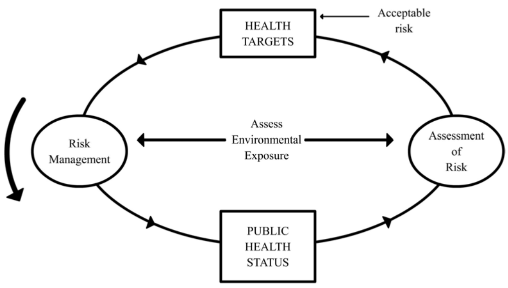

16

Implementation of guidelines: some practical aspects

Marcos von Sperling and Badri Fattal

The setting up of adequate legislation for the protection of the quality of water resources is an essential point in the environmental development of all countries. The transfer of guidelines into practicable standards, which are used not merely for enforcement, but as an integral part of public health and environmental protection policy, has been a challenge for most countries. This chapter examines that process, with an emphasis on the developing country situation.

16.1 INTRODUCTION

One of the main stages of guideline implementation is the conversion and adaptation of the philosophy, guidance and numeric values of the general guidelines, such as those set by the World Health Organization (WHO), into quality standards, defined by each individual country. WHO guidelines are generic by nature, aimed at protecting public health on a worldwide basis. National standards are defined by each country, have legal status and are based on the specific conditions of the country itself. Depending on the political structure of the country, regional standards may also be developed. Economic, social and cultural aspects, prevailing diseases, environmental circumstances, acceptable risks and technological development are all particular to each country or region, and are better taken into account by the country or region itself when converting the WHO guidelines into national/regional standards. This adaptation is crucial: adequate consideration of the guidelines prior to the adoption of standards may be an invaluable tool in the health and environmental development of a country, whereas inadequate consideration may lead to discredit, frustration, unnecessary monetary expenditure, unsustainable systems and other problems. The setting of standards should be based on sound, logical, scientific grounds and should be aimed at achieving a measured or estimated benefit or minimising a given risk for a known cost (Johnstone and Horan 1994).

16.2 COMPARISON BETWEEN DEVELOPED AND DEVELOPING COUNTRIES

It is very difficult to make comparisons and generalisations regarding developed and developing countries. There are large disparities within countries as well as between countries. The aim of the present section is to highlight some aspects that are important in terms of the implementation of guidelines in developing countries and to demonstrate the need for specific approaches.

Developed nations have, to some degree, overcome the basic stages of water pollution problems, although there are still numerous problems and little room for complacency. Developing nations, however, are under pressure from two sides: on the one hand, observing or attempting to follow the international trends of reducing standard concentration levels and, on the other, being unable to reverse the trend of environmental degradation. In many countries the increase in sanitary infrastructure can barely cope with the net population growth. The implementation of water and sanitary regulations depends to a large extent on political will and, even when this is present, financial constraints are often the final barrier, which undermines the necessary steps towards environmental restoration and public health maintenance. Time passes, and the distance between desirable and achievable, between laws and reality, continues to grow.

Figure 16.1 presents a comparison between the current status of developed and developing countries in terms of microbiological drinking-water quality. In this example, the microbiological standard is assumed to be the same for both developed and developing countries. In developed countries, compliance is achieved most of the time, and the main concern is related to occasional episodes of non-compliance. However, in developing nations pollutant levels are still very high, and efforts are directed towards reducing the gap between existing values and the prescribed standards with a view to eventually achieving compliance.

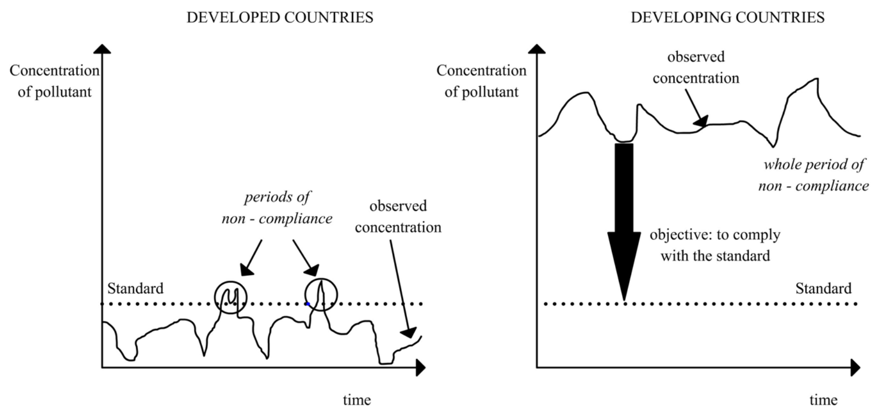

Figure 16.1. Comparison between developed and developing countries in terms of compliance with standards.

The implementation of national water quality standards is intimately linked to the adoption of adequate technologies for the treatment of water and wastewater. There is a wide variety of systems that can be used for wastewater treatment. This, in addition to the diversity of standards encountered in the different countries, will influence the choice of technology. The cost component and the operational requirements, while important in developed countries, play a much more decisive role in developing countries. A further aspect in developing countries is the marked contrast often seen between urban areas, periurban and rural areas. All of these factors make the preliminary selection of the most appropriate system for the intended application a critical step. An additional factor in developing countries may be the influence of foreign expertise. Foreign consultancies may advise according to standards and conditions with which they are familiar, rather than the ones that may be appropriate or those that prevail in the country in question.

Figure 16.2 presents a comparison of important aspects in the selection of water and wastewater treatment systems, analysed in terms of developed and developing countries.

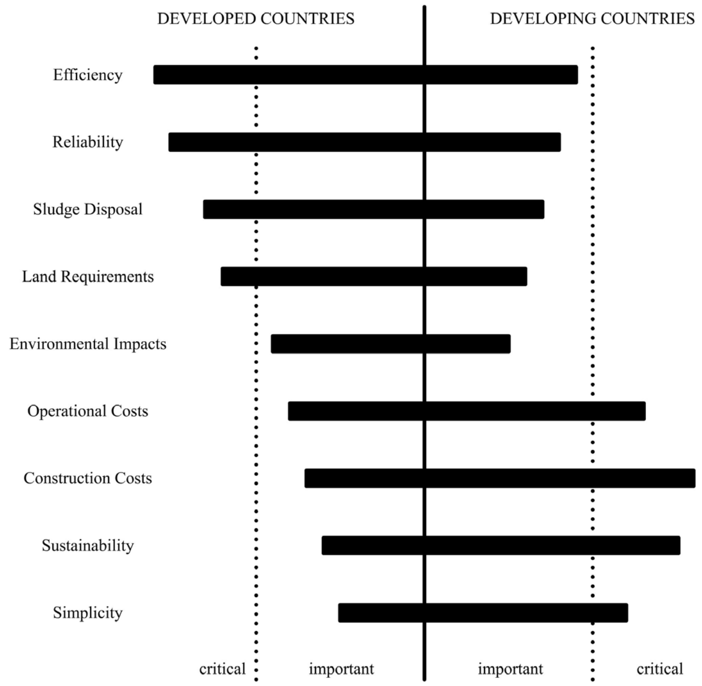

Figure 16.2. Important aspects in the selection of water and wastewater treatment systems: a comparison between developed and developing countries.

The comparison is necessarily general, due to the specificities of individual countries and the contrasts seen within the developing countries. The items are organised in descending order of importance for the developed countries. In these countries, critical items are usually efficiency, reliability, sludge disposal aspects and land requirements. In developing countries, these aspects follow the same pattern of decreasing importance but are less important than in developed countries. In contrast to developed countries the factors of over-riding importance (von Sperling 1996) for developing countries are:

- construction costs
- sustainability
- simplicity
- operational costs.

16.3 TYPICAL PROBLEMS WITH SETTING UP AND IMPLEMENTING STANDARDS IN DEVELOPING COUNTRIES

Several researchers have discussed the inadequacies and difficulties in setting up discharge standards for developing countries. Johnstone and Horan (1994, 1996) presented some interesting papers in which they analysed institutional aspects of standards and river quality and compared different scenarios for the UK and other developed and developing countries. Von Sperling and Nascimento have conducted a detailed analysis of the Brazilian legislation (von Sperling 1998), covering aspects such as comparisons between the limit concentrations in the standards with quality criteria for different water uses (Nascimento and von Sperling 1998), standards for coliforms, sensitivity of laboratory techniques (Nascimento and von Sperling 1999) and requirements for dilution ratios (river flow/effluent flow) in order to match the compliance of water and discharge standards (von Sperling 2000).

Table 16.1 (over) presents a selected list of common problems associated with setting up and implementing standards, especially in developing countries. A further issue relates to international trade and the globalisation of services. Increasingly, companies operate in both developing and developed countries and the acceptability of offering different levels of service (based on different standards) has to be questioned.

It is clear from this table that there is no substitute for adequate examination of guidelines according to prevailing conditions and the adoption of standards based upon realistic expectations.

16.4 STEPWISE IMPLEMENTATION OF STANDARDS

Usually, the stepwise implementation of a water supply or sewerage system is through the physical expansion of the size or number of units. A plant can have, for example, two tanks built in the first stage, and another tank built in the second stage, after it has been verified that the influent load has increased (through, for example, population growth). This stepwise implementation is essential in order to reduce the initial construction costs.

Table 16.1. Common problems associated with establishing and implementing standards, especially in developing countries

Problem	Ideal situation	Frequent outcome
Guidelines are directly taken as national standards.	Guidelines are general worldwide values. Each country should adapt the guidelines, based on local conditions, and derive individual national standards.	In many cases the adaptation is not carried out in developing countries, and the worldwide guidelines are directly taken as national standards, without recognising the country's specific characteristics.
Guideline values are treated as absolute values, and not as target values.	Guideline values should be treated as target values, to be attained in the short, medium or long term, depending on the country's technological, institutional or financial conditions.	Guideline values are treated as absolute rigid values, leading to simple 'pass' or 'fail' interpretations, without recognising the current difficulty of many countries to comply with them.
Protection measures that do not lead to immediate compliance with the standards do not obtain licensing or financing.	Control agencies and financial institutes should license and fund control measures (e.g. wastewater treatment plants) which allow for stepwise improvement of water quality, even though the standards are not immediately achieved.	Agencies or financial institutions do not support control measures which, based on their design, do not lead to immediate compliance with the standards. Without licensing or financing, intermediate measures are not implemented. The ideal solution, even though approved, is also not implemented, because of lack of funds. As a result, no control measures are implemented.
Some standards are excessively stringent or excessively relaxed.	Standards should reflect water quality criteria and objectives, based on the intended water uses.	In most cases, standards are excessively stringent, more than is necessary to guarantee the safe use of water. In this case, they are frequently not achieved. Designers may also want to use additional safety factors in the design, thus increasing the costs. In other cases, standards are too relaxed, and do not guarantee the safe intended uses of the water.

Table 16.1 (cont'd)

Problem	Ideal situation	Frequent outcome
Discharge standards are not compatible with water quality standards.	In terms of pollution control, the objective is the preservation of the quality of the water bodies. However, discharge standards should be compatible with water quality standards, assuming a certain dilution or assimilation capacity of the water bodies.	Even if water quality standards are well set up, based on water quality objectives, discharge standards may not be compatible with them. The aim of protecting the water bodies is thus not guaranteed.
There is no affordable technology to lead to compliance of standards.	Control technologies should be within the countries' financial conditions. The use of appropriate technology should be always pursued.	Existing technologies are in many cases too expensive for developing countries. Either because the technology is inappropriate, or because there is no political will or the countries' priorities are different, control measures are not implemented.
Monitoring requirements are undefined or inadequate.	Monitoring requirements and frequency of sampling should be defined, in order to allow proper statistical interpretation of results. The cost implications for monitoring need to be taken into account in the overall regulatory framework.	In many cases, monitoring requirements are not specified, leading to difficulty in the interpretation of the results.
Required percentage of compliance is not defined.	It should be clear how to interpret the monitoring results and the related compliance with the standards (e.g. mean values, maximum values, absolute values, percentiles or other criteria).	Lack of specification regarding the treatment of monitoring results may lead to different interpretations, which may result in diverging positions as to whether compliance has been achieved.
There is no institutional development to support and regulate the implementation of standards.	The efficient implementation of standards requires an adequate infrastructure and institutional capacity to license, guide and control polluting activities and enforce standards.	In many countries appropriate institutions are not adequately structured or sufficiently equipped, leading to poor control of the various activities associated with the implementation of standards.

However, another use for stepwise implementation that should be considered, especially in developing countries, is the gradual improvement of the quality of the water or wastewater. It should be possible, in a large number of situations, to implement an initial stage that is not optimally efficient (or a process that does not remove all pollutants), graduating at a later stage (as funds become available) to a system that is more efficient or more wide-reaching in terms of pollutants. If the planning is well structured, with a well-defined timetable, it may be possible for allowances to be made permitting a temporary standards violation in the first stage. Naturally a great deal of care must be exercised to prevent a temporary situation from becoming permanent (a common occurrence in developing countries). This use of a stepwise development of water or wastewater quality is undoubtedly much more desirable than a large violation of the standards, the solution to which is often unpredictable over time.

Figure 16.3 presents two alternatives in wastewater treatment implementation. If a country decides to utilise treatment plants that can potentially lead to immediate compliance with the standards, this is likely to require a large and concentrated effort, since the baseline water quality is probably very poor (especially in developing countries). This effort is naturally associated with a high cost, which most developing countries will be unable to afford, the result being that the plant construction is postponed and may never be put into effect. On the other hand, if the country decides to implement only partial treatment, financial resources may be available. A certain improvement in the water quality is achieved and health and environmental risks are reduced, even though the standards have not been satisfied. In this case, the standards are treated as target values, to be achieved whenever possible. The environmental agency is a partner in solving the problem, and establishes a programme for future improvements. After some time additional funds are available and the standards are eventually satisfied. In this case, compliance with the standards is likely to be obtained before the alternative without stepwise implementation.

In developing countries it is not only water and wastewater systems that should expand on a stepwise basis, but also the national water quality standards. The following situations may be encountered:

- If the legislation in a developing country explicitly states that the standards are to be considered a target, then the national standards could have the same values as in the guidelines. Stepwise implementation, however, is complex and requires the provision that if a target value is achieved there should be no slipping back to the previous level.

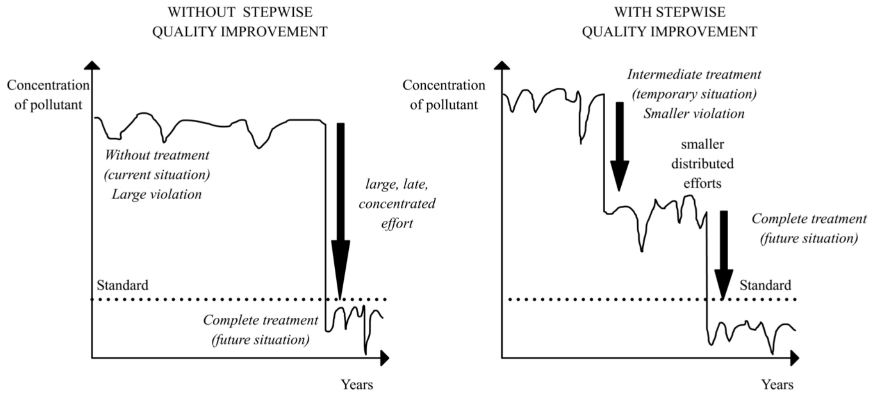

Figure 16.3. Concept of the stepwise improvement of water quality.

- If the concept of targets is not clear in the legislation, then the numerical values of the limit concentrations could progress in a stepwise fashion towards increasing stringency. The standards should be adapted periodically, eventually reaching the same values as those in the guidelines. Ideally the timetable for progressive implementation should be defined, and adequate/ appropriate lead time should be allowed.
- If there are specific conditions in a particular country then the related standards may not necessarily need to converge with the guideline values.

Further advantages of stepwise implementation of standards and sanitary infrastructure are discussed in Table 16.2.

An important issue in the stepwise approach is how to guarantee that the second, subsequent stages of improvement will be implemented, not interrupted after the first stage. Due to financial restrictions, there is always a risk that the subsequent stages will be indefinitely postponed, using the argument that the priority has now shifted to systems that have not yet been implemented in the first stage. Even though this might well be justifiable, it cannot be converted into a commonly used excuse. The control agency or responsible institution must set up a series of intervention targets with the body responsible for the required improvements. These should include the minimum intervention associated with the first stage and subsequent specifications, including required measures, benefits, costs and timetable. The formalisation of the commitment also helps in ensuring continuation of water quality improvement.

Table 16.2. Advantages of stepwise implementation of standards and sanitary infrastructure

Advantage	Comment
Polluters are more likely to afford gradual investment for control measures.	Polluters and/or water authorities will find it much more feasible to divide investments into different steps than to make a large and, in many cases, unaffordable investment.
The present value of construction costs is reduced.	The division of construction costs into different stages leads to a lower present value than a single, large, initial cost. This aspect is most relevant in countries in which (due to inflation) interest rates are high.
The cost-benefit of the first stage is likely to be more favourable than the subsequent stages.	In the first stage, when environmental conditions are poor, a large benefit is usually achieved at a comparatively low cost. In the subsequent stages, the increase in benefit is not so substantial, but the associated costs are high (i.e. there are diminishing returns).
Actual water or wastewater characteristics can be determined.	Operation of the system will involve monitoring, which will result in familiarity with the water or wastewater characteristics. The design of the second or subsequent stages can, therefore, be based on first-hand experience and not on generic values taken from the literature.
There is the opportunity to optimise operation, without necessarily requiring physical expansion.	Experience in operating the system will lead to a good knowledge of its behaviour. This will allow, in some cases, optimisation of the process (improvement of efficiency or capacity), without necessarily requiring physical expansion of the system. The first stage will be analogous to a pilot plant.
There is time and opportunity to implement, in the second stage, new techniques or more developed processes.	The availability of new or more efficient processes for water and wastewater treatment increases with time. Second or subsequent steps can make use of these better and/or cheaper technologies, and realise benefits that would not have been possible with a single step.
The country has more time to develop its own standards.	As time passes, the experience gained in operating the system and evaluating its positive and negative implications in terms of water quality, health status and environmental conditions will lead to the establishment of standards that are really appropriate to the local conditions.
The country has more time and better conditions for developing a suitable regulatory framework and institutional capacity.	Experience gained in operating the system and in setting up the required infrastructure and institutional capacity for regulation and enforcement will also improve progressively, as the system expands in the second and subsequent stages.

16.5 THE PRINCIPLE OF EQUITY

The principle of equity is well rooted within the ethos of the World Health Organization, in that all peoples, irrespective of race, culture, religion, geographic position or economic status are entitled to the same life expectancy and quality of life. Broadly speaking, the reasons for a lower quality of life are associated with environmental conditions. If these improve the quality of life is expected to increase accordingly. On this basis, there is no justification for accepting different environmental guideline values between developed and developing countries.

If guideline values are treated as absolute values, then only developed countries are likely to achieve them, and developing nations will probably not be able to afford the required investments. However, if guideline values are treated as targets, then all countries should eventually be able to achieve them, some on a short-, some on a medium- and others only on a long-term basis.

16.6 COST IMPLICATIONS

Any analysis of guidelines and standards is incomplete and merely an academic exercise if cost implications are not taken into account. Ideally, a cost-benefit analysis should be undertaken when implementing a system of standards or sanitary infrastructure system, although it should be noted that there may be a host of non-health benefits that are difficult to account for (see also Chapter 15). However, in many cases, even though the cost-benefit analysis may prove to be entirely favourable, in developing countries financial resources may not be available to cover the required costs, and the system will remain unimplemented. This point reinforces the need for stepwise implementation and the consideration of guidelines as target values.

16.7 CASE STUDY

The need for defensible standards, both in terms of the degree of protection offered and cost-effectiveness, is a global requirement but one that takes on even greater significance in cash-strapped developing countries. Adopting the wrong approach has led to hundreds of cities in the developing world not being able to afford to meet the standards that they had innocently copied from elsewhere, and thus taking no action. This is a classic tragedy of where insisting on the *very best* prevented achievement of the *good*. This case study examines the level of protection afforded by existing microbiological guidelines for the reuse of wastewater in agriculture in light of acceptable levels of risk and comments on justification of standards on a cost basis. It is based on the publication by Shuval *et al*. (1997) and is revised and reproduced here with the permission of the authors.

16.7.1 Background

In 1982, the World Bank and the World Health Organization embarked upon a broad spectrum, multi-institutional scientific study in order to provide a rational health basis for the revaluation of microbial guidelines for wastewater irrigation. This involved three teams of independent scientists reviewing the epidemiological and technological evidence available concerning health risks associated with wastewater irrigation (Feachem *et al*. 1983; Shuval *et al*. 1986; Strauss and Blumenthal 1989). These studies resulted in the WHO Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture (WHO (1989); reviewed in detail in Chapter 2) which recommended a mean of 1000 faecal coliforms (FC)/100ml and less than one helminth egg per litre of effluent for the irrigation of vegetables eaten raw. These new guidelines have become widely accepted by international agencies including the FAO, UNDP, UNEP and the World Bank, and have been adopted by the French health authorities and the governments of a number of developing as well as developed countries.

In 1992, the US EPA together with the US Agency for International Development (US AID) published their own Guidelines for Water Reuse intended both for internal use in the US and for use by the USAID missions working in developing countries (US EPA/USAID 1992). These new guidelines, for irrigation of crops eaten uncooked are extremely strict and, in microbiological terms, call for no detectable FC/100ml – essentially a drinking water standard.

16.7.2 Methodology

For the purposes of this case study (funded by USAID) the risk assessment model, estimating the risk of infection and disease from ingesting micro-organisms in drinking water, developed by Haas *et al*. (1993) has been used (see Chapter 8), adapted to estimate the risk of infection associated with eating vegetables irrigated with wastewater of various microbial qualities.

Estimates of pathogen levels ingested from eating selected wastewater-irrigated vegetables were made from laboratory experiments which determined the amount of water that might cling to the irrigated vegetables, and then by estimating the concentration of indicator organisms and pathogens that might remain on such irrigated vegetables. A worst-case scenario was chosen by assuming that any micro-organisms contained in the residual wastewater retained on the irrigated vegetables would cling to the vegetables even after the wastewater evaporated.

Based on the laboratory determinations it was estimated that the amount of wastewater that would cling to the outside of irrigated cucumbers would be 0.36ml/100g (or one large cucumber) and 10.8ml/100g on long-leaf lettuce (about three leaves). To estimate the risk of infection and illness from ingesting selected wastewater-irrigated vegetables a numbers of assumptions were made, namely:

- Raw wastewater has a FC concentration of 10^7/100ml.
- The enteric virus:faecal coliform ratio in wastewater is 1:10^5 (Schwartzbrod 1995).
- The degree of pathogen reduction, between irrigation and consumption, is 3 logs.
- All of the enteric viruses are a single pathogen such as infectious hepatitis or polio (allowing assumptions to be made about median infectious dose and infection to morbidity ratios).
- An infection to disease ratio of 50%, i.e. $P_{D:I} = 0.5$.
- N_{50} values range between 5.6 to 10^4 (see Table 16.3).
- $\alpha = 0.2$ (assuming $\alpha = 0.5$ decreases the risk by about 1 log).
- Individuals eat 100g of either cucumber or long-leaf lettuce (unwashed) per day. For an annual estimate of risk, the same level of daily consumption takes place for 150 days of the year.

16.7.3 Results

A total of four pathogens were examined; two enteric viruses (rotavirus and hepatitis A) and two enteric bacteria (*V. cholerae* and *S. typhi*), all of which have a clear epidemiological record indicating environmental and waterborne transmission (Schwartzbrod 1995). Table 16.3 shows the estimated risk of infection and illness from eating lettuce (which carries a higher risk than cucumbers) irrigated with either raw wastewater or wastewater complying with WHO guidelines.

Comparison of the hypothetical examples with data obtained from an outbreak of cholera in Jerusalem in 1970 allowed the validation of some of the assumptions used in Table 16.3 (Fattal *et al*. 1986).

Table 16.3. Risk of infection and disease from eating 100 grams (3 leaves) of long-leaf lettuce irrigated with raw- and WHO guideline compliant-wastewater effluent

Pathogen	N_{50}	One time risk of eating lettuce (100g)		Annual risk of eating lettuce (100g/d for 150 days)	
		P_I	P_D	P_I	P_D
Raw wastewater					
Rotavirus*	5.6	2.7×10^{-3}	1.3×10^{-3}	4.0×10^{-1}	1.0×10^{-1}
Hepatitis A**	30	1.3×10^{-3}	6.5×10^{-4}	1.7×10^{-1}	4.4×10^{-2}
*V. cholerae***	10^3	6.2×10^{-3}	3.1×10^{-3}	6.0×10^{-1}	1.5×10^{-1}
*S. typhi***	10^4	6.2×10^{-3}	3.1×10^{-3}	6.0×10^{-1}	1.5×10^{-1}
WHO compliant wastewater effluent					
Rotavirus*	5.6	2.7×10^{-7}	1.3×10^{-7}	4.0×10^{-5}	1.0×10^{-5}
Hepatitis A**	30	1.3×10^{-7}	6.5×10^{-8}	1.7×10^{-5}	4.7×10^{-6}
*V. cholerae***	10^3	6.2×10^{-7}	3.1×10^{-7}	9.2×10^{-5}	2.3×10^{-5}
*S. typhi***	10^4	6.2×10^{-7}	3.1×10^{-7}	9.2×10^{-5}	2.3×10^{-5}

P_I = Risk of infection; P_D = Risk of developing clinical disease
N_{50} number of pathogens required to infect 50% of the exposed population
* α=0.265 ** α=0.20 where α= a slope parameter (ratio between N_{50} and P_I)

16.7.4 Case study conclusions

The US EPA has determined that microbial guidelines for drinking water should be designed to ensure that human populations are not subjected to a risk of infection by enteric disease greater than 10^{-4} (or 1 case per 10,000 persons/year, Regli *et al*. 1991). Thus, compared with this US EPA level of acceptable risk the WHO Wastewater Reuse Guidelines, based upon the outlined calculations, appear to be some one or two orders of magnitude more rigorous in terms of protecting consumers.

It is questionable, therefore, whether additional expenditure to provide further treatment to comply with more rigorous standards (such as those proposed by US EPA/USAID, which are 1000-fold more stringent) could be justified in terms of consumer protection. This risk assessment, however, does not account for the risks that may be run by agricultural workers using the wastewater, nor does it take into consideration other benefits that may derive from installing additional infrastructure.

16.8 IMPLICATIONS FOR INTERNATIONAL GUIDELINES AND NATIONAL REGULATIONS

This chapter highlights the complex nature of adopting standards at national level based on guidelines and details a range of factors that need to be considered. Developed countries have generally undergone an implicit stepwise implementation of standards as regulations have become progressively more stringent. Many developing countries are now faced with trying to comply with these stringent levels, but are far from meeting them. For this reason, the concept of stepwise implementation needs to be explicit and it has been recommended that specific guidance on this issue be included in future guidelines.

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