Part 4. Indicators

Good indicators must fulfill a number of criteria. They must have a scientific evidence base, be policy-relevant, make it possible to monitor progress towards internationally agreed targets (such as the targets of the MDGs), and reliable data necessary to compute the indicator values should be available in the public domain. Several indicators relevant to water and health are well-defined, well-established and backed by databases with global coverage that are updated at least on an annual basis. Examples include access to safe drinking water and adequate sanitation, under the WHO/UNICEF Joint Monitoring Programme (JMP); global burden of specific diseases, expressed in deaths and DALYs (WHO’s World Health Reports); child mortality (UNICEF); and nutritional status (WHO Global Database on Child Growth and Malnutrition).

4a. Burden of water-related diseases

Databases on the number of deaths and DALY’s by cause (disease), age, gender and region are maintained by WHO. The major water-related diseases and hazards whose mortality rate and burden can be monitored in this way include diarrhea, malaria, schistosomiasis, lymphatic filariasis, onchocerciasis, dengue, Japanese encephalitis, trachoma, intestinal helminth infections (separate for Ascaris, Trichuris and hookworm), and drowning. Some water-related diseases of interest are separately accounted for or not included, notably cholera, typhoid fever and Guinea worm disease. For these diseases, and for selected other diseases like diarrhoea and malaria as well, it is still useful to report the direct measures of disease frequency (incidence or prevalence) when data are available. Changing epidemiological patterns, with important implications for planning appropriate cost-effective interventions, make it preferable to segregate reported diarrhoea figures for watery diarrhoea, persistent diarrhoea and dysentery.

In the context of ongoing mass treatment campaigns, increasing numbers of baseline prevalence data will be generated for intestinal helminth infections. Such mass treatment campaigns will result in immediate prevalence reductions. Over longer periods of time, the prevalence of intestinal helminth infections can be an important indicator for monitoring the impact of improvements in sanitation, so long as it is possible to control for other confounding factors, especially treatment. Spatial differences in prevalences following extended periods of mass treatment will indicate particular environmental risk factors linked to sanitation conditions and specific behaviours.

4b. Access to improved drinking water and sanitation: Standards and definitions

The question of what exactly constitutes access to safe drinking water and basic sanitation has been a topic of debate in recent years. Since the publication of the 2000 coverage estimates for access to improved facilities, produced by WHO, UNICEF and their Joint Monitoring Programme (WHO/UNICEF, 2000), in which definitions based on an expert consensus are presented, several publications have attempted to provide alternative definitions (see UN Millennium Project, 2004b).

JMP, responsible for monitoring progress towards the MDG targets, has used proxy indicators to estimate the number of people with and without access to safe drinking water and adequate sanitation, under the WHO/UNICEF Joint Monitoring Programme (JMP), global burden of specific diseases, expressed in deaths and DALYs (WHO’s World Health Reports); child mortality (UNICEF); and nutritional status (WHO Global Database on Child Growth and Malnutrition).

Table 6.7: Classification of improved and unimproved drinking water sources

<table>
<thead>
<tr>
<th>Improved sources of drinking water</th>
<th>Unimproved sources of drinking water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped water (into dwelling, yard or plot)</td>
<td>Unprotected dug well</td>
</tr>
<tr>
<td>Public tap/standpipe</td>
<td>Unprotected spring</td>
</tr>
<tr>
<td>Tubewell/borehole</td>
<td>Vendor-provided water</td>
</tr>
<tr>
<td>Protected dug well</td>
<td>Tanker truck water</td>
</tr>
<tr>
<td>Protected spring</td>
<td>Surface water (river, stream, lake, pond, canal, irrigation channel)</td>
</tr>
<tr>
<td>Rainwater collection</td>
<td>Bottled water*</td>
</tr>
</tbody>
</table>

*Bottled water is considered an ‘improved’ source of drinking water only where there is a secondary source that is ‘improved’.

quality; nor do they take into account accessibility of the drinking water source (in terms of the distance or time) or the affordability of drinking water. Issues of intermittence, reliability or seasonality are not reflected either. For access to basic sanitation, JMP monitors the number of people using different types of sanitation facilities, not taking into account whether or not they provide privacy and dignity or whether or not they are used by all household members at all times. Nor does the outcome of the monitoring process reflect the actual level of hygiene or cleanliness of the facility. This type of information is generally not collected at national level. Nonetheless, using the categorization ‘improved/unimproved’, JMP has a yardstick for measuring progress and change over time. It allows a reasonably accurate estimate of the number of people without access to any type of improved facility: the have-nots on which the MDGs focus.

However, access to safe drinking water and sanitation needs to be better defined. Howard and Bartram (2003) propose four access categories (see Table 6.9), based on the relationship between accessibility expressed in time or distance and the likely quantities of water collected or used. The four categories are: no access, basic access, intermediate access and optimal access. Global access, as monitored by JMP, corresponds to the level of basic access. The definitions applied by WHO and UNICEF constitute a pragmatic approach to a complex global monitoring need and ensure consistency, replicability and a focus on those without access.

Over the years, a number of comprehensive definitions of access have been formulated. Such definitions and the accompanying standards may serve in the planning or design of new drinking water and sanitation services. The related indicators are specific, objective and measurable on an individual, setting-specific basis. However, when

Table 6.8: Classification of improved and unimproved sanitation facilities

<table>
<thead>
<tr>
<th>Improved sanitation facilities</th>
<th>Unimproved sanitation facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush/pour flush to: piped sewer system</td>
<td>Public or shared latrine</td>
</tr>
<tr>
<td>Septic tank</td>
<td>PIT latrine without slab or open pit</td>
</tr>
<tr>
<td>Pit latrine with slab</td>
<td>Hanging toilet/hanging latrine</td>
</tr>
<tr>
<td>Composting toilet</td>
<td>Bucket latrine</td>
</tr>
<tr>
<td>Ventilated improved pit latrine</td>
<td>No facilities (i.e. people use any area, for example, a field)</td>
</tr>
</tbody>
</table>


Over longer periods of time, the prevalence of intestinal helminth infections can be an important indicator for monitoring the impact of improvements in sanitation...
Since 2000, JMP coverage estimates have been based on user data derived from nationally representative household surveys and national censuses. This marks an important shift away from the approach of using data originating from governments in the 1990s, which became possible after the introduction of the five-yearly Multiple Cluster Indicator Surveys (MCIS) by UNICEF in sixty-four countries in 1995. Together with results of the Demographic and Health Surveys (DHS), or data from national censuses and other sources, including WHO’s Water, Sanitation and Health Programme, this provides a large enough knowledge base to calculate coverage estimates supported by evidence-based datasets.

Why are data derived from household surveys better than those provided by governments or water utilities? The latter suffer from variations in the interpretation of what constitutes access. This complicates comparability between countries and even within a country over time. Often only those facilities that are constructed under government programmes or by water utility companies are counted. Facilities constructed by households, NGOs or the private sector may be partially or totally excluded. Water providers are inclined to report progressively on the number of facilities constructed and do not take into account facilities that are not used or that have fallen into disuse. Household surveys, on the contrary, record, at a given point in time, the facilities people actually use — broken facilities are not counted.

Informal settlements and slums, even those that are home to hundreds of thousands of people, frequently do not appear in official government statistics because of questions of tenure or land ownership. In general, access to such areas tends to be poor and when not counted, a significant over-reporting of coverage will result. Household surveys usually survey peri-urban areas when they fall into one of the selected sampling clusters, thus providing a better picture of the actual situation (see also Chapter 3). Household surveys including national censuses together provide the most reliable, nationally representative, comparable data, and they are available for almost every country in the world.

The three principal international guidelines on water quality of relevance to human health are as follows.\(^{15}\)

- **Guidelines for Drinking-Water Quality**
- **Guidelines for the Safe Use of Wastewater, Excreta and Greywater**\(^{26}\)
- **Guidelines for Safe Recreational Water Environments**

These guidelines are addressed primarily to water and health regulators, policy-makers and their advisors, to assist in the development of national standards. For a long time, in the absence of good epidemiological studies, guidelines and standards for water-related hazards were based on the technical feasibility of providing treatment and took a ‘no or very low’ risk approach. However, setting targets that are too high can be counter-productive: they may be ignored if they are not attainable. National standards should therefore reflect national conditions, priorities and capacities to improve water supplies. All the recently developed guidelines are based on risk-assessment methods. This considers the risk for disease, not just the presence or absence of pathogens or chemicals in the water.

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\(^{15}\) All of these guidelines are available online at www.wssinfo.org/water_sanitation_health/

\(^{16}\) In four volumes: (1) Policy and regulatory aspects; (2) Wastewater use in agriculture; (3) Excreta and greywater use in agriculture. All of these are available at www.wssinfo.org/water_sanitation_health/norms/
Clinical illness in healthy individuals has not been conclusively defined. Drinking water quality guidelines have always included permissible levels of chemical substances. Chemicals in drinking water can be naturally occurring or originate from pollution by agricultural activities (fertilizer, pesticides), human settlements and industrial activities. While the revised WHO guidelines state that microbial hazards continue to be a priority concern in both developed and developing countries, there is increasing recognition that a few key chemicals, notably fluoride and arsenic, cause large-scale health effects. For a risk analysis, information from the catchment on naturally occurring chemicals is essential. If chemicals such as fluoride or arsenic are present in unusually high concentrations in rocks, soil or groundwater, there is an elevated risk for public health. In many countries, the development of appropriate risk management strategies is hampered by a lack of information on the presence and concentrations of chemicals in drinking water and the lack of information on disease cases. In the case of chemical hazards with high measurable disease burden, the target would be to reduce the occurrence of disease cases. If the disease burden is low, it cannot be directly measured by public health surveillance systems, and quantitative risk assessment methods can be applied (see also Chapter 10).

**Drinking water quality**

An important recent event was the publication of the third edition of the Guidelines for Drinking Water Quality (WHO, 2004b). These guidelines are widely accepted in industrialized and developing countries. Recent developments in microbial risk assessment and its linkages to risk management are taken into account. Increased attention is paid to effective preventative management through a ‘framework for drinking water safety’, including ‘water safety plans’ (see Box 6.8).

The guidelines pay attention to the adequacy of supply, which is not only determined by water quality but also by water quantity, accessibility, affordability and continuity. The importance of water quality at the point of use (within the house) is emphasized, while previously, quality guidelines tended to refer only to the source of the drinking water. There is agreement that the best available indicator of faecal pollution of individual drinking water sources is *Escherichia coli* (or thermo-tolerant coliform bacteria). The presence of E. coli provides conclusive evidence of recent faecal pollution, but its absence does not automatically prove that the water is safe. There is certainly a need for additional indicators, especially for protozoa such as *Cryptosporidium parvum*. To date, no water quality standards regarding *Cryptosporidium* oocysts have been established, and the minimum concentration of oocysts in drinking water leading to clinical illness in healthy individuals has not been conclusively defined.

Drinking water quality guidelines have always included permissible levels of chemical substances. Chemicals in drinking water can be naturally occurring or originate from pollution by agricultural activities (fertilizer, pesticides), human settlements and industrial activities. While the revised WHO guidelines state that microbial hazards continue to be a priority concern in both developed and developing countries, there is increasing recognition that a few key chemicals, notably fluoride and arsenic, cause large-scale health effects.

**Table 6.9: Requirements for water service levels and health implications**

<table>
<thead>
<tr>
<th>Service level</th>
<th>Access measure (distance or time)</th>
<th>Needs met</th>
<th>Level of health concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>No access – quantity collected often below 5 litres (L) per capita per day</td>
<td>More than 1,000 metres (m) or 30 minutes total collection time</td>
<td>Consumption cannot be assured</td>
<td>Very high</td>
</tr>
<tr>
<td>Basic access – average quantity unlikely to exceed 20 L per capita per day</td>
<td>Between 100 and 1,000 m or 5 to 30 minutes total collection time</td>
<td>Consumption should be assured</td>
<td>High</td>
</tr>
<tr>
<td>Intermediate access – average quantity about 50 L per capita per day</td>
<td>Water delivered through one tap on plot or within 100 m or 5 to 30 minutes total collection time</td>
<td>Consumption assured; all basic personal and food hygiene possible; laundry and bathing should also be assured</td>
<td>Low</td>
</tr>
<tr>
<td>Optimal access – average quantity 100 L per capita per day</td>
<td>Water supplied through multiple taps continuously</td>
<td>Consumption; all needs met</td>
<td>Very low</td>
</tr>
</tbody>
</table>

close to freshwater bodies more than double their risk of infection, and it is speculated that the exponential growth of aquaculture is the major contributing factor to this emerging disease trend (Keiser and Utzinger, 2005).

Mitigating health risks while maximizing benefits requires holistic approaches that involve all stakeholders in a process to enhance knowledge sharing, promote realistic measures for hygiene and sanitation improvement, generate income, produce food for better livelihoods and sustain the strengthening of water and sanitation services at household and community levels.

For the protection of public health in this context, WHO has developed updated Guidelines for the Safe Use of Wastewater, Excreta and Greywater (WHO, 2006a–d). They define an acceptable and realistic level of public health protection, which can be achieved through a combination of setting microbial water quality targets and implementing health protection measures, such as crop restriction, application techniques and irrigation timing. This approach is flexible and is applicable to both industrialized and less-developed countries. Countries can choose to meet the health target level by wastewater treatment alone, or through a combination of partial wastewater treatment and additional health protection measures.

In adopting wastewater use guidelines for national standards, policy makers should consider what is feasible and appropriate in the context of their national situation. They should use a risk-benefit approach that carefully weighs the benefits to household food security, nutrition and local economic development against possible negative health impacts. The revised guidelines call for a progressive implementation of measures and incremental improvements in the public health situation.
4d. Child mortality

Children under the age of 5 are the most affected by poor water supply and sanitation. Diarrhoea is one of the directly preventable causes of under-5 mortality. Child mortality is the result of a complex web of determinants at many levels. The fundamental determinant is poverty, and an underlying determinant is under-nutrition. The under-5 mortality rate has become a key indicator of health and social development. It can be seen as a cross-cutting indicator for several of the challenge areas and for achieving the MDG targets.

There is sufficient evidence that improvements in water supply, sanitation and hygiene result in fewer cases of diarrhoea and lower overall child mortality. To obtain the maximum possible reduction in child mortality, these improvements would have to be combined, however, with other preventive interventions (breastfeeding, vitamin A supplementation) and treatment interventions (oral rehydration therapy and zinc) (Jones et al., 2003). This combination of interventions could save more than 1.8 million children under the age of 5 each year, which is 88 percent of the annual under-5 mortality due to diarrhoea. 17

The infant mortality rate is a less suitable indicator than the under-five mortality rate in the context of water-related diseases, since only a small proportion of deaths in the neonatal period (first twenty-eight days of life) can be attributed to water-related diseases (Black et al., 2003). In the first six months of life, children are, to some extent, protected against diarrhoea (if they are being breastfed) and malaria. It is only towards the end of the first year of life that infectious diseases due to poor water, sanitation and hygiene take their huge toll on children's health.

4e. Nutritional status

Nutritional status is probably the single most informative indicator of the overall health of a population (see also Chapter 7). For evaluating the impact of water supply and sanitation interventions, nutritional status is as important and appropriate a measure as the incidence of diarrhoeal disease. Anthropometric measurements are well defined, and are easily and inexpensively performed. Data on childhood under-nutrition are available from the WHO Global Database on Child Growth and Malnutrition, 18 which is based on nationally representative anthropometric surveys. It is a good example of international collaboration in standardizing indicators and data collection systems (de Onis and Blössner, 2003).

One of the indicators for monitoring progress towards the MDG targets is the prevalence of underweight children under 5 years of age. Underweight (low weight-for-age) reflects the effects of acute as well as chronic under-nutrition. Weight-for-age is a composite indicator of height-for-age and weight-for-height, which makes its interpretation difficult. Stunting (low height-for-age) reflects chronic under-nutrition and is an indicator of the cumulative effects of standard of living, women’s educational level, access to food, access to water supply and sanitation, and burden of infectious diseases. Stunting is a good indicator to monitor the long-term impact of improvements in water supply, sanitation and hygiene, provided it is possible to correct for confounding variables.

Part 5. Comparative Risk Assessment

Most water-related diseases have multiple risk factors. This raises a number of questions: What part of the burden of disease is attributable to inadequate water supply and sanitation? What would be the health gains of improvements in water supply and sanitation? Similar questions may be posed for water management in agriculture: What burden of disease can be attributed to poor water management, and what are the health benefits of improved water management?

To answer these questions, epidemiological measurements are needed that quantify the public health relevance of important risk factors. The population-attributable risk provides a measure of the amount of disease in the whole population, which is attributable to a certain level of exposure (risk to health), assuming that the association between exposure and the disease is one of cause-and-effect. The known attributable risks for a disease often add up to more than 100 percent, because some risk factors act through other more proximal factors, such as under-nutrition. The potential impact fraction expresses the proportion of disease that could be eliminated by reducing exposure risk.

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17. Child mortality data are available online from UNICEF at www.childinfo.org/cmrd/15b02.htm

18. Available online at www.who.int/nutgrowthdb/
Section 3: DEVELOPMENT

...washing hands with soap can reduce the risk of diarrhoeal diseases by 42 to 47 percent, and the promotion of handwashing might save a million lives per year.

The relative importance of the availability of drinking water, quality of drinking water, sanitation and hygiene behaviour for the occurrence of diarrhoeal diseases continues to be a subject of discussion. Many of the viral, bacterial and protozoan pathogens that cause diarrhoea can be transmitted through the ingestion of contaminated water. Accordingly, water supply utilities and programmes aim to remove these pathogens before the drinking water is provided to consumers. The importance of drinking water quality for the transmission of diarrhoeal diseases was challenged when several reviews in the 1980s and 1990s showed that increasing the quantity of water available for personal and domestic hygiene and ensuring the safe disposal of excreta led to greater reductions in diarrhoeal morbidity than improving drinking water quality (Eley et al., 1991). Safe excreta disposal and handwashing after defecation would stop the transmission by preventing faecal pathogens from getting into the environment. If these primary barriers were in place, then secondary barriers such as removing faecal pathogens from drinking water would be less important. As the debate continues and setting-specific case studies tip the balance in one direction or the other, one thing is clear: improvements in access to safe water will only provide real health benefits if sanitation facilities are improved at the same time. In this respect, it is alarming that global sanitation coverage has only increased from 49 percent in 1990 to 58 percent in 2002, lagging behind the successful increase in global coverage for access to safe drinking water, which is now 83 percent and on track to meet the 2015 MDG target (WHO/UNICEF, 2004).

Further analysis by the CRA Collaborating Group in multiple age and exposure categories, or along a continuum of exposures, showed that globally a considerable proportion of the disease burden attributable to major risk factors occurred among those with only moderately raised risk levels, not the extremes (Rogers et al., 2004). This is consistent with the fundamental axiom in disease prevention: a large number of people exposed to a small risk may generate many more cases than a small number exposed to high risk (Rose, 1992). It follows that population-based strategies that seek to shift the whole distribution of risk factors have the potential to substantially reduce total disease burden, possibly over long time periods if the interventions alter the underlying risk behaviours or their socio-economic causes (Rogers et al., 2004).

The Comparative Risk Assessment (CRA) module of the Global Burden of Disease study aims to assess risk factors in a unified framework. It provides a vision of potential gains in population health by reducing exposure to a risk factor or a group of risk factors. This has provided sufficient evidence that in the poorest regions of the world, unsafe water, sanitation and hygiene are major contributors to loss of healthy life, expressed in DALYs (Ezzati et al., 2002). Globally, 88 percent of DALYs lost due to diarrhoea can be attributed to unsafe water, poor sanitation and lack of hygiene, while 92 to 94 percent of DALYs lost due to diarrhoea can be attributable to the joint effects of unsafe water, sanitation and hygiene; underweight; vitamin A deficiency; and zinc deficiency (Ezzati et al., 2003).

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**BOX 6.9: BENEFITS OF IMPROVED SANITATION**

The best way to prevent faecally transmitted diseases such as diarrhoea is the sanitary disposal of human faeces in pit latrines or other improved sanitation facilities. Improved sanitation is also the only long-term sustainable option for controlling intestinal worms and schistosomiasis.

Improved sanitation has important additional benefits, especially to women. In many cultures, the only time when women or girls can defecate, if they have no latrine, is after dark. The walk to the defecation field, often in the dark, is when women run the greatest risk of sexual harassment and assault. The lack of adequate, separate sanitary facilities in schools is one of the main factors preventing girls from attending school, particularly when menstruating. In Bangladesh, a gender-sensitive school sanitation programme increased girls’ enrolment by 11 percent.

Source: www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets.htm/aps.htm
Network to Promote Household Water Treatment and Safe Storage, providing a framework for global collaboration of UN and bilateral agencies, governments, NGOs, research institutions and the private sector committed to improve household water management as a component in water, sanitation and hygiene programmes.

Epidemiological studies have established a causal relationship between malnutrition and diarrhoea. Malnourished children experience higher risks of mortality associated with diarrhoea (Rice et al., 2000). This is especially true for persistent diarrhoea and dysentery that now account for the majority of deaths related to diarrhoea in the developing world. About 61 percent of deaths due to diarrhoea in young children are attributable to underweight (low weight-for-age) (Caulfield et al., 2004). About 15 percent of the global disease burden can be attributed to the joint effects of childhood and maternal underweight or micronutrient deficiencies. In terms of DALYs, in 1990, under-nutrition was the single leading global cause of health loss, estimated at 140 million DALYs (9.5 percent of total) attributable to underweight (Ezzati et al., 2002). Although the prevalence of underweight has decreased in most regions of the world, it has increased in sub-Saharan Africa.

Based on current evidence, washing hands with soap can reduce the risk of diarrhoeal diseases by 42 to 47 percent, and the promotion of handwashing might save a million lives per year (Curtis and Cairncross, 2003). Handwashing promotion should become an intervention of choice. Hygiene depends on the quantity of water that people have available, and one has to realize that in many areas, handwashing after defecation or before preparing food seems like a luxury when the water has to be fetched from a water point far away.

Recently, there has been increased attention to the fact that drinking water, even if it is of good quality, can become contaminated between the point of collection and the home, and in the domestic environment, when children dip their freshly polluted hands in a household water container, for example. The water quality of drinking water sources might not be associated with the occurrence of diarrhoea (Jensen et al., 2004), because it does not reflect the water quality at the point of use. There is increasing evidence that simple, low-cost interventions at the household and community level are capable of improving the microbial quality of domestically stored water and of reducing the associated risks of diarrhoeal disease and death (Casen and Cairncross, 2004; Sibson, 2002). This has led to the creation of the WHO-coordinated International Network to Promote Household Water Treatment and Safe Storage, providing a framework for global collaboration of UN and bilateral agencies, governments, NGOs, research institutions and the private sector committed to improve household water management as a component in water, sanitation and hygiene programmes.

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Part 6. Governance

Challenges with respect to water availability, water quality and sanitation are intertwined with challenges on food security, urbanization and environmental degradation. They stand in the way of poverty reduction and sustainable development. Providing for effective and sustainable water supply and sanitation services requires adequate governance structures and includes a commitment to good governance. In certain countries, broad policy and institutional constraints are greater obstacles than resource and technological constraints. Often, policy and institutional reforms are needed, and these would have to: (1) balance the competition for water between different uses and users; (2) implement a genuinely integrated approach to water resources management; and (3) establish effective governance institutions and institutional arrangements conducive to such an integrated management approach.

6a. Economic evaluation of interventions

Global disease control priorities should be based on the global burden of disease and the availability of cost-effective interventions. In the long term, many environmental health interventions have proved to be cost-effective compared to medical interventions. Water connections in rural areas have been estimated to cost US $35 per DALY saved, hygiene behaviour change US $20 per DALY saved, and malaria control US $35–75 per DALY saved (Listorti and Doumani, 2001).

Hutton (2002) was commissioned by WHO to test a number of intervention scenarios and concluded that cost-benefit ratios high when all benefits are included, standing at an economic benefit of around US $3 to 6 per US $1 invested for most regions and for most interventions. Time saving
...estimated benefits of US $3 to 34 per US $1 invested if the water and sanitation MDG targets were achieved...

BOX 6.10: DOMESTIC USE OF IRRIGATION WATER

Millions of people around the world rely on surface irrigation water for most of their domestic needs. This is especially true of irrigation communities living in areas with low rainfall, under-developed drinking water supply systems, and in regions with low groundwater tables or unsuitable groundwaters due to high concentrations of salt or hazardous chemicals. In such circumstances, the way in which irrigation water is managed has a tremendous bearing on the health of the populations living in these areas. Unfortunately, irrigation water management is based entirely on crop requirements and not on domestic water needs. Therefore, when decisions for water allocation are made, domestic users are rarely taken into account. Also, with the looming freshwater crises, there is increasing pressure on the irrigation sector to make water use in agriculture more efficient. In this process, the non-agricultural uses of irrigation water need to be considered.

Studies in Punjab, Pakistan have documented the links between availability of irrigation water for domestic use and its impact on diarrhoea and the nutritional status of children. It was concluded that irrigation water management has a clear impact on human health and that bridging the gap between the irrigation and domestic water supply sectors could provide great health benefits by taking into account the domestic water availability when managing irrigation water. In the same study, it was found that using irrigation wastewater as a safe source for domestic supplies was a possible option.

Source: Van der Hoek et al., 2001b; 2002a, b.
The difference between credible high and low estimates of the water globally required for agriculture in 2025 is in the order of 600 cubic kilometres (km$^3$) - more than is estimated to be required for all domestic uses. This has created a widely prevalent notion that a small diversion from the irrigation sector could fulfil the demands of a growing population for domestic water supply. In reality, this reallocation of water between sectors can be very difficult, and truly integrated water management is constrained by the traditional sectoral thinking and priorities set by professionals in the various disciplines and the existing power structure. The main concern of public health officials and researchers is the increasing deterioration of water quality due to industrial and urban waste, agricultural runoff and insufficient investments in the domestic water supply infrastructure.

This global concern for water quality is, to a large extent, a reflection of the very high quality standards traditionally imposed on drinking water by institutions and professionals in industrialized countries. On the other hand, the managers of water for agricultural production see their responsibilities largely confined to the provision of water in time and space in accordance with the cropping cycle requirements. Few irrigation managers would see it as part of their mandate to supply water for domestic use. To water planners, domestic uses in rural areas concern only a small fraction of the total amount of freshwater utilized and are therefore easily overlooked. This may lead to the situation that high investments have been made to mobilize freshwater into an area, without realizing that apart from irrigating crops, irrigation water is used for many other purposes, including drinking, cooking, livestock rearing, aquaculture and wildlife. Washing clothes and bathing are probably among the most frequently observed domestic uses of irrigation water, the determinants of its use, the realistic alternatives, and the consequences of these uses in order to promote informed water policy formulation (see Box 6.10).

6d. Falling groundwater levels

The over exploitation of groundwater for agricultural and industrial purposes renders the availability of shallow groundwater for drinking and domestic purposes increasingly problematic. In some of the major breadbaskets of Asia, such as the Punjab in India and the North China Plain, water tables are falling 2 to 3 metres a year. The wealthier farmers can continue to drill deeper tubewells with larger, more expensive pumps, but poor farmers are unable to do so. The problem of falling groundwater levels is now seen by all stakeholders as a threat to food security. What has received less attention is that it also causes the shallow drinking water wells of poor communities to run dry. Deepening these wells is very costly and beyond the means of the poor. In coastal areas such as the State of Gujarat, India, over-pumping causes salt water to invade freshwater aquifers, making them unsuitable for drinking. Over-pumping has also been linked to the contamination of drinking water with arsenic. Clearly, pumping groundwater has become a key policy issue that can only be dealt with in the context of FWM.

6e. Poverty Reduction Strategy Papers

One of the main instruments for national governments in their attempts to reduce poverty are the Poverty Reduction Strategy Papers (PRSPs), which give clarity and direction to all the development work in a country. These...
are country-owned development strategies demanded by the World Bank and the International Monetary Fund of countries that want to be eligible for loans. Reducing an excessively-high disease burden will have a positive economic impact, and strategies on communicable disease control and child health can be seen as evidence of a pro-poor approach. A review of twenty-one PRSPs found that all of them included strategies on communicable disease control, child health and water and sanitation improvement [WHO, 2004c]. However, the emphasis was overwhelmingly on government delivery of health services to reach health goals without examination of the role of non-government providers and other sectors. Furthermore, quantifiable targets were mostly not mentioned, making it difficult to link PRSP indicators with the MDGs. One of the overarching criticisms of the PRSPs from NGO sources has been that participation – the widely proclaimed centrepiece of national ownership of the PRSPs – is poorly implemented (UN Millennium Project, 2004a).

Cambodia is one of the poorest countries in South-East Asia. It is still recovering from decades of conflict, and all sectors, including the health sector, require reconstruction. The life of most people in Cambodia is still defined by poverty and a very high burden of disease with a government health care system that is ill-equipped to deal with a range of health problems. Access to improved drinking water sources (estimated at 34 percent in 2002) is extremely low, even by developing country standards (WHO/UNICEF, 2004). In the capital, Phnom Penh, the water supply and drainage systems have deteriorated over the years due to war, poor management and lack of maintenance. This problem has been worsened by the rapid growth of the urban population. However, successful rehabilitation projects have taken place with foreign aid and technical assistance. Since 1993, the Phnom Penh Water Supply Authority (PPWSA) has increased its distribution network from serving 40 percent of the Phnom Penh population to over 80 percent. Non-revenue water – the result of leaks, mismeasurement, illegal connections and illegal sales – has been reduced to 22 percent (from 72 percent) andcollections are almost 99 percent with full cost recovery achieved. By mid-2004, it is predicted that the water supply capacity in the city will have increased to 235,000 cubic metres per day. This is now considered a success story for which the PPWSA was awarded the Water Prize of the Asian Development Bank.

Charging for water and the relative roles of public versus private management are controversial issues (see Chapters 2 and 12). Phnom Penh provides a rare example of an efficient water-delivery system in a large city run by a public body.

Part 7. Water for Life: Making it Happen

With respect to human health, this second edition of the World Water Development Report consolidates our new and updated insights into the diverse nature and broad scope of conditions where the development, management and use of water resources are associated with community health status. The concept of burden of disease, expressed in Disability-Adjusted Life Years lost, has strengthened its position as a universal indicator of that status with valid applications in economic evaluation as well as development planning. New tools have also become available to better estimate the costs and benefits of different options, particularly for improving access to drinking water and sanitation.

The basic driving forces of the water–health nexus have not changed in nature and include population expansion, rapid urbanization, globalization and increasing scarcity of good-quality freshwater resources. At the global policy level, the MDGs are exerting an increasingly marked pressure on both thinking about and acting on water-health issues; newly emerging economic realities (particularly the rapid developments in China and India) further modulate these pressures.

Positive and negative trends can be distinguished. The positive trends include:

- Global progress towards achieving the MDG target on drinking water.
- A significant reduction in mortality due to childhood diarrhoea.
- The availability of good indicators for monitoring progress towards achieving health-related MDG targets at the global and regional level.
- A significant evolution in approaches to managing the quality of drinking water, recreational waters and wastewater, from a technical no-risk concept to a comprehensive system of risk assessment and management.
- Greater recognition of health impact assessment as the critical starting point for a functional incorporation of human health considerations, especially into integrated water resources development and management.

Together, these trends will influence and improve the governance of water and health issues in the coming years. Authorities now can apply adaptive management and ensure optimal solutions in local settings. Decision-making will have a stronger evidence base, even though the indicators used need further development and refinement. An example of this is provided by the new vision on the safe use of wastewater, excreta and greywater in agriculture and aquaculture that assesses and manages health risks and that balances health costs and benefits rather than applying rigid water quality standards. In many parts of the world rigid standard setting has proved to be neither feasible nor enforceable, whereas through water safety plans, through safe household water management and storage or through safe use of wastewater, governments can achieve solid and sustainable progress.

On the downside, the following constraints and bottlenecks can be observed:

- Lack of progress towards achieving the MDG sanitation target left 2.6 billion people without access to improved sanitation at the end of 2002.
- The significant increase in the absolute number of people without access to an improved drinking water source and improved sanitation, in both urban and rural areas, since 1990 as exclusively experienced in sub-Saharan Africa.
- The problematic health situation (with no signs of improvement) in sub-Saharan Africa, as reflected in practically all indicators, and in particular by the increasing malaria burden.
- Lack of progress in the implementation of the IWRM concept specifically, and in the realization of intersectoral action for health in general.
- An inadequate evidence base needed to advocate for increased investment in urban sewage treatment, resulting from a lack of indicators and mechanisms for monitoring the sewerage discharge and the added burden of disease for people downstream.
Despite the general acceptance of the Integrated Water Resources Management concept, the different water use sectors still fail to coordinate their planning and to collaborate at the implementation phase, with a range of predictable, and therefore in many cases preventable, adverse consequences for human health. Like the more generic concept of intersectoral collaboration, IWRM is embraced by all, but funded by few. The innovative proposals of the World Commission on Dams for improved planning procedures and best practice in implementation, in the broader governance context (of generic value to all water resources development and transferable to water and health issues), have received insufficient follow-up and seem all but forgotten.

Growing challenges in the health sector range from drug resistance in important parasitic and bacterial pathogens to newly emerging diseases (with SARS and the H1N1 avian influenza virus as recent examples) underscore the need for water resources development, management and use to take human health into consideration in a far more comprehensive and integrated manner.

The following recommendations aim to strengthen the positive trends and help counter the constraints:

- Re-focus a much more broadly supported programme of development aid and technical assistance on meeting the MDG drinking water and sanitation targets especially in rural areas that still lag far behind urban areas, but also in peri-urban and slum areas that are likely to absorb most of the urban population increase in the coming decade.
- Increase investments in sanitation coverage and improvement worldwide, ensuring a progressively expanding portion for sewerage and proper maintenance.
- Increase investments for meeting the MDG drinking water and sanitation targets in sub-Saharan Africa.
- Refine the correlations between water indicators and the indicators for childhood illness/mortality and nutritional status, the importance for accelerated access to safe water and adequate sanitation, and better Integrated Water Resources Management (IWRM) practices.
- Promote intervention studies that provide scientific information and help strengthen the evidence base on the effectiveness of environmental management methods for control of water-associated vector-borne diseases, and develop a toolkit for environmental managers in this area.
- Make the multiple uses and multiple users of water the starting point of planning, developing and managing water resources at the river basin level, and promote the principle of subsidiarity in the governance of water resources.
- Introduce the use of available tools for estimating costs and benefits of different drinking water and sanitation options initially at the national and subsequently at lower levels of governance.


International Development Research Centre (IDRC Canada) Ecohealth Programme: www.idrc.ca/ecohealth

International Water and Sanitation Centre, the Netherlands: www.wc.nl

International Water Association: www.iwahq.org.uk

International Commission for Irrigation and Drainage: www.icid.org

WHO Collaborating Centres in Water, Sanitation and Health:
  Water Quality and Health Bureau, Health Canada: www.hc-sc.gc.ca/waterquality
  Office national de l’Eau potable (ONEP), Morocco: www.onep.org.ma
  Institute of Environmental Engineering and Research: www.uet.edu.pk/Departments/Environmental/environmental.main.htm
  DIB Institute for Health Research and Development, Denmark: www.dibtest.dk
  DHL Water and Environment Denmark: www.dhi.dk
  Institute for Water, Soil and Air Hygiene, Federal Environment Agency, Germany: www.umweltbundesamt.de
  Institute for Hygiene and Public Health, Bonn, Germany: www.mbb.un-bonn.de/hygine
  Institute for Water Pollution Control (VITUKI), Hungary: www.vituki.hu
  University of Surrey, School of Engineering: www.surrey.ac.uk/eng
  National Centre for Environmental Toxicology: www.wrcplc.co.uk/asp/business_areas.asp#ncet
  British Geological Survey, Groundwater Systems and Water Quality Programme: www.bgs.ac.uk
  International Water Management Institute, Sri Lanka: www.iwmi.cgiar.org
  Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand: www.ttm.mahidol.ac.th
  Asian Institute of Technology, Department of Environmental Management Programme: www.ait.ac.th
  Queensland Institute for Medical Research, Mosquito Control Laboratory, Australia: www.qimr.edu.au/research/labs/mosquito/index.html
  National Institute of Public Health, Department of Water Supply Engineering, Japan: www.niph.go.jp
  Centre regional pour l’Eau potable et l’Assainissement à faible Coût, Burkina Faso: www.nipa.uwrfop.org

Future Harvest centres associated with the CGIAR doing research on water management/health
  International Food Policy Research Centre: www.ifpri.org/events/seminars/2005/20050623AgHealth.htm
  Africa Rice Centre (formerly: West African Rice Development Association): www.wirad.cgiar.org/research/health