of the

'Water Decade' (1981–90), for example, it was suggested that an intervention that was acting on a cause of less than 5% of diarrhoeal disease burden should not be justified on health grounds but, rather, interventions acting on greater proportions should be prioritised. The problem is analogous (although not equivalent) to that of 'apportionment' of exposure to chemical hazards through multiple routes. Such simplifications, while illustrative of real concerns, have tended to be superseded by demands for more comprehensive cost-benefit analysis – itself extremely difficult to apply to environmental interventions with health benefits.

Costs of interventions may be high and substantial benefits may accrue not only to health but also to, for example, diverse economic sectors (see Chapter 15). Both health and non-health benefits may be delayed. Care is therefore required in promoting one area of intervention (or indeed one specific intervention) on the basis of health gain and there is an increasingly recognised need for representatives of the health sector to engage more effectively as participants in intersectoral planning and decision-making.

The limited inter-guideline consistency, new advances, and the need to take a more holistic approach to risk management logically lead to the need for a harmonised approach to the development of guidelines for water-related exposures to microbiological hazards.

This issue was tackled by a group of experts at a meeting in Stockholm held in September 1999. The output from the meeting was the proposal of a harmonised framework to inform guideline development and revision, along with a series of recommendations for the adoption of the framework. The remainder of this chapter describes the framework and the principal reasons underpinning its elements. It also outlines the important issues that are covered in greater detail in other chapters of this book.

1.3 THE OVERALL FRAMEWORK

Experts at the meeting in Stockholm agreed that future guidelines should integrate assessment of risk, risk management options and exposure control elements within a single framework with embedded quality targets. The normative part of the end product of the guidelines would therefore constitute the requirement to define, adopt and implement a strategy and measures to adequately protect human health appropriate to specific conditions. While this would require the embedding of water quality targets (in turn justified on the basis of targets for health protection) and also the development of measures and limit values for measures of water quality, the experts recommended strongly that such measures and values were a part of, and supportive, to the requirement to define and exercise good management. The harmonised framework put a

mechanism in place to achieve this goal, which would be applicable within and between the three areas of present concern (drinking water, wastewater and recreational water). It also allows the guidelines to be considered within the overall context of public health policy and transmission of disease through other routes.

In its simplest form the framework can be conceptualised as shown in Figure 1.1. It is essentially an iterative process linking assessment of risk with risk management via the definition of health targets and the assessment of health outcomes. While health targets and outcomes are inevitably local or national in character, the former can be informed by 'acceptable risk' which provides a means to support the development of internationally-relevant guidelines which can, in turn, be adapted to specific national and local conditions.

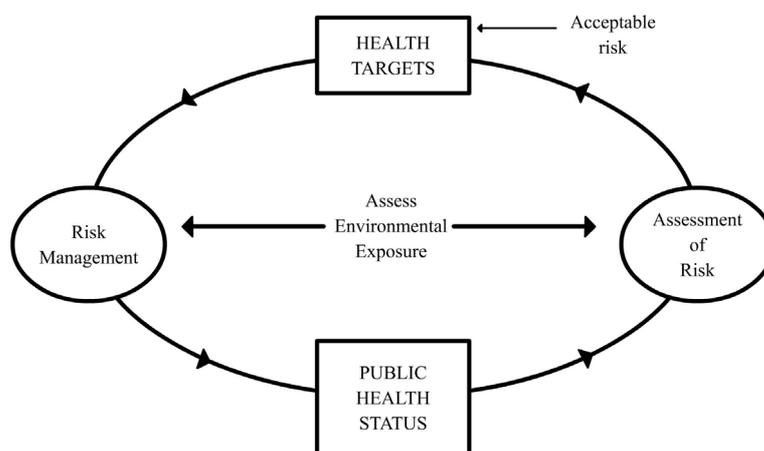


Figure 1.1. A simplified framework.

1.3.1 Assessment of risk in the overall framework

In this framework, the assessment of risk is not a goal in its own right but rather a basis for decision-making and in the first iteration of the process it is the starting point. For the purposes of WHO guidelines the exclusive emphasis is upon health and, as such, the assessment is an assessment of health risk. In applying the guidelines to specific circumstances one may wish to take into account other non-health factors and in practice these may have a considerable impact upon both costs and benefits.

For the purposes of microbiological hazards, the health risk is the risk of disease, which in turn translates into the risk of infection. The group recommended that the guidelines utilise a best estimate of risk and not overlay conservative or safety factors as a means to accommodate uncertainty. This was recommended in order to better inform decision-making and especially the prioritisation of interventions and cost-benefit analysis. It was recognised that this would in turn lead to an iterative process within the guidelines themselves and progressive adjustment to take account of new information. Assuming equivalence between risk of infection and risk of disease may appear to be a measure of conservatism. It is also, however, a means to specifically reflect the health concerns of more sensitive members of the normal population, such as children who in the absence of previous exposure have not developed immunity. As such it is similar to the approach taken towards chemical hazards in the 'guidelines for drinking-water quality'.

Given the diverse range of possible infections which may be water-related, the range in severity of immediate health outcome and also the existence of, sometimes important, delayed effects associated with some of the infections concerned, a common exchange unit (such as Disability Adjusted Life Years (DALYs)) was considered essential to account for acute, delayed and chronic effects (including both morbidity and mortality) in order to maximise relevance to policy making and decision-taking.

The guidelines should operate from the assumptions that pathogens do occur in the environment (unless there is specific reason to exclude a particular pathogen, such as its absolute absence from the area under consideration) and that there is a susceptible population. These assumptions are strongly supported by the evidence outlined in Chapters 3–6, and by the continued occurrence of water borne disease outbreaks in countries, at all levels of socio-economic development, worldwide.

Full use should be made of the vast array of information sources, studies and tools to inform the assessment. Where available and appropriate, information sources should include outbreak investigation (Chapter 6), epidemiological studies (Chapter 7) and microbiological risk assessment (Chapter 8) as well as studies on behaviour of microbes in the environment (and their inactivation, removal and addition/multiplication through resource and source management and in water abstraction and use). Some of these sources provide information on exposure-response, some on the effectiveness of interventions and some on both. Bringing together information on these two aspects of health protection was considered important.

Explicit attention should be paid to the quality of studies and of data and information from them (Chapter 9). In general, publication in the internationally accessible peer-reviewed literature serves as an initial screen for quality but is

not a guarantee of it. Coherence among multiple studies (including differences with rational explanation) should be seen as an important element in determining the quality of evidence. Ideally a simple ranking scheme should be developed to assist in assessing the quality of available evidence in terms of its suitability for demonstrating cause-effect and (separately) for supporting quantitative study (including guidelines derivation).

Considerable discussion at the meeting of experts related to the importance of short-term deviations in quality to health, to the extent that overall health risk may be dominated not by the ‘typical’ or ‘average’ water quality but water quality in short periods of sub-optimal performance (even where these may in fact comply with conventional ‘standards’). The overall agreement was that specific measures were required to enable identification and management response to such events and also that such events should be properly accounted for in estimating human health risk.

1.4 THE ELEMENTS OF THE FRAMEWORK

This section describes the individual elements of the framework in more detail. Figure 1.2 shows an expanded version of the framework shown in Figure 1.1.

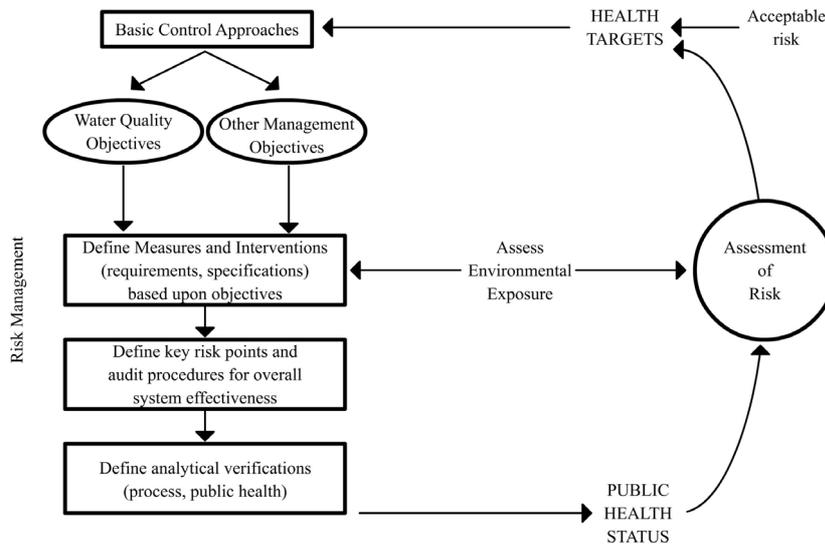


Figure 1.2. Expanded framework.

1.4.1 Environmental exposure assessment

Environmental exposure assessment is an important input to both the assessment of risk and to risk management. Exposure assessment is a formal component of the risk assessment process (Chapter 8).

Exposure assessment is a required input for microbiological risk assessment. As noted earlier, the expert group that met in Stockholm agreed that the harmonised process should be based upon the assumption that pathogens occur in the environment. However, representative quantified assumptions will have to be made in the development of guidelines and these may then be one of the fields for adaptation in passing from guidelines to national and/or local standards. In such a process of adaptation, both pathogen occurrence *per se* and, indirectly, weighting factors applied to pathogens of greater concern should be taken into account. Paradoxically this might imply the need for greater stringency in protective measures and safeguards in less developed countries where capacities to apply such measures are least.

An important role for environmental exposure assessment is in prioritisation among potential interventions in the context of overall environmental exposure to pathogenic micro-organisms. Thus, for example, if most exposure to a given pathogen occurs from non-water related sources and, say, only 5% of the burden of disease is associated with (for example) drinking water, then it may reasonably be argued that greater public health benefit is likely to be achieved by intervening in the other routes of exposure. Such simple analysis in practice is conditioned by factors such as the availability of interventions in the various exposure routes and their cost. Furthermore, prioritisation of this type is normally applied to at the local and national levels and is not applicable within the context of global guidelines, where representative assumptions must be made that may then be amended by local and national authorities to take account of specific conditions.

1.4.2 Acceptable risk and health targets

In its Guidelines for Drinking-water Quality (1993), WHO suggests that:

The judgement of safety – or what is an acceptable level of risk in particular circumstances – is a matter in which society as a whole has a role to play. The final judgement as to whether the benefit resulting from the adoption of any of the Guideline Values ... justifies the cost is for each country to decide.

While the general public may prefer the idea of 'zero risk', in a world of limited resources and competing demands some idea of tolerable risk is vital in order that health targets are sensible and achievable and that measures to pursue them are cost-effective.

There is increasing recognition, especially among the policy-making and scientific communities, of the concept of 'acceptable risk'. The term 'tolerable risk' is preferred by some workers to recognise that the risk is not truly acceptable but may be tolerated, either absolutely, or in deference to greater or more highly perceived priorities.

Different agencies have begun to explore what might constitute a tolerable disease burden. WHO, for example, calculates its guideline values for genotoxic carcinogens (for which there is no threshold concentration below which there is zero risk) as equivalent to the upper bound estimate of the one in 100,000 lifetime excess risk (of cancer). For other toxic chemicals, where a threshold does exist, guideline values are set in relation to this. The present state of knowledge suggests that infection and disease can be initiated by a single micro-organism and can therefore show non-threshold properties. The consequence, given that sterility is not a feasible goal, is the need to recognise the issue of 'tolerable' risk (see Chapter 10). The United States surface water treatment rule is concerned with minimising health risks from pathogenic micro-organisms occurring in surface waters and originally established a goal that fewer than one person in 10,000 per year would become infected from exposure to the protozoan *Giardia* in drinking water (and this was assumed to be protective against other diseases at the time).

All present descriptions of tolerable disease burden in relation to water are expressed in terms of specific health outcomes (such as cancer, diarrhoeal disease, etc.). The expert group in Stockholm was concerned that such approaches would prove problematic in relating some common water-related diseases to one another, whether because of their diverse acute effects (cholera, dysentery, typhoid, infectious hepatitis, intestinal worms) or because of their varied severity weightings (mild self-limiting diarrhoea through to significant case mortality rates) or because of delayed effects (such as the association of Guillain-Barré syndrome with campylobacteriosis). The group therefore recommended that a reference level of acceptable risk be adopted which should be expressed in DALYs with an appropriate accompanying explanation to assist non-expert readers in interpreting its significance.

Unnecessarily strict guidelines and standards may militate against beneficial uses of water and therefore prevent society from enjoying their benefits. Recreational water use leads to significant benefits to the individual and to society as a whole (rest, recreation, hygiene) and guidelines and standards

should be established that are protective of public health without unnecessarily hampering the enjoyment of these benefits. The use of wastewater in irrigation can similarly contribute to food security, the closing of nutrient cycles in agriculture and improved conservation and protection of aquatic ecosystems. Such benefits should be considered alongside the requirements for the protection of human health.

Wealthy and poor countries are united by increasing prevalence of sensitive sub-populations, particularly those that are immunocompromised, in addition to the young, elderly and pregnant. The issue of immunocompromised populations has been especially highlighted because of HIV/AIDS but in some (especially more industrially developed) regions other causes (notably therapy) may also be significant. Questions remain regarding water quality requirements to protect specific sensitive sub-populations and the Stockholm group therefore recommended that guidelines normally be set so as to offer protection throughout a lifetime, acknowledging the different sensitivities and susceptibilities within that timeframe (i.e. to include the young, elderly and pregnant). For more specific sub-groups, the prevalence of which may vary widely between countries and whose water quality requirements may not be achievable through available measures, additional guidance should be included where adequate evidence allows this.

Health targets are to be based upon the outcome of the assessment of risk and on information concerning levels of acceptable risk. Although health targets have not, as yet, been used in WHO water-related guidelines they have been used very successfully in other areas. Table 1.2 outlines some of their benefits.

Table 1.2. Benefits deriving from the use of health targets

Target development stage	Benefit
Formulation	Gives insight into the health of the population
	Reveals gaps in knowledge
	Gives insight into consequences of alternative strategies
	Supports the priority-setting process
	Increases the transparency of health policy
	Ensures consistency among several health programmes
Implementation	Stimulates debate
	Inspires and motivates partners to take action
	Improves commitment
	Fosters accountability
Monitoring and evaluation	Guides the allocation of resources
	Supplies concrete milestones for evaluation and adjustments
	Provides opportunities to test feasibility of the targets
	Provides opportunities to take actions to correct deviations
	Exposes data needs and discrepancies

WHO guidelines should be relevant to the widely varying socio-cultural, economic and environmental conditions that prevail in different countries and regions. Use of a reference level would facilitate the adaptation of guidelines to enable account to be taken of such conditions. In consequence, it was felt to be important that guidelines make explicit reference to and provide guidance on issues associated with the adaptation of guidelines to standards.

1.4.3 Risk management

Consideration of the risk management process leads to the expanded version of the framework as shown in Figure 1.2. Based on the defined health targets acceptable risk water quality targets are defined. Ideally, such health targets will employ a selected index pathogen (see Chapter 13) that combines both control challenges and health significance in terms of health hazard and, ideally, the availability of other relevant data. In practice, more than one pathogen will normally be required in order properly to reflect diverse challenges to the safeguards available. While water quality targets may be expressed in terms of exposure to specific pathogens, care is required in relating this to overall population exposure, which may be concentrated into small periods of time. Further care is required to account properly for potentially 'catastrophic' events (leading to large-scale outbreaks of disease) rather than only for background rates of disease during normal cycles of performance and efficiency. Both relate to the recognised phenomenon of short periods of very decreased efficiency in many processes and provide a logical justification for the long established 'multiple barrier principle' in water safety. It is important to note that the inclusion of water quality targets expressed in terms of human exposure to pathogens does not imply that those pathogens should be directly measured, nor even that the capacity for such measurement should be within the analytical capacity of normal ('routine') monitoring laboratories, nor that measuring their reduction to below the water quality target necessarily implies safety. This is because the reference pathogens act as surrogates for other pathogens in determining safe practices but may not necessarily occur in the environment when other pathogens of concern occur.

Information concerning the efficiency of processes combined with data on the occurrence of pathogens in source waters and water quality targets enables definition of operating conditions that would reasonably be expected to achieve those targets. In this, information on process efficiency and pathogen occurrence should take account of steady-state performance and performance during maintenance and periods of unusual load. While the indicator systems required to verify adequate performance may require the use of 'conventional' laboratory-

based analytical measures, it was seen that overall a greater relative emphasis would be given to periodic inspection/auditing and to simple measurements that could be rapidly and frequently made and directly inform management. Greater emphasis on measures to confirm that processes are operating as expected is required to protect public health and this will create challenges for the form of present approaches to monitoring.

Within each set of guidelines, water quality objectives and their associated management controls will need to respond not only to 'steady-state' conditions but also the possibility of short-term events (such as variation in environmental water quality, system challenges and process problems) in order to minimise the likelihood of outbreaks of disease.

The overall package of appropriate measures will vary between countries and localities. In order that guidelines be relevant and supportive, the experts recommended that representative scenarios including description of assumptions, management options, critical control points and indicator systems for verification be included (see Chapter 12). It was envisaged that these would be supported by general guidance regarding the identification of priorities and regarding progressive implementation that would be of special, but not unique, relevance to less industrially developed countries, thereby helping to ensure that best use is made of limited resources.

The expert group suggested that the management strategy adopted within the risk management process, whilst being adapted to the specific needs of the respective guidelines, should be based on the extensive and accumulating experience with Hazard Analysis and Critical Control Points (HACCP). An examination of various management tools, including details of HACCP, is made in Chapter 12.

1.4.4 Implementation

A range of tools and approaches may be deployed in seeking implementation. These may include incentives, legal enforcement, education (both professional and public) and so on (see Chapters 14–17). They may be linked to wider level management (e.g. integrated basin or coastal zone management) or may fall largely outside traditional water sector management (certification of materials, chemicals, operators, consumer protection, and so on). While general comment on the available measures and experience with their effective application is important, detailed guidance on such aspects (which vary widely with social, political, economic and cultural factors) is not universally applicable and should not therefore constitute a part of the guidelines.

The issue of progressive implementation is however a prime concern for the guidelines and is of universal relevance. WHO guidelines should provide

explicit guidance on step-wise implementation. Advice, in the form of a procedure, on gradation and likely speed of achievement will reduce false expectations and should increase incentives for compliance. The need for stepwise implementation based upon public health priority is especially great in developing countries, a point which is well illustrated in Chapter 16.

1.4.5 Public health status

There has been an increasing trend to reappraise the 'linear' presentation of risk assessment and associated risk management into a more circular format, recognising both the need to respond to advances and general developments and to explicitly address the incremental nature of most environment and health decision making and the need to identify and to respond to both successes and failures through specific feedback. Such a circular process better accommodates the need to identify opportunities for public participation.

The final stage before re-entering the process is, therefore, logically to examine the public health outcome (see Chapter 11). Are the measures being put into place having the desired effects in the required time frame? The first iteration or iterations may lead to water quality objectives and management objectives being met without the desired public health outcome, or contrariwise that a greater response is achieved than expected. Equally, it may be found that the 'management and implementation' side of the circle requires further attention in order that the measures applied lead to the desired management changes. Without explicitly addressing these aspects it is impossible to see if the processes put into place are effective. Failure to achieve stated health targets in early stages should not be seen as a weakness of the approach but as part of the process, enabling best use to be made of resources, and also a source of experience and information with which to inform future stages.

Approaches to reliably estimating the disease burden (Chapter 3) are under development and, if reliable and adequately sensitive, will be important at this stage as they will allow changes to be monitored. Measurement of public health outcomes will vary between countries and it is recognised that present approaches and capacities for both surveillance and for outbreak detection and investigation are typically inadequate for this purpose.

1.5 FURTHER DEVELOPMENT

The proposed harmonised framework has not yet been subjected to the acid test of implementation. Groups of experts, however, have tested the process in a desk

exercise examining hypothetical studies from each of the guideline areas. These are detailed in Chapter 18.

It is likely that there will be extensive data requirements to support the application of guidelines of all types at country level. While some of this information will be presented in the guidelines *per se*, WHO could also be instrumental in collating, synthesising and making more readily available such information and this was considered a priority by experts at the Stockholm meeting.

Outcomes, especially health-related outcomes, deriving from the implementation of the guidelines within the three areas of concern are, and will continue to be, very important in disease reduction in terms of global burden of disease in both developing and developed countries. However, until recently, there has been a trend in some quarters to believe that drinking water in more industrially developed countries was the cause of little disease and that infectious disease in particular was of largely historical interest. The experience with a single recently recognised pathogen significantly associated with water borne disease (i.e. *Cryptosporidium*) has shattered that optimistic assessment and focused interest on this area of universal concern (Chapter 6).

Experts noted that the experience of bringing together individuals from three sub-sectors (drinking water, recreational water and wastewater reuse) and from different disciplinary areas (risk assessment, epidemiology, engineering, regulatory affairs and economics) has highlighted the need for care in the use of terms that may be used with subtle or grossly different meanings, and recommended that all guidelines be accompanied with a simple glossary of terms to minimise misunderstanding.