Safe Water as the Key to **Global Health**

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Preface

We have great choices available to us for managing our water resources, treating water for drinking purposes, using innovative financing approaches to generate capital, protecting our ecosystems, and motivating communities to actively participate in these processes. And yet, there remains an almost insurmountable chasm between our self-professed targets – such as those entwined in the various Millennium Development Goals (MDGs) – and the reality of a large number of people without a safe water source or an adequate sanitation system.

Numerous statistics, such as those presented in this report, highlight the consequences for communities in developing countries as a result of non-provision of these very fundamental human needs. Lack of access to safe water and adequate sanitation are the leading causes of morbidity and mortality, particularly amongst children. Indirect and adverse consequences on education levels, nutrition and economy are also documented quite effectively.

More recently, the benefits of water and sanitation provision have also been quantified. This measurement can be made in terms of improved well-being of people and communities, reduction in public health costs, and catalysis for local economic growth. Such benefits accrue in perpetuity and can potentially lift communities out of poverty and misery.

And yet, global and national commitments to meet these challenges are far from adequate. This report explores why that is the case and how we can change the situation.

Such change comes in two parts: First, we need to effectively change public and political perceptions of the nature of the problem, identify the stumbling blocks in responding effectively, and articulate the consequences of failure. Second, we need to mobilize human, technological and managerial resources that match the magnitude of the crisis.

It is very important that we aim high. That is, the target should be to provide appropriate and sustainable supply of safe water and adequate sanitation to everyone. We believe that such a target is achievable by the year 2025, if we accept MDGs as a stepping stone and the year 2015 as a mid-term milestone.

The first step in this direction must to be strengthen the capacity of developing countries, with the explicit aim of achieving 100% coverage. Such capacity should include human and technological development, but must also focus on nurturing institutions that can absorb and retain it. Over time, these institutions can enrich managerial skills as well.

The second major step is to initiate out-of-the-box thinking on resource mobilization. Two roadblocks must be surpassed to achieve this. First, we have to accept that national governments in developing countries will likely never have sufficient resources at their disposal, even when counting the meagre overseas development aid; accepting this reality then opens up the door to considering real innovations. Second, some of the resources from the private sector must be engaged. Some bad experiences in privatization of public utilities and a general mistrust of potential profiteering by the private sector have led to effectively closing the door on this option. In the same vein, many community groups and civil society organizations need to re-think and shift their positions to better serve the public interest.

A number of other processes also have to be triggered to achieve success.

Greater mobilization of public opinion can lead to both better actions at the local level and improved steering of national political agenda. Previous examples of such interaction, like eradication of polio through community-centered, nationally-driven vaccination schemes, demonstrate that it is achievable.

Greater cohesion in policies and a universal inclusion of water and sanitation provision in national development planning are the key elements to success. Examples in many developing countries, notably Madagascar, have demonstrated that political interests and public well-being converge very well when dealing with water and sanitation issues.

We also need to provide politicians and policymakers with the knowledge and tools essential for guiding policies in their own domain. We, at UNU-INWEH, are striving to develop such tools in close cooperation with our partners. Development of a global map of communities that are vulnerable to water-related diseases and a worldwide knowledge base of cheap, safe water provisioning options are two such initiatives.

I hope that the ideas presented in this report help bring about the necessary changes in thinking, and the urgency to respond to this global crisis is driven home. This report is one step in an on-going dialogue on finding effective ways to move towards our ultimate goal – provision of safe water and adequate sanitation to every woman, man and child on this earth.

Dr. Zafar Adeel
Director UNU-INWEH
18 September 2008

Summary For Decision-Makers

Access to safe and affordable water is considered to be a basic human right, yet the universal reality does not reflect this principle. A lack of adequate capacity and financing, and national policies which often rely on unsustainable use of water resources, prevent effective and sustainable provision of safe water and sanitation.

HOW IS HUMAN WELL-BEING INFLUENCED BY WATER AND SANITATION PROVISION?

Access to safe and affordable water is considered a basic human right. Policies at various levels and their implementation, however, do not reflect this principle. Improved access to clean water can reduce diarrhoea and waterborne diseases by at least 25%; improved sanitation is accompanied by more than a 30% reduction in child mortality. This urgent global challenge is pragmatically achievable, politically feasible and ethically important.

Water-related diseases are a significant contributor to the global burden of illness. Waterborne (mainly gastrointestinal disease), water-washed and water-based (including vector-borne) diseases are a significant contribution to the global burden of illness. Microbial and chemical contamination of water resources and new threats which are constantly emerging - from pharmaceuticals in drinking water to exposure to Avian Influenza related to habitation of wetlands by migrating birds - have a significant impact upon human health around the world. Simple solutions such as improved water supply (especially in the house), improved sanitation and hand washing with soap can reduce associated morbidity rates by at least 25%.

Poverty deprives people of access to tenable solutions to water and sanitation problems through lack of resources, lack of education and limited political, social and economic influence. Poverty and ill-health go hand–in-hand. Individuals who are poor are more prone to ill-health, and vice-versa. This becomes a self-perpetuating cycle of degrading human well-being that can only be broken through increased standards of living and education. The role of water in poverty reduction is threefold. First, new business opportunities are created for local entrepreneurs to provide water and sanitation services; governments can play an important role in creating enabling environments for such initiatives. Second, significant savings in the public health sector, achieved through improvements in overall health, can be invested elsewhere for economic growth. Third, individuals are better able to participate in capacity building and economic activities when experiencing improved health and well-being.

A lack of global investment in water and sanitation has put the attainment of the MDGs in serious jeopardy. Water is a central theme that can be used to achieve Millennium Development Goals (MDGs), including the achievement of a 50% reduction in the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. Historically, water and sanitation has suffered from severe under financing. This results from lack of internal financial capacity in the poorest of countries, poor political decisions in allocating development aid, the overall reduction in development aid over time, and the limited cost-recovery potential in poverty-stricken regions.

WHICH GLOBAL TRENDS ARE IMPORTANT DRIVERS IN THE WATER-HEALTH EQUATION?

Population dynamics, poverty, climate change, globalization, investment policies, urbanization and intensification of agriculture all exacerbate water supply and sanitation problems. Population growth is projected to continue at an unsustainable rate in developing countries. Increased urbanization and the intensification of agriculture in many parts of the world, and overconsumption of water in highly industrialised countries, are directly linked to decreasing water quality and availability. Demographics and migration patterns will alter the number and spatial patterns of those at increased risk. Climate change impacts availability of water (manifesting as droughts, floods and other high impact weather events), water quality and pathogen dynamics.

National policies often rely on unsustainable use of water resources and provide inadequate attention to the provision of safe drinking water and sanitation. National policies need to include the integrated management of groundwater and surface water sources as well as source water protection and give due consideration to societal factors that affect access to, and use of, water. Risk assessment (based on scientific evidence) and communication of risk are important elements in policy formulation and for ensuring that water-related health issues figure prominently in the national agenda. In other words, policy makers need to better understand the benefits for national development as a result of sustainable water management and provision of safe water.

The provision of safe water and sanitation is a key mechanism required to break the cycle of poverty, particularly for women and girls. Lack of access to water usually precludes the use of latrines because this becomes an additional water requirement and therefore an additional burden on the water collector. Gaining access to a latrine, rather than practicing open defecation, means that there is no direct contact with faeces, an opportunity for hand washing (ash or soap) and a reduction in contamination of local water supplies. The results are significant, especially for women and girls: improving household health, reducing the time spent to collect water and providing a safe and dignified environment for practising sanitation. This means that there is more time to tend to crops and livestock, more time and resources to spend on improved food preparation, more time to attend school, and an opportunity to participate in the local economy; all mechanisms which work towards breaking the cycle of poverty.

HOW CAN THE MAJOR OBSTACLES TO SAFE WATER PROVISIONING BE OVERCOME?

Lack of adequate capacity and financing are the main factors preventing effective and sustainable provision of safe water. Capacity can be described in terms of the human, technological, infrastructural, institutional and managerial resources required at all levels from the individual through to the state. Not only does capacity have to be built within each of these levels, but it has to be institutionalized and local communities need to be empowered to use it effectively. This becomes very difficult within the fractured governance system which is often associated with water resource management and provision of safe water.

A greater emphasis on capacity building and its retention is needed to facilitate change. This capacity needs to be built internally to a country and through South-South collaborations and partnerships, rather than depending on consultants from developed countries. Capacity is a very flexible concept and encompasses the public sector, academia, community based organizations and the private sector, ranging from the individual to institutions to society as a whole. Incorporated within this capacity building is:

1. The capacity to engage, educate and train, including community awareness building, adult training and formal education;
2. The capacity to measure and understand aquatic systems, through monitoring, applied research, technology development and forecasting;
3. The capacity to develop and implement policies and programmes through effective governmental, non-governmental and private sector institutions; and,
4. The capacity to identify and provide appropriate, affordable water technologies, infrastructure, services and products through sustained research, investment and management.

Alternate financing solutions are available to overcome the status quo. Enhancing the status of the water and sanitation sector in order to increase aid is key. Additionally, financing models need to move beyond traditional approaches (bilateral and multilateral aid agreements, international NGOs and banks, public development aid, tariffs on the user and local taxes) towards innovative strategies, such as the International Finance Facility or a G20 led initiative (see next section), partial credit guarantees, output-based aid and re-invented Public-Private Partnerships (PPPs).

Strong economic returns should influence national spending priorities. Epidemiological studies and economic data show the financial benefit of preventative measures for water related diseases, and the costs to society of not preventing the diseases. Recent studies suggest a return of between US$3 and 34 for every dollar invested in safe water and sanitation. Policy makers can use these data to justify their actions, identify areas of deficiencies and better prioritize action, in order to facilitate their decisions in re-allocating needed resources for the provision of safe water and sanitation.

HOW CAN COUNTRIES BEST INTEGRATE THE MANAGEMENT OF HEALTH AND WATER?

Cohesive programmes are required for protecting watersheds and ecosystems, protecting public health and ensuring a sustainable water infrastructure. This type of approach incorporates both disease eradication and enhanced human well-being, recognising that neither is possible without the realisation that human beings are located at the centre of the hydrologic cycle. This hydro-social-health framework guides the investigation, prioritisation and implementation of activities at the water-health nexus.

Policy makers must understand the importance of conserving and maintaining safe and secure water for ecosystem and human health needs. It is not simply a question of access to resources, but ecosystem interlinkages and the prioritisation of resource allocation. Decisions need to be situation specific and require effective education and communication between the affected people and policy makers.

Data must provide the foundation for management, policy decisions and interventions. Without a scientific basis, it is impossible to make informed decisions. However, capacity and fiscal constraints often make routine, standardised and spatially distributed surveillance or data collection systems difficult. Even if data are systematically collected, centralised access -- especially in developing countries -- can still be problematic. Further, a mechanism is required that translates data into knowledge and which leads to ideas for mobilising action.

HOW CAN WE BEST ARTICULATE THE POLITICAL SIGNIFICANCE OF WATER AND SANITATION?

The mobilisation of global public opinion can lead to action at national and international levels. Networking technologies can create linkages and promote awareness of global issues surrounding water. The processes through which this is undertaken have to be participatory and create a sense of belonging and identity. In particular, youth should be engaged to develop their own ways of creating and sustaining wealth and employment through addressing global problems, developing solutions and informing key policy decisions that affect their future.

Within the community, incentives can be created for private actions and behaviours at the household level that lead to a public good in terms of sanitation and hygiene. Scientists should play a key role at this level by involving community members in the development of research activities that target local problems.

Global targets need to be translated into realistic, operational, politically acceptable targets at the national and sub-national levels. These specific targets can be used to empower and involve society at the lowest appropriate level. Attention has to be focused on the countries, populations and groups within society that are most vulnerable and where the problems are the worst, which are often those in remote, rural or peri-urban areas.

The G20 group of developed and developing countries is uniquely positioned to meet water and sanitation provisioning goals. The G20 group of economic ministers consists of a broad membership that could capitalise on its significant political, economic, scientific and technological capacities to leverage support from other international groups and to provide an alternate delivery model for solving the global water and sanitation crisis.

WHICH RESEARCH QUESTIONS ARE ESSENTIAL, BUT UNANSWERED GLOBALLY?

A better understanding of the functions and linkages between natural and social systems is essential. Understanding the distribution of and access to safe water becomes comprehensive when it is layered with attempts to understand the social, political, cultural and economic systems through which water flows. In order to optimize investments and the resultant benefits, a strategy is required which incorporates this enhanced understanding and the potential implications of climate change into account. Generally, a broader approach is required to incorporate water-health perspectives into plans and activities to address the significant challenge of meeting the MDGs and improve the quality of life of people around the globe. This strategy is essential for informing the development of effective policy and legal frameworks at the national and international level.

Scientists must increase their efforts to integrate key elements of knowledge and technology. What can social, health, physical and other scientists bring to the table? They can help integrate knowledge to conserve natural systems, manage water properly, and protect and promote human health. Research activities in the areas of new technologies for information dissemination, economic evaluations and assessments of water treatment and sanitation technology deployments, integrated risk assessments, capacity needs assessments, and models for the engagement and investment of the private sector will be required to underpin these activities.

We need greater investment in the development of policy tools to identify the most vulnerable people and communities and augment monitoring programmes. Data-driven models that can link provision of water and sanitation to human health and well-being are critically needed. These validated models can be used to test the efficacy of policy interventions, especially in the absence of reliable data and monitoring programs. Significant collaboration is required worldwide to bring scientific consensus around these tools. There is a further need for a globally accessible platform that provides visual representation of vulnerability to specific diseases and water-related hazards to inform and to empower all levels of civil society.

How is human well-being influenced by water and sanitation provision?

THE CURRENT BURDEN OF ILLNESS

Lack of access to safe water and adequate sanitation is one of the most important threats to human well-being worldwide. It is estimated that diseases resulting from poor water, sanitation and hygiene account for almost 10% of the total global burden of illness (Prüss-Üstün et al., 2008). Globally, almost 900 million people lack access to safe water supplies and 2.5 billion people live without access to improved sanitation[1] the majority (at least 80%) of whom live in rural areas (JMP, 2008). Further, one third of the world's population live in countries experiencing moderate to high water stress (IWMI, 2007). Currently, 1.4 million children die as a result of diarrhoea and 0.5 million people die as a result of malaria each year (Prüss-Üstün et al., 2008). In 2002, the total number of deaths attributed to poor water, sanitation and hygiene was over 3.5 million (Prüss-Üstün et al., 2008). An estimated 4 billion cases of diarrhoeal diseases occur every year, such as rotavirus gastroenteritis which is responsible for approximately half a million deaths per year among children under age five (Parashar et al., 2003). Diarrhoea is not only significant in terms of mortality: chronic diarrhoea can result in malnutrition in children, making them susceptible to other diseases and resulting in 860,000 deaths per year (Prüss-Üstün et al., 2008). This is all unnecessary given that 94% of diarrhoea cases are preventable.

Water-related diseases are a significant contributor to the global burden of illness. In addition to waterborne (mainly gastrointestinal disease), water-washed and water-based (including vector-borne) diseases contribute to the significant global burden of illness associated with water. There are 300 million clinical cases of, and 1 million deaths from, malaria recorded per year (WHO, 2007b). Chemical contamination of water increases the burden of illness, with, for example, 50 – 100 million people in Asia consuming water with unsafe levels of arsenic (Graziano and van Geen, 2005). New threats are constantly emerging, from pharmaceuticals in drinking water to exposure to Avian Influenza related to habitation of wetlands by migrating birds.

WATER AS A KEY ELEMENT OF THE DEVELOPMENT EQUATION

No other single intervention is more likely to have a significant impact on global poverty than the provision of safe water. Water is a central theme which can be used to achieve MDGs, including the goal of a 50% reduction in the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015 (Figure 1). It is well documented that improved access to clean water would reduce diarrhoea and waterborne diseases, and

Diarrhoea: about 4 billion cases per year cause 1.5 million deaths, mostly among children under 5 years old, of which 88 % are attributable to unsafe water, poor sanitation or a lack of hygiene.

Intestinal worms infect about one third of the global population and undernutrition caused by the infections can lead to cognitive impairment, anaemia or massive dysentery.

Trachoma: about 5 million people are visually impaired from trachoma. Studies have found that the infection rate could be reduced by 27% if an improved water supply was provided.

Schistosomiasis: about 200 million people are infected with schistosomiasis. Studies show that having access to improved water supply and sanitation could reduce the infection rate by up to 77%.

Source: WHO, 2004; 2007a; 2008

[1] Improved sanitation ensures that humans do not come into contact with their excreta

Flooded street caused by failures in the water and sanitation systems, Iraq
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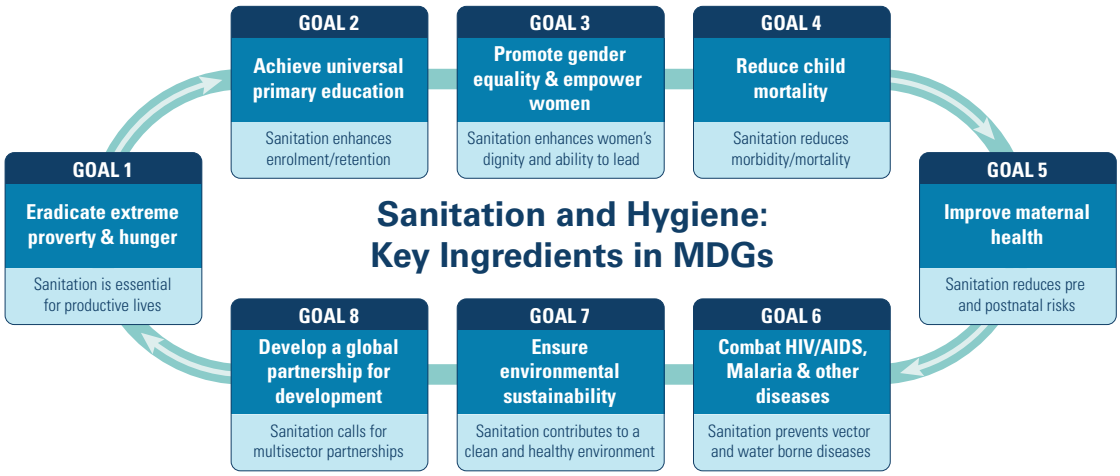

Figure 1: Sanitation and Hygiene: Key Ingredients in MDGs (modified from Mehta and Knapp, 2004)

that the transition from unimproved to improved sanitation is accompanied by more than a 30% reduction in child mortality (e.g. Esrey et al., 2001).

Simple solutions such as improved water supply (especially in the house), improved sanitation and hand washing with soap can reduce morbidity rates by at least 25% (e.g. Esrey et al., 1991; Esrey, 1996; Jalan and Ravallion, 2001; Luby et al., 2004; Fewtrell et al., 2005; Zwane and Kremer, 2007). However, some options are more effective than others. Cost, reduction of disease and improvement in overall health should all be considered when deciding the most appropriate solutions. For example, even though a communal tap may reduce the overall number of diarrhoea cases, it can increase the duration of disease by up to 40% through container contamination (Jalan and Ravallion 2001).

Reduction in poverty through safe water provisioning can be achieved in three ways. First, new business opportunities are created for local entrepreneurs to provide water and sanitation services; governments can play an important role in creating enabling environments for such initiatives. Second, significant savings in the public health sector, achieved through improvements in overall health, can be invested elsewhere for economic growth. Third, individuals are better able to participate in capacity building and economic activities when experiencing improved health and well-being.

Water is inextricably linked to sanitation; they must be addressed in concert to provide significant reductions in morbidity and mortality. The main diseases in the poorest countries around the world are related to lack of basic sanitation services, including the provision of potable water and the disposal of excreta and solid wastes. The effects of improper sanitation result in devastating diseases that are transmitted through faecal pollution of the household and community environment. Moreover, disease prevalence and duration are increased when piped water is provided without consideration of sanitation (Jalan and Ravallion, 2001). However, provision of sanitation can be made difficult by tradition and culture; the stigma and embarrassment associated with talking and teaching about sanitation; and, the social inertia regarding behavioural change.

Provision of sanitation can be made difficult by tradition and culture; the stigma and embarrassment associated with talking and teaching about sanitation; and, social inertia regarding behavioural change.

Which global trends are important drivers in the water-health equation?

POPULATION DYNAMICS

Rapid population growth puts increasing pressure on our limited resources. Population growth has been rapid, particularly in low and middle income countries (LMICs) over the past few decades (Table 1), pressuring resources and altering demographics through variations in rates. For example, many high income countries (HICs) are experiencing low or even negative population growth, resulting in an aging population. LMICs with high birth rates are increasing the percentage of young children within the population. In terms of public health, and particularly infectious waterborne diseases, both scenarios are increasing the proportion of the total population at highest risk (gastrointestinal illnesses disproportionately affect the health of the very young and very old). Increased population growth further leads to increased densities and competition for land, water, fuel and materials. This tends to result in the utilisation of marginal and fragile habitats, further degrading the environment with direct impacts on water quality and quantity, exacerbating health problems.

Table 1: Population increase 1980 – 2005 (data source: UN DESA http://esa.un.org/unpp/)

	Less Developed Regions	More Developed Regions	World
1980	3.4 billion	1.0 billion	4.4. billion
2005	5.3 billion	1.2 billion	6.5 billion
% increase	56%	20%	48%

By 2008, over 50% of the world's population will live in urban areas (UNFPA, 2007). The location of population growth within countries is equally important from a water supply and sanitation perspective. Rapid growth in these areas will exacerbate the impacts of poverty, high population densities and inadequate infrastructure on the transmission of disease and public health and wellbeing, particularly in peri-urban areas. The UN Population Fund predicts that we will see an unprecedented scale of urban growth over the next few decades, particularly in Africa and Asia (UNFPA, 2007).

POVERTY

Poverty deprives people of access to tenable solutions to the water and sanitation problems through lack of resources, lack of education and limited political, social and economic influence. Health (strongly influenced by access to safe water) and poverty are inextricably linked. Poor health, especially chronic illness, can force a household below the poverty threshold. This becomes self-perpetuating as a poverty-stricken household is more prone to ill health given an on-going lack of resources for living and care. Low education levels and lack of knowledge further sustain this cycle, as the understanding of links between hygiene and waterborne diseases tends to come more easily to households with higher education levels. Moreover, the uptake of behavioural changes, such as enhanced sanitation and hygiene practices, tends to take longer in poorer households (Jalan and Ravallion, 2001).

The provision of water and sanitation is one of the key mechanisms to break the cycle of poverty, particularly for women and girls. Lack of access to water usually precludes the use of latrines because water required for cleansing and/or waste disposal is an additional burden on the water collector. However, gaining access to a latrine, rather than practicing open defecation, means that there is no direct contact with faeces, an opportunity for hand washing (ash or soap) and a reduction in contamination of local water supplies. The results are significant, especially for women and girls, improving household health, reducing the time spent to collect water and providing a safe and dignified environment for practising sanitation. This means

> Income poverty and lack of education and knowledge may well constrain the potential health gains from water infrastructure improvements. The incidence of health gains need not favour children from poor families, even when facility placement is pro-poor.
>
> (Jalan and Ravallion, 2001)

Collecting river water to drink, Bangladesh ©UNICEF/HQ07-1894/S. Noorani

Shrimp fishing in sewage-infested flood waters, Haiti ©UNICEF/HQ05-1953/R. LeMoyne

that there is more time to tend to crops and livestock, more time and resources to spend on improved food preparation, more time to attend school and, an opportunity to participate in the local economy; all mechanisms which work towards breaking the cycle of poverty.

CLIMATE CHANGE

Climate change can impact human health and well-being through multiple avenues and at varying scales. Effects of climate change could include more frequent and intense rainfall events, leading to increased overland and shallow sub surface flow which can mobilize pathogens and other contaminants. Increased frequency and magnitude of flood events impacts not only availability of clean water, but chemical storage and sewage facilities, compromising quality. Sea-level rise in coastal areas will affect groundwater aquifers as well as flood low-lying areas, reducing the availability of freshwater. Alterations in temperature regimes, particularly those affecting absolute minimum and maximum temperatures, could result in changes in reproduction, survival and infectivity rates of various pathogens. Ecology will alter providing either more or less favourable habitat conditions; this could mean that areas which currently cannot support pathogens (or vectors and their hosts) may be able to do so in the future (Figure 2).

Climate change will have profound impacts on the burden of illness associated with waterborne disease. Links between weather events and waterborne illness have been identified (e.g. Aramini et al., 2000; Rose and Patz, 2001; Singh et al., 2001; Thomas et al., 2006). According to the 2007 IPCC Report, it is accepted with high confidence that water temperatures, increased precipitation intensity and longer periods of low flows will exacerbate many forms of water pollution, with impacts on ecosystems, human health and the reliability and operating costs of water systems (Kundewicz et.al., 2007). The use of water for drinking and sanitation, industry, recreation, navigation and agriculture (by far the heaviest user) is already outpacing the earth's ability to replenish it (particularly for ground water users). Increasing water stress has led, and will continue to lead, to an increase in morbidity and mortality especially amongst the populations of developing countries. For example, it is estimated that by 2030 the risk of diarrhoea will be up to 10% higher in some countries than if no climate change occurred (McMichael et.al., 2003).

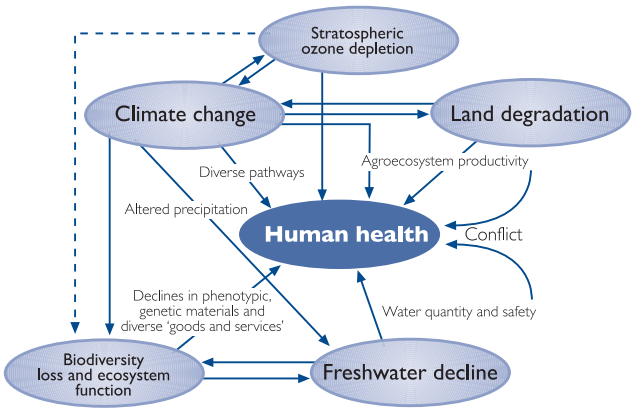

Figure 2: Interrelationships between major types of global environmental change, including climate change (McMichael et.al., 2003 p.8)

Adaptation to climate change is essentially a matter of basic public health protection. The challenges of rapid environmental, demographic and social changes all call for greater emphasis on disease prevention, providing a better balance with the current focus on curative and reactive measures. The necessary preventive actions to deal with most climate-sensitive diseases are already quite clear. Climate change and other environmental stresses should help to refocus political and financial commitments to implement these measures.

(Campbell-Lendrum et al., 2007)

Water infrastructure and management practices will be affected by climate change. The 2007 IPCC Report states with very high confidence that climate change will affect not only the function of water infrastructure, but their operation and management practices as well (Kundewicz et al., 2007). Generally, water treatment plants and distribution systems are built to withstand weather events of a given return period or probability (e.g. the 100-year flood). Under changing climate conditions, these return periods are likely to alter, increasing the likelihood of and frequency at which drinking and wastewater infrastructure systems will be overwhelmed. According to Campbell-Lendrum et al. (2007), in order to mitigate future health impacts associated with climate change and decreased availability of safe water, investments should be made now to scale up water and sanitation services and to increase point-of-use disinfection of potable water supplies.

Current public policies and governance approaches for water-health issues fall short in accounting for the effects of climate change. The additional stressors and uncertainties associated with climate change cause further concerns for the ability of governance and public policy to adequately address health issues related to water. Safe water scarcity is induced by failure in policy and poor water management (leading to urban, agricultural, human and industrial pollution), over exploitation of resources and climate change. Adaptive capacity and mitigation tools will be required in an attempt to minimize the effects of climate change in regions and countries already experiencing water-health stresses. The capacity of communities has to be enhanced in order to develop scenarios that build people's resilience to environmental change through early warning and response systems and finding alternative solutions that include political, legal and educational components.

GLOBALIZATION

Infectious and vector-borne diseases associated with water are able to span great distances in an increasingly shorter time. Not only is it easier for people, pathogens and vectors to travel, but the large number of international companies and immigrant populations around the world are increasing the requirement for, or interest in, travel of a professional and personal nature. The effective size of the world, when it comes to communicable diseases, has been shrinking rapidly over the past few decades. People can circumnavigate the globe in less than 24 hours, carrying diseases with them and exposing others even before manifestation of symptoms. Surveillance of disease has become international in scope, as evidenced by the SARS pandemic, Ebola threats and the heightened global awareness surrounding a potential influenza pandemic. As part of this increase in mobility, waterborne threats are being transported around the globe, through tanker ballast water and agricultural produce. With the advent of climate change, it is possible that introduced pathogens will be able to become endemic in altered ecologies. Even if not directly linked to health, these threats can have a devastating effect on the ecosystem, indirectly threatening water supplies.

Wading through flood waters, Kenya ©Richard Lough/IRIN

The emerging patterns of environmental refugees will contribute to the mobilisation of diseases and alter the geographic distribution and burden of illness. As a result of climate and desertification-related impacts on developing countries, an emerging pattern of local and international migration is being observed. As part of this migration pattern, these 'environmental refugees' will transport diseases to other regions where they may or may not be able to survive, potentially exposing host communities. Concurrently, people who arrive without prior exposure to regional diseases will further increase the burden of illness currently experienced at those locations. Additional stressors include cramped and inadequate living conditions, poverty etc. that are associated with the mass movement of refugees, whether as a result of conflict or natural disasters (including famine and flood).

INTERNATIONAL TRADE AND VIRTUAL WATER

The volume of virtual water that is tied up in imports and exports needs to be incorporated into national policy development and water management strategies. It is becoming increasingly apparent that large volumes of water are unaccounted for within water management structures around the world. Termed virtual water, this water is the amount used to produce items from food items to vehicles. According to the World Water Council, 1000 l of water is required to produce 1 kg of wheat. A single kilogram of beef requires 16 000 l (Waterfootprint.org). By understanding this trade in virtual water, it is possible to manage imports within an IWRM framework in order to maximise water availability for domestic purposes. Thus, if a country has water scarcity issues, it should not be trying to develop a beef export market or any other product with a large virtual water footprint. Rather, it should be exporting products with a small virtual water footprint and importing those which use significant volumes of water to produce. This will become increasingly important with the push towards biofuel production. In addition to the issues associated with food versus fuel production, there is an equally important discussion surrounding the amount of water required to produce these crops and how this affects the water budget of the region.

Fishing in oil polluted water, Nigeria ©UNICEF/HQ05-2321/M. Kamber

NATIONAL AND INTERNATIONAL POLICIES

National policies often rely on unsustainable use of water resources and provide inadequate attention to the provision of safe drinking water and sanitation. In order to ensure a cohesive approach to water and sanitation supply, it is essential to examine the issues within the context of integrated water resource management (IWRM). Policies need to include the integration of groundwater and surface water sources, source water protection and the social, political, economic and cultural systems through which water flows. Further, discussions should be evidence-based, informed by the best science available but flexible enough to incorporate new knowledge when and if it arises. It is essential to assess both the positive and negative effects of major undertakings placed on national agendas to identify potential risks. For example, hydroelectric power and irrigation projects require water storage such as large-scale dam construction. In some cases, creation of these reservoirs (e.g. Aswan dam; Three Gorges dam) has resulted in increases in cases of schistosomiasis and malaria, affecting large segments of local communities. National policies can unwittingly serve to degrade potable water supplies. One example is the Gulf Domestic Food Provision policy, designed to encourage the Gulf region to become self-reliant in the area of food production. However, this national policy has led to increased demand for irrigation and chemically assisted agricultural practices, resulting in chemical contamination, salinisation and increased pressure on limited resources (arable land and fresh water). A second example is the decision, made by the former Soviet Union, to turn the now independent country of Uzbekistan into the largest cotton producer in the world. This region – primarily desert – remains the fourth largest cotton producer in the world, at the expense of the Aral Sea and the now devastated ecosystem that surrounds it.

Political instability will affect safe water and sanitation provisioning. Turnovers, military coups or other such rapid changes in political status make it difficult to ensure sustained funding for, and comprehensive governance of, water. In the short term, emergency situations resulting from political instability lead to urgent requirements for basic humanitarian needs; at the same time, these increasing conflicts and their related reduction in security hamper efforts to provide safe water and sanitation. Over the long term these emergency measures need to be replaced with sustainable solutions. Several barriers exist for safe water and sanitation provisioning within unstable regions:

- Water and sanitation is often not high on the list of priorities
- Decisions made to allocate money to water and sanitation are not likely to be honoured, especially if another group comes to power
- The governance structures required for development of laws, policies and approaches for provisioning safe water and sanitation are likely to be dysfunctional
- Long term capital investments are not likely to be made in areas of instability, especially when returns depend on undesirable political and social forces (Purvis and Sahni, 2004).

What are the major obstacles preventing the provision of safe water?

Lack of adequate capacity and financing are the main factors preventing effective provision of water and sanitation. Capacity can be described in terms of the human, technological, infrastructural, institutional and managerial resources required at all levels from the individual through to national governance. Not only does capacity have to be built within each of these levels, but it has to be institutionalised and local communities need to be empowered to use it effectively. This becomes difficult within the fractured governance system often associated with water resources management and the provision of safe water (i.e. water for health, versus water in the environment, versus water as an economic good). To find workable solutions within finite fiscal resources, there is a need for better understanding of the costs and payoffs at all levels and for all sectors.

LACK OF CAPACITY

Greater emphasis on capacity building and its retention is needed to make sustainable improvements to global water supply and sanitation. This capacity needs to be built internally to a country and through South-South collaborations and partnerships, rather than depending on consultants from developed countries. Capacity is a flexible concept and encompasses the public sector, academia, community based organizations and the private sector, and ranges from the individual to institutions to society as a whole. Incorporated within this capacity building is:

1. The capacity to engage, educate and train; including community awareness building, adult training and formal education; so as to provide sufficient numbers of competent human resources to develop and apply enabling systems within the local environment;
2. The capacity to measure and understand aquatic systems through monitoring, applied research, technology development and forecasting, so that reliable data are used for analysis and decision-making;
3. The capacity to develop policies and programmes and to legislate, regulate and achieve compliance through effective governmental, non-governmental and private sector institutions and through efficient enforcement and community acceptance, particularly for rural areas; and,
4. The capacity to identify and provide appropriate and affordable water technologies, infrastructure, services and products through sustained research, investment and management.

Buildign leach pit latrines, India ©UNICEF/HQ05-0765/P. Bagla

COMMUNITY CAPACITY AND ENGAGEMENT

Engagement of local people is essential to finding sustainable solutions and increasing the chances of long-term success. It is essential to give citizens awareness of and autonomy for creating their own favourable conditions within the community. Communication, within the context of cultural and societal norms, as well the involvement of key, or influential, people within the community, and the integration of local institutions and organizations are critical. A strong focus on the participation of women has further been demonstrated to improve the success of project outcomes (Chattopadhyay and Duflo, 2004).

Community capacity has to involve management of water supplies through infrastructure improvements, training and enhancement of overall know-how. It is important to revive indigenous capacities and knowledge, perhaps augmenting, updating or integrating with current scientific knowledge. Inter-personal relations have to be enhanced to cope with risks, life skills and self-esteem. Methods, approaches, data requirements and minimum knowledge requirements have to be defined for both water and health professionals. Train-the-trainer programmes can be used effectively to enhance local capacity, strengthen retention and provide peer-to-peer training that is sensitive to social and cultural frameworks. Incentives

Private tankers fill up with raw river water for sale, Angola ©Jaspreet Kindra/IRIN

such as opportunities for promotion, greater responsibilities or enhanced standing in the community can all be effective, not only for participation, but for retention of capacity once established. Additional capacity building and retention practices include diplomas, certification courses and curriculum credits for continuing education, which further serve to enhance dissemination of current and emerging knowledge, especially to the front-line.

Education, and the engagement of academic institutions, is a critical factor in achieving success.
Schools are cornerstones for education within the community. By emphasizing the importance of responsibility for their own health and links between residential actions and environmental effects to children, the uptake of new practices is disseminated into both the household and the community as a whole. In general, educating individuals can have the additional advantage of reducing the number of stressors that they face, resulting in improved health. Moreover, there are benefits accrued from the more rapid uptake, and enhanced health benefits, of water and sanitation solutions that are associated with increased education and awareness. There is a need to create local centres with a knowledge-based and innovative approach to training that ensures availability to and appropriateness for operators in small, remote communities and which address both long and short-term needs. In addition to training, opportunities exist to provide technology demonstrations, operation and maintenance support, education and outreach, advice for governments on research and development priorities, scholarships to Universities and partnerships with research groups.

Solar desalination, Egypt: Courtesy of T. Schaff, UNESCO

Risk communication is essential, particularly as the provision of safe drinking water and sanitation requires community participation and possible behavioural changes outside social and cultural norms.
Risk assessment tools are the basis for risk communication, but without a risk management plan in place, the information gathered serves no practical purpose. These tools have to be coupled with risk management approaches, including technological, regulatory and incentive-based, and must differentiate between acute and chronic health effects. Early warning and response tools and emergency planning can form a significant part of any plan and community engagement and knowledge dissemination in conjunction with interventions provide successful solutions through empowerment and ownership. However, these solutions must be reliable, affordable, robust, appropriate and comprehensive and must be developed in line with policies and effective implementation plans. Opportunities may exist to strengthen the local private sector through micro-industries to supply parts and maintenance. Other options include outsourcing to the private sector, but first it has to be ascertained whether this is an affordable and viable option. Linking renewable energy supplies to water and sanitation provides an additional dimension to improving the economic and social wellbeing of a community.

TECHNOLOGICAL CAPACITY

Innovative technologies are essential to overcome barriers to water and sanitation service provision.
Technological capacity includes the development and application of new technologies; the knowledge to effectively construct, operate and manage a technical solution; the translation of information regarding technologies to promote informed decision-making when implementing a technical solution; and the capacity to undertake data collection for monitoring and evaluation purposes, develop database architecture and establish the infrastructure. However, technology providers need a better understanding of local conditions and policies.

INSTITUTIONAL CAPACITY

There is a need for institutions that bring together many disciplines, such as the natural sciences, public health, engineering and the social sciences. Integration and interaction between institutions and different sectors of the population, at decision-making, executive and participative levels, is required to plan and execute actions in a coordinated way. This integration is the basis for multi-sectoral approaches to ensure that planned goals are achieved and actions converge to solve environmental, water and health problems. In this respect, key influential people brought in as partners from the various levels are more likely to form an active group that will sustain a project beyond its initial stages. Knowledge translation, synthesis and exchange underpin this approach, particularly as emerging risks associated with changing land use, climate change, pathogens, disinfection by-products and chemicals will continue to make provision of safe water a scientific challenge and a public priority.

Increased networking capacity is required for exchanging knowledge and creating conditions for innovation. Knowledge translation, transformation, synthesis and exchange, in association with a global platform to provide products to as broad an audience as possible, can provide a basis for informed decision-making and technological advances to fill gaps. At the practical level, demonstration and pilot projects provide examples of success and application of innovations (including governance, institutional, and technological). However, knowledge transfer is a challenge for the academic community, requiring novel ways to engage various aspects of the population. To this end, new academics need to be recruited and trained to better meet the needs of the future.

UNU-INWEH WVLC certification in IWRM: Courtesy of the Asian Institute of Technology

INADEQUATE FINANCING

A lack of global investment in water and sanitation has put the attainment of the MDGs in serious jeopardy. Historically, water and sanitation has suffered from severe under financing. This results from: a lack of internal financial capacity in the poorest of countries to achieve water and sanitation goals; poor political decisions for allocation of development aid; an overall reduction over time in development aid; and the limited cost-recovery potential in poverty-stricken regions. In addition, poor targeting of aid and a multiplicity of actors and structures compound the financial shortfall. Prioritisation of spending plays a key role, with many developing countries investing only a small fraction of money into water compared with military spending. For example, military spending in Ethiopia is 10 times greater than that spent on water and sanitation and in Pakistan the discrepancy is even greater – 47 times (UNDP, 2006). To ensure that resources for safe water and sanitation are used effectively at the local level, the local capacities to design, finance and manage improved service delivery must be greatly enhanced. To this end, the Camdessus Panel and others have urged that corruption, managerial capacity, sustainable cost recovery and legal and contractual aspects of safe water and sanitation management within developing countries be addressed.

Financing models need to move beyond traditional approaches towards innovative strategies. However, in order to facilitate this, there needs to be a supportive legal framework and governance structure in place.

Alternate financing solutions are available to overcome the current status quo. Enhancing the status of the water and sanitation sector in order to increase aid is key. Additionally, financing models need to move beyond traditional approaches (bilateral and multilateral aid agreements, international NGOs and banks, public development aid, tariffs on the user and local taxes) towards innovative strategies, such as the International Finance Facility (DFID, 2004) or an G20 led initiative (Daley et al., 2004), partial credit guarantees, output based aid and Public-Private Partnerships (PPPs). However, as identified in the Camdessus report (Wilpenny, 2003), in order to attract greater and novel financing, there needs to be a supportive legal framework in place. Specifics of this framework include corporate laws for structuring corporate vehicles; investment protection laws; sector specific regulation; and better protection for freedom of contract and PPPs (Wilpenny, 2003). An example of a new global finance initiative within the water and sanitation sector is the Water and Sanitation Sector Collaborative Council's (WSSCC) Global Sanitation Fund (http://www.wsscc.org/en/what-we-do/global-sanitation-fund/index.htm), launched in 2008 as part of the International Year of Sanitation. The fund is a single entity

The most critical challenge for financing of SDS is the scale and continuity of investment. Whatever financing mechanisms are used – taxation at the local and national levels, user charges, cross-subsidies, private investment or targeted ODA and FDI – a very large absolute increase in funding is essential, at least to the levels agreed in the Monterrey Consensus, or beyond, if deemed necessary.

(Daley et al., 2004)

that welcomes contributions from any sector. The funds are allocated to executing agencies in select countries who then grant the funds to groups to implement the specific hygiene and sanitation programmes for that country.

Strong economic returns should influence national spending proportions and priorities. Epidemiological studies and economic data show the financial benefit of preventative measures for water related diseases, and the costs to society of not preventing the diseases, identifying direct and indirect benefits along with tangible and intangible cost savings. Recent studies suggest a return of between US$3 and 34 for every dollar invested (Hutton and Bartram, 2008). Using these data, policy makers can more easily justify these actions and better prioritize action and areas of deficiencies as well as justify decisions in relocating needed resources for the provision of safe water and improved sanitation. For example, in the case of Honduras, water and sanitation for everyone is fiscally attainable, but in practice, this requires changes in priorities and policy within the water sector itself. However, the development of these data is a major challenge, as they are costly, there is a lack of technical capacity to perform the studies and, in order to make the economic evaluations needed by policy makers, capacity building and tool development are required. Success stories do exist, such as the Bangladesh National Sanitation Strategy (People's Republic of Bangladesh, 2005) which allocates 20% of the Annual Development Programme fund to improve sanitation coverage. Of the funds allocated, 25% are for promotional activities to raise awareness and educate people. Another 20% of the Annual Development Programme fund is given to urban sanitation.

Investment in water infrastructure and services can, and should, serve as a catalyst for economic activity and development. The consequences of action need to be measured in terms of health outcomes, economy, environment and broader impacts on the community. Economic benefits accrue from less time spent on water collection and reduced illness in the community, resulting in greater attendance at school and increased productivity. The funds to supply these services, particularly in low-income countries, need to be rendered by the developed world although political, institutional, financial constraints and technical challenges all impede service delivery. However, the international community can successfully overcome the political and institutional challenges through their combined leadership and by capitalizing on their comparative advantages as a group. It is estimated that an investment of US$0.04 per capita per day from developed countries would enable the attainment of the water and sanitation MDGs (Daley et al., 2004).

The private sector and public-private sector partnerships (PPPs) represent a potential resource for achieving the MDGs for water and sanitation. Success stories, such as that of Argentina, estimate that child mortality fell by an average of 5-7%, up to a maximum 24% in poorest areas with private sector intervention (Galiani et al., 2005). The private sector is generally less risk-averse than governments in supporting the application of new technologies for sanitation services and, by virtue of cost efficiencies, vested interest and greater fiscal resources, may provide more timely up-keeping. Given adequate monitoring and proper regulation, this would be advantageous, particularly for operation and maintenance. However, ownership of the system infrastructure and the role of the sector in service provision must be clear, with transparent disclosure of the full cost (including maintenance). Micro-financing is another option to provide small communities with the resources to establish water supply and sanitation systems, but they need to be monitored to ensure that appropriate technologies are being funded in a sustainable manner. Privatization is not always a success story. In order for successful and sustainable partnerships to be established, there are often social barriers to overcome. In Bolivia, privatization of water delivery resulted in two public uprisings to protest, inter alia, water rights and large and rapid spikes in water prices in key cities.

Promotion of private sector participation has to be in conjunction with the establishment of social policy responses. Private companies work on a profit-making basis. While this can have advantages because charging for a service means that only people willing to make behavioural changes will become involved, there is a need to have a mechanism for poor households to still become engaged and to access water and sanitation, even if it is delivered privately. Thus PPPs can only exist within an institutional framework that includes social policies and mechanisms for regulation and accountability.

How can countries best integrate the management of health and water?

INTEGRATE DISCIPLINES

Cohesive programmes are required for protecting watersheds and ecosystems, protecting public health and ensuring a sustainable water infrastructure.
Challenges and opportunities exist in rethinking the determinants of health and disease linked to water and the environment; in reflecting and re-evaluating how we find and learn from precedents and success stories; and in how we re-train and re-educate the practitioners and researchers who will work at the water-health nexus. Research into methods for integration, application and engagement will help to bridge the information gaps. This type of holistic and integrative approach incorporates both disease eradication and human well-being as part of the same eco-hydro-social-health cycle and facilitates examination and prioritisation of health risks. The most promising interventions reduce pressures, harness/recreate ecosystem processes and enhance the carrying capacity of ecosystems. Although integrated water resources management (IWRM) attempts to integrate all of the aspects of good water management, including economic, technical, biological, physical, human health, social, hydrological and governance components, it has proven difficult to accomplish this in practice. Historically, the emphasis on technical aspects within this extremely complex system has been at the expense of investigations into the hydro-social and public health components.

Challenges to implementing an integrated approach can be overcome by stepping outside traditional roles and applying a combination of quantitative and qualitative methods in a creative manner.
Conceptual challenges to the practical implementation of integration include an anthropocentric approach to the assessment of natural resources, the need to understand and explain current patterns that exist, the asymmetry of power and access to resources and the lack of absolute values that are likely to come out of future research as a result of complexity and uncertainty (Parkes, 2006). The paradigm requires transdisciplinary approaches to investigate problems and find solutions that expect scientists and policy makers to step outside their traditional silos. Dialogue is required to explore `perspectives, theories and methodologies emerging at the interface between ecological and health sciences` (Wilcox et al., 2004:3). Furthermore, the research has to be community based and participatory, as many of the complexities can be invisible outside the community (Bopp and Bopp, 2004). External experts become coaches of a community team, identifying and facilitating procurement of what they need to have, what they need to know, what they need to do and what they need to be (Bopp and Bopp, 2004).

BROADEN THE DEFINITION OF HEALTH

Health is more than simply the absence of disease. In fact, WHO (1986) defines health as a resource for everyday living that allows us to cope with, manage and even change our environments. This broader definition of health requires an equally broad view of its determinants, including not only biology and genetics but socioeconomic status, lifestyle behaviours, culture, etc. While these broader notions of health are well recognized by policy makers, their principles are much harder to implement on the ground, primarily due to sectoral barriers and bureaucratic inertia. The way forward therefore requires a multi-sectoral policy development strategy that encompasses all key stakeholders, at all levels. Moreover, it must address human security, basic requirements for good life, good social relations and freedom of choice and action, in addition to health (Corvalan et al., 2005).

EcoHealth: Examines the impact of environmental factors on health and well-being in order to identify opportunities to reduce associated human morbidity and mortality

EcoHydrology: Explores options for sustainable development of water resources that maintain essential ecosystem processes and services

Hydrosocial: An approach that includes not only the understanding of the hydrologic system, but also the social, political, cultural and economic systems that govern the flow of water through societies

Drainage canal contaminated with raw sewage, Jamaica ©UNICEF/HQ08-0268/S. Markisz

Humanity has always depended on the services provided by the biosphere and its ecosystems. Water management without regard for the ecosystem unit is set up for failure from the outset, as all aspects of ecosystem health have to be addressed to maintain equilibrium within the system. Given the significant and ever-increasing demand for services, ecosystems are being changed to alter the provisioning ratios (e.g. converting forest to agricultural land). In many cases, this contributes to degradation of ecosystems, further reducing the capacity to provide the services that we depend upon. The resulting burden is disproportionately held by rural communities, especially those who are impoverished. Further, environmental/water conservation and good use by local people will depend on their objective living conditions and the capacity to meet their basic immediate material needs (e.g. if a family cannot afford to purchase fuel, they will harvest local materials for their needs). As identified by Corvalan et al. (2005), allowing the continuation of ecosystem degradation is preventing achievement of the MDGs.

INCORPORATE INTO POLICY DEVELOPMENT

Integrated water policies are preferable to isolated policies which focus on a single issue. In light of the numerous and complicated stressors known to be affecting health, how do we make policy decisions that result in the best overall health for people? Policies need to reflect the ubiquitous nature of, and competing uses for, water and incorporate drinking water supply, sanitation requirements, industrial effluent management, urban and agricultural runoff, ecosystem habitat, urban/industrial/agricultural water requirements and public health simultaneously. The urgency and scale of issues should be key determinants in developing a strategy to deal with multiple health issues. Through knowledge synthesis, transdisciplinary approaches and stakeholder participation and concensus, ecohealth research goes a long way to developing policy (Lebel, 2004).

Policymakers must understand the importance of conserving and maintaining safe and secure water for ecosystem and human health needs. It is not simply a question of access to resources, but the prioritisation of resource allocation. Decisions need to be situation specific and require effective education and communication between the affected people and policy makers.

The policy framework required must prioritise water use and extraction and establish public health structures, effective governance, social policies and legal arrangements. Institutional arrangements have to be well defined, with explicit roles for training, oversight and monitoring. The whole system has to be transparent and accountable -- backed up by databases of information, best management principles, manuals for tried and true technologies, integrated, multidisciplinary, international demonstration projects, and networks (research, communication, knowledge dissemination etc.). Cost-recovery is fundamental to sustainable water and sanitation systems, but alternatives have to be in place for those who cannot afford the costs.

RE-EVALUATE MONITORING AND DATA COLLECTION

Data must provide the foundation for management, policy decisions and interventions. Without a scientific basis, it is impossible to make informed decisions. However, capacity and fiscal constraints often make routine standardised and spatially distributed monitoring difficult. Even if data are systematically collected, centralised access to resultant databases -- especially in developing countries -- can still be problematic. An important point to address when developing these data collection systems is that they need to be geared towards intervention and policy development and incorporate practical indicators for evaluation purposes. Further, a mechanism is required that translates data into knowledge and which leads to ideas for mobilising action.

Standardised and centralised data collection is key to understanding global issues. Effective and reliable global mechanisms to foster co-ordination and monitor progress have to be established. Once the data collection framework has been developed and implemented, a need exists for centralised, standardised and accessible databases that are collected and shared at an appropriate level. These databases require capacity in terms of hardware, software and human expertise, all of which need to be developed locally and provided for financially. An immediate benefit is to facilitate assessment of current status, further providing a link between science and policy.

How can we best articulate the political significance of water and sanitation?

COMMUNITY AND MEDIA MOBILISATION

The mobilisation of global public opinion can lead to action at national and global levels. Networking technologies can create linkages and promote awareness of global issues surrounding water. The processes through which this is undertaken have to be participatory and create a sense of belonging and identity. In particular, youth should be engaged to develop their own ways of creating and sustaining wealth and employment through addressing global problems, developing solutions and informing key policy decisions that affect their future. At the community level, incentives can be created for private actions and behaviours at the household level that lead to a public good in terms of sanitation and hygiene. Scientists should play a key role at the community level by involving community members in the development of research activities targeting their problems.

POLICY LINKAGES

A better understanding of the functions and connections of natural and social systems has to be achieved. In order to optimize investments and the resultant benefits, a strategy is required which takes the natural distribution of water and the potential implications of climate change into account. Generally, a broader approach is required to include water-health perspectives into plans and activities to address the significant challenge of meeting the MDGs and improving the quality of life of people around the globe. Actions required to meet these goals include provision of water supply, sanitation and treatment infrastructure as well as promotion and education of proper hygiene and integrated water resource management. Policy and legal frameworks that fit within this context need to be developed at the national and international level.

Demonstrating water treatment supplies, Indonesia ©UNICEF/HQ06-1855/J. Estey

Global targets need to be translated into realistic, operational and politically acceptable targets at the national and sub-national levels. These specific targets can be used to empower and involve society at the lowest appropriate level. Attention has to be focused on the countries, populations and groups within society that are most vulnerable and where the problems are the worst, which are often those in remote, rural or peri-urban areas. Currently, this is not the case and there needs to be some thought about why and how to fix it, especially as the provision of rural services such as improvements on traditional practices, pit latrines, etc. are quite low cost compared to the more advanced urban requirements. A focus on service delivery (accomplished through simple propositions and policy applications) instead of infrastructure, will result in more sustained and reliable benefits. Additionally, there is a need for reforms in the health sector, examining efficiency of service provision and shifting emphasis to public health promotion and prevention, as most of the factors that affect health are outside of the scope of traditional health care provided to individuals.

Washing dishes beside a hanging latrine, Bangladesh ©UNICEF/HQ06-2701/S. Noorani

Making a cement slab for a latrine, Zambia ©UNICEF/HQ98-0928/G. Pirozzi

ALTERNATIVE GOVERNANCE MODELS

Current international frameworks have not demonstrated sufficient flexibility and co-operation to effectively and efficiently meet the global water and sanitation requirements. Historically, the provision of water and sanitation has been hindered not only by human, technological and financial barriers, but by the inflexibility of international institutional and governance frameworks and a lack of political will (e.g. Wilpenny, 2003; Daley et al., 2004). For example, within the UN system, there are more than 23 organizations with a mandate for working on water issues. An inter-agency group, called UN-Water, has been striving to reduce redundancy and improve harmonization of actions. The Camdessus report calls for an "unprecedented effort to reform the way the entire world tackles its water problem. This concerns those at all levels of responsibility, from village communities up to the United Nations" (Wilpenny, 2003:v). Specifically, greater transparency, responsibility and decentralisation are needed, with greater co-operation and less abdication from responsibilities.

> Changes in institutional and... governance frameworks are sometimes required in order to create enabling conditions for effective management...; in other cases, existing institutions could meet these needs but face significant barriers.
>
> (Corvalan et al., 2005)

The G20 group of developed and developing countries is uniquely positioned to meet water and sanitation provisioning goals. The G20 consists of a broad membership of economic ministers that encompasses both affluent and rapidly-developing nations. Member countries of the G20 group account for approximately 70% of the global population without adequate sanitation and 55% of the global population without safe drinking water. As such, the G20 could capitalise on its significant political, economic, scientific and technological capacities to leverage support from other international groups and to provide an alternate delivery model for solving the global water and sanitation crisis. Some argue that elevating the G20 forum to heads-of-state would provide the much needed impetus to solve the global water and sanitation crisis.

> Member countries of the G20 group account for approximately 70% of the global population without adequate sanitation and 55% of the global population without safe drinking water. As such, the G20 could capitalise on its significant political, economic, scientific and technological capacities to leverage support from other international groups and to provide an alternate delivery model for solving the global water and sanitation crisis.

Which research questions are essential, but unanswered globally?

Scientists must increase their efforts to integrate key elements of knowledge and technology within the context of safe water and sanitation in order to improve human health and well-being. What can social, heath, physical and other scientists bring to the table? They can help integrate knowledge to conserve natural systems, manage water properly, and protect and promote human health. Research activities in the areas of new technologies for information dissemination; economic evaluations and assessments of water treatment and sanitation technology deployments; integrated risk assessments; capacity needs assessments; and models for the engagement and investment of the private sector will be required to underpin these activities. Research has to be multidisciplinary and scientists need to integrate their disciplines to better serve the emerging needs. The United Nations has a unique role to play given its global outlook, international networks, resources and access to governments around the world. In particular, the UNU can be a significant mobiliser and facilitator, considering its proven track record of leveraging additional resources, creating awareness, encouraging research and assessment, guiding policy development and establishing monitoring programmes.

Social scientists, heath scientists, physical scientists and others can help integrate knowledge to conserve natural systems, manage water properly, and protect and promote human health.

RESEARCH GAPS

A common lexicon around water and health is needed to identify what is safe, what is adequate, what is accessible, what is appropriate and what is affordable. In order to assess progression towards water and sanitation goals, it is important to have working definitions of what is safe, adequate, accessible and affordable. These definitions will vary spatially, depending on a variety of factors including population density, culture and socio-economics. The JMP (2006) has defined improved versus unimproved water and sanitation services and has broken down other indicators into categories, such as how long it takes to fetch water. However, there is no indication of which of these are acceptable; the indicators are used for comparative purposes to identify improvements, rather than to identify whether a country, region or community has reached minimum standards.

A toolbox of alternative approaches and technologies for rural, peri-urban and urban environments will help to identify options and inform choices. A comprehensive, widely accessible knowledgebase of approaches and technologies for geographic, social and cultural environments is needed to identify options and inform choices. This learning network further needs to incorporate a mechanism to assess and collect information to support prioritisation actions to fill gaps. It is important to capitalise on advances that have been made in communication technologies to provide global access to a dynamic and evolving system. A virtual library and database of educational materials, technologies, governance, models, etc. made available in a variety of languages would facilitate information exchange of both established and innovative tools.

Current research projects based in river basins around the world should be expanded to incorporate and emphasise the hydro-social system, especially with respect to human health. There are many existing investigations of river basins and other water bodies and it should be possible to build upon current work by adding the health component. Basins of interest would exhibit diverse ecosystems and governance structures. Furthermore, aspects of human health and the hydro-social system should become an integral component of future river basin-based research.

An assessment of the current global status of water-related health requires maps of global water quality and water-related health hazards. Given the many locations within the GEMS database for which both water quality and quantity data are now available, the development of Global Water Quality Indices (GWQI) is a major priority. Specifically, the development of indices to assess Drinking Water Quality (Rickwood and Carr, 2007), aquatic biodiversity (CBD) and general water quality (EPI) (Esty et al., 2008) are currently in

Children playing in flood water, Somalia ©Manoocher Deghati/IRIN

Key requirements to improving human health and well-being within the context of safe water include:

A common lexicon to identify what is safe, what is adequate, what is accessible, what is appropriate and what is affordable

A safe water toolbox of alternative approaches and technologies for safe water provisioning in rural, peri-urban and urban environments to help identify options and inform choices

A globally accessible platform that provides visual representation of vulnerability to specific diseases and water-related hazards to inform and to empower all levels of civil society

progress. These indices will help to identify temporal trends and spatial patterns for the targeted studies and intervention purposes. Combining this with a vulnerability map for water-associated diseases can form the basis for evidence-based policy development.

We need greater investment in the policy tools to help identify the most vulnerable people and communities. Data-driven models that can link provision of water and sanitation to human health and well-being are critically needed. Significant collaboration is required worldwide to bring scientific consensus around these tools. Specifically, epidemiological models that link diseases to water and sanitation services and which can be applied to predict and prioritize interventions are required, as are risk assessment models that can establish the nature and relative importance of competing risks within a watershed (e.g. microbial versus chemical contamination). Other models may include those linking the hydro-social system to specific water-related illnesses and models that will predict the impact of climate change on water and wastewater infrastructure. Ideally, these models would be based within the watershed context for an holistic, multidisciplinary approach. This can be used to inform policy and decision makers in the areas of application by providing them with a comprehensive understanding of the problem and its possible solutions. There is a further need for a globally accessible platform that provides visual representation of vulnerability to specific diseases and water-related hazards to inform and to empower all levels of civil society.

We need to develop effective approaches for adaption to, and mitigation of, impacts on human health from climate change. Validated models need to be developed that will predict the impact of climate change on water and wastewater infrastructure, water availability, water quality and waterborne / water-associated diseases in order to identify the effect of climate change on the distribution of vulnerability to water-related illnesses. The results can be used for policy development, intervention, adaptation and mitigation purposes as well as the effect on achieving MDGs and global migration patterns.

Alternative mechanisms for finding financial capital and requisite enabling policies need to be identified. Challenges to be overcome include identifying new capital, minimising risk for potential investors, creating livelihood opportunities for the absolute poor and correctly accounting for the local willingness to pay. Policies that promote private investment, while securing public interest, need to be identified within the context of local culture, governance processes and economic conditions.

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Acronyms

CBD	Convention on Biological Diversity
EPI	Environmental Performance Index
G20	Finance Ministers and Central Bank Governors of industrial and emerging-market economies
GEMS	Global Environmental Monitoring System
GWQI	Global Water Quality Index
HIC	High Income Countries
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Network, UN Office for the Coordination of Humanitarian Affairs
IWMI	International Water Management Institute
JMP	Joint Monitoring Programme
IWRM	Integrated Water Resources Management
LMIC	Low and Middle Income Countries
MDG	Millennium Development Goal
NGO	Non-Governmental Organization
PPP	Public Private Partnership
SDS	Safe Drinking Water and Sanitation
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFPA	United Nations Population Fund
UNU	United Nations University
UNU-INWEH	United Nations University International Network on Water, Environment and Health
WHO	World Health Organization
WSSCC	Water and Sanitation Sector Collaborative Council
WVLC	Water Virtual Learning Centre (UNU-INWEH and UNDESA)

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