WATER-RELATED ISSUES AND PROBLEMS
OF THE HUMID TROPICS
AND OTHER WARM HUMID REGIONS

IHP HUMID TROPICS PROGRAMME SERIES NO.3

WATER AND HEALTH

UNESCO

INTERNATIONAL HYDROLOGICAL
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PROGRAMME

HOW IMPORTANT IS WATER FOR HEALTH IN THE TROPICS?

Whereas in dire circumstances one can survive on as little as two litres of water a day, the minimum amount of water for cooking and personal hygiene is estimated to be 20 litres per person per day. Yet, where agriculture is industrialized, the actual use shoots up to between 400 to 500 litres per person... a dream for most developing countries where rural communities have no access to piped water. There, they commonly have to use raw water from nearby sources for drinking, cooking, animals and a number of other activities.

Water resources are clearly a major problem for sustaining life. In all civilizations, water has been considered THE source of life. Two decades ago, in 1972, the U.N. Conference on the Human Environment focused worldwide attention on the environmental hazards that threatened human beings. Since then, much of the discussion on health and environmental issues has been devoted to better protection, management and distribution of water resources.

Since the International Water Supply and Sanitation Decade ("The Water Decade"), it has been estimated that 1200 million people are still without safe drinking water, and that about 1900 million remain without access to sanitation. Water-borne diseases are the main cause of 14.6 million deaths annually in developing countries of children under the age of five; out of these 3.6 to 4 million are diarrhoea-related. The adult population too, suffers heavily in mortality and morbidity from the same diseases. And the demand for water accelerates every year. Water is necessary for the sustenance of life. But, is the water cycle on our planet sufficient to provide us with safe water ?

Are there special risks in the tropics?

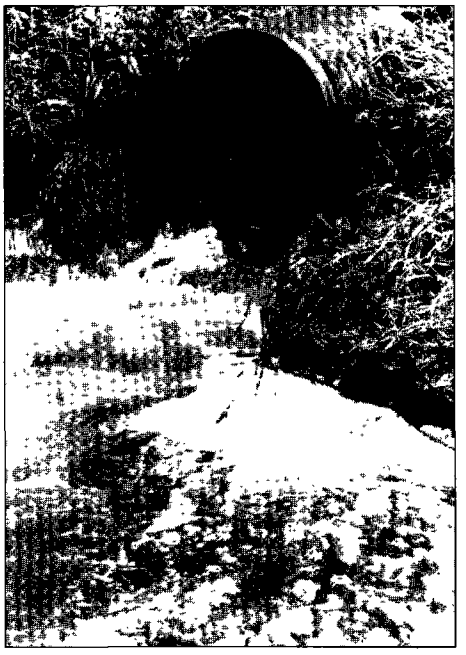
The warm humid regions are made up mostly of developing countries. In these countries, 50 per cent of the people still have 'no reasonable' access to a safe water supply and approximately 75 per cent have inadequate sanitation facilities. In 1988 it was estimated that one billion people in developing countries (China and India excluded) did not have 'ready access' – that is within a 15-minute walk – to potable water. Not surprisingly, of more than 250 million new cases of water-associated diseases reported yearly, 75 per cent occur in tropical areas.

The population living in the humid tropics will more than double between 1980 and the year 2000. It is estimated that it will then amount to about one-third of the world population of about 6.5 billion. Considering such figures and the increasing effects of pollution, the yearly toll generated by unsafe water in these regions will be terrifying if rapid and drastic prevention measures are not rapidly applied.

Urban population served with water (percentage)

	Served	Not served
High income countries	100	0
Upper middle income countries	90	10
Lower middle income countries	77	23
China and India	69	31
Low income countries	65	35
World total	86	14

Source: Prost, A. 1989.



Water carries a wide range of various infective agents that can be deadly pathogens either directly or acting as vectors. Unfortunately, sanitation equipment is not easily affordable in these regions where poverty prevails, nor is the sanitation concept understood or readily acceptable by many of the people. Ancient local habits and cultures are adaptations made throughout centuries to almost unchanging environmental conditions. These no longer prevail. Rapid population growth and urbanization, among other factors, are such that they have overtaxed ancestral habits. But, it takes time for individuals, facing a shock that is both cultural and environmental, to keep up with the pace of such a rapid and radical change that is sometimes completely reshaping their standards and values.

Besides and not least, microbial contamination is unpredictable in humid tropical countries. The movement of microbial pathogens through soil in tropical areas is an unknown factor. As it is for a number of other sectors in many developing countries, policy makers and planners are hampered by a lack of up-to-date, reliable and comprehensive data. Too often, therefore, a decision-maker is still forced to rely on assumptions and guesswork, like the captain of a ship sailing the seas with no compass or, in the best cases, with a faulty one.

The countries with the lowest income are mostly situated between the two Tropics latitudes. Not surprisingly, they also have the lowest level of water management and service coverage. Hence their populations are the most susceptible to water-related diseases. Tropical countries with good service coverage are all small countries such as Brunei, Costa Rica, Hong Kong, Singapore, and Trinidad and Tobago.

Considering that rural populations also generally have a lower education level, they have limited access to either the knowledge or the know-how that would help them to improve their situation. Moreover, because decision-makers usually belong to the more modern and wealthier segment of the society and are more sensitive to the needs of the social category they belong to, rural populations of the tropical areas also suffer from a lack of strong political backing.

In most countries of tropical regions, too, the financial resources are insufficient to meet all the demands put on them.

Another challenge: population growth

Tropical countries also have to face another challenge. Between 1980 and 1985, the annual average population growth rate was 1.9 per cent in the low income group of countries, and 2.3 per cent in the middle income group.

It is estimated that it will reach respectively 1.9 per cent and 2.1 per cent between 1985 and 2000. Hence, for this period of 15 years alone, about 55 million additional people per year will need to be provided with water and sanitation services. It is difficult to keep up with the increase in additional water services and sanitation coverage to match the pace of population growth. This explains why the International Drinking Water Supply and Sanitation Decade could give the impression of having been a partial failure.

Population growth led a number of developing countries to trim their plans. Almost none of them is now looking for an achievement of the 100 per cent coverage target originally planned, even in urban areas.

Access to water supply services: world population coverage

	Total population (millions)			Population served (millions)			Percentage of total population		
per capita income categories	urban	rural	total	urban	rural	total	urban	rural	total
High income (over $ 5000) 37 countries	807	283	1090	806	280	1086	100	99	100
Upper middle income ($ 1800 to 5000) 24 countries	347	196	543	312	125	437	90	64	80
Lower middle income ($ 500 to 1800) 46 countries	282	444	725	218	200	418	77	45	58
China and India ($ 300)	427	1408	1835	295	858	1153	69	61	63
Low income (less than $ 500) 42 countries	144	518	662	93	168	261	65	32	39
TOTAL 151 countries	2007	2849	4855	1724	1631	3355	86	57	69

The table does not include countries and territories with a population of less than 0.1 million. Also are excluded: South Africa, Namibia, Comoros, Equatorial Guinea, Cambodia, Macau and Taiwan for which no data are available (total population excluded is about 55 million).

Source: Prost, A .1989.

Population growth so much offsets the progress made that no more than 15 per cent of these countries can foresee the completion of rural coverage. Unless the international community makes a substantial investment, there is little prospect that the situation will rapidly improve.

Universal safe water coverage: the year 2000's challenge

Another factor that may reduce the impact of health intervention is that bringing water to households is not sufficient to guarantee community health. It was mentioned earlier that more than one billion people in the developing countries have no ready access to safe and sufficient water. But about twice this number are without adequate sanitation. The situation is even worse in the urban slums currently mushrooming on the outskirts of Third World cities. Universal coverage in the foreseeable future is a formidable challenge. Can it be achieved under the current conditions ?

It is the responsibility of both the scientific community and the people themselves to help managers take the right decisions so as to control the threats to human health and to find ways to make the very best of the most humble resources.

Controlling the enormous toll of water-associated diseases is of economic importance, no doubt, but it is equally a moral duty to diminish the sufferings they cause.

MANAGING TROPICAL WATERS FOR HEALTH

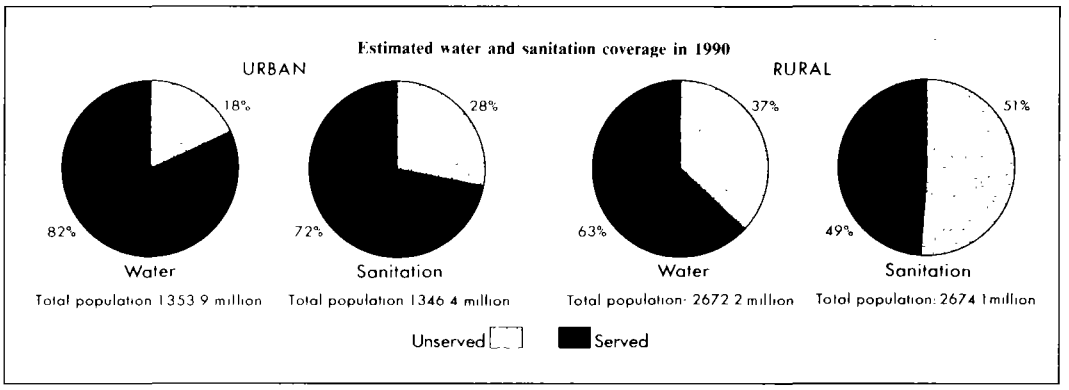
Almost everywhere rivers and lakes are being contaminated by chemicals (from industries, municipal sewage discharges, agriculture, etc.). Consequently, water is becoming unfit for human consumption unless it is treated. Much the same applies to its use for irrigation, aquatic life and industrial purposes. Groundwater is often under-utilized in the humid tropics because rainwater and surface water are normally abundant. Yet, its use may be growing. Consequently, its protection is a factor that will become increasingly important in the future. As has been observed: "ground-water contamination by pesticides presently rampant in developed countries, including locations in humid tropics like Hawaii and Florida should be a lesson for developing contries" (*Lau and Mink, 1986*).

General information is usually well documented for many of the surface waters of the humid tropics in Africa, Central America, the Caribbean Islands, South America and the Pacific. However, there are still too few ground-water experts to have permitted sufficient attention to be devoted to specific ground-water investigations in these regions. From 1962 to 1977, 76 per cent of the U.N. ground-water exploration and development programmes in developing countries were devoted to regions outside the humid tropics (*U.N., 1979*). Not surprisingly, there is still an almost complete lack of data and information for many regions, particularly where surface water is abundant. The Amazon basin is a striking example.

Local standards are needed

The natural phenomena that control the physical, chemical and microbiological quality of the surface water are basically the same in the humid tropics as in temperate climate regions. Standards relate the quality of water to the use. They are related to the preservation of health, to the protection of human activites (e.g. salinity of irrigation waters), or to general personal comfort. They are people-oriented and therefore universal. But while they are theoretically the same in all regions, irrespective of the chemical processes that occur naturally in water, it is difficult to expect that microbiological water quality standards in the humid tropic regions would be held as strictly as they are in the temperate ones. Why not?

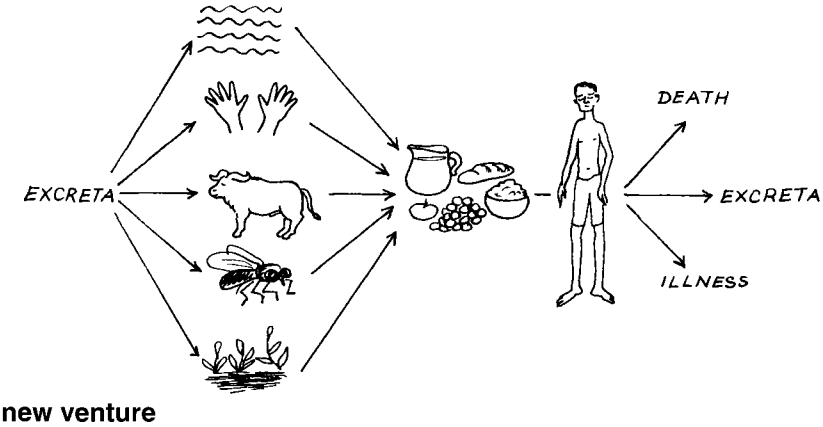
At first glance, this might be understood as being due to the greater lack of adequate sewage treatment that obliges people to rely on untreated and, consequently, contaminated waters as drinking water sources. Yet, things are not so simple.



In this part of the globe, solar energy has a higher intensity and a more seasonally uniform impact on surface waters. The action of photosynthesis also imparts more turbidity to the surface waters. The heat and the turbidity create ideal environmental conditions for the rapid growth and proliferation of a large variety of organisms, among which are pathogenic bacteria. They create a permanent threat to the populations' health and a heavy burden on the public health services of developing countries which often believe themselves to be too economically hampered to easily afford extensive systems and sewage treatment plants.

Eutrophication: food chain at risk

In some cases, when lakes and reservoirs are located in areas of high urbanized concentration and used for discharging human wastes and other domestic wastewaters, the eutrophication due to the climatic conditions of humid tropics is worsened by the decay of the wastes that depletes the water of oxygen essential to the aquatic life. Not only does it upset the natural balance of the aquatic system and can seriously affect natural biological systems but it can also render the water supply extremely dangerous to human health, especially when eutrophication is further enhanced by runoff of fertilizers from agricultural areas, increasing the growth of algae and, thus, the suspended organic matter content. Pathogenic bacteria and viruses, derived from human faeces in urban sewage, add to the health risks created by the toxic wastes produced by industrial process and that accumulate in aquatic life. Metals or chemical compounds, for example, accumulate in the suspended organic matter and algae and can contaminate the whole food chain.



A new venture

In tropical countries, urban growth will make the management of water quality increasingly crucial. The self-cleansing action of streams that, until recently, diluted the effluents from human activities is often no longer able to accommodate both the population growth and the increased economic and industrial activity. Much work remains to be done regarding the water quality databases and scientific studies by the tropical countries concerned. A series of studies conducted by the Water Resources Research Centre at the University of Hawaii has shown that indicator bacteria chosen for water quality standards in the temperate regions are naturally present in the tropical environment (soil, plant and stream waters). Since there is not always evidence of contamination with fecal matter of man or animal, the most likely

explanation is that these bacteria are able to grow in the warm soil of a tropical environment of Hawaii. It is only logical that the phenomenon may be also occurring in other tropical places. Data to verify this still need to be obtained. Wastewater recovery and treatment methods, together with the design of different industrial processes that will produce less contaminated wastewater constitute a broad field for modern research.

Shrinking water

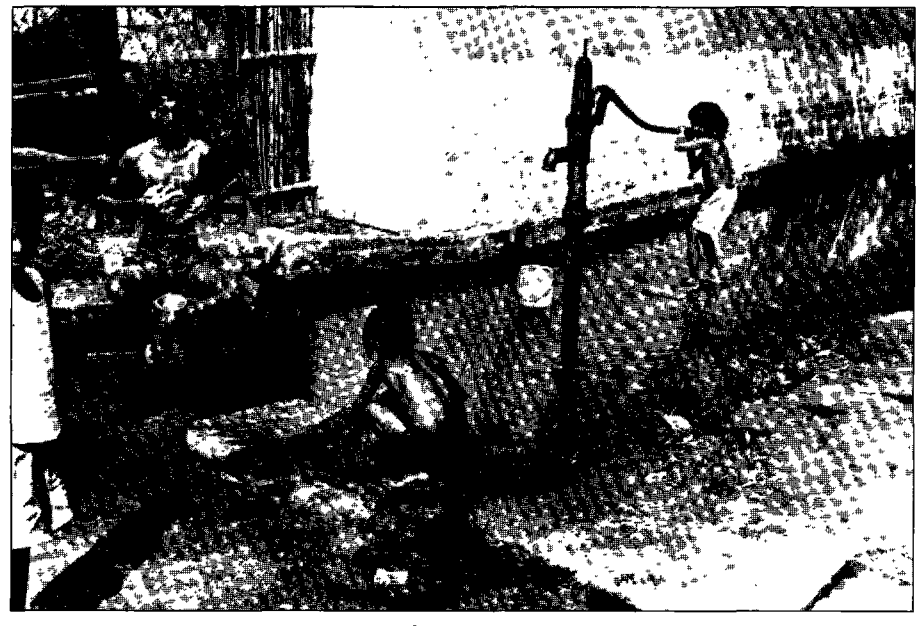
Only one per cent of water on Earth is available for human use. Moreover, it is unevenly distributed. As it has been observed, water is rarely in the right place, at the right time and in the right quantity and quality. Before the era of urban-dominated societies and the industrial-chemical additions to the waters, the hydrological cycle was expected to go on and on, without interference by man. Today, our better knowledge of the biosphere and its water system makes such a concept obsolete.

Throughout the world, it has taken only two or three decades for an increasing number of people to become aware that water is no longer a "natural" commodity available in unlimited quantities of good quality.

For not only is the quantity of available water per capita now shrinking, but the quality of freshwater, too, is constantly deteriorating. This is due to a variety of pollutants: heavy metals, organics, hazardous and toxic compounds and disease-producing organisms. In tropical areas, the health hazards caused by polluted water supplies are more numerous and more serious than those in the temperate and developed areas.

Because of the accelerated urbanization and rapid population growth, the amount of usable fresh water is currently decreasing even in the humid tropics. Providing more water means increasing threats to human health, due to pollution in one form or another, and particularly to microbiological contamination of drinking water supplies.

It is estimated by WHO and UNEP that in 1990, around ninety per cent of sewage collected in indus-trialized countries was ade-quately treated as opposed to two per cent in developing countries. Only a few large urban centres are being partly served by waste water treatment schemes in Africa and Asia. In Latin America, present cove-rage and future expansion of control measures is far more advanced .



But, having treatment facilities and operating them satisfactorily are two different things as can be seen in the following:

Developing countries only	Percentage of cities with sewage treatment facilities	Percentage of facilities operating satisfactorily
Sub-Saharan Africa	2	30
Asia/Pacific	5	50
Arab/Moslem Countries	10	40
Latin America	25	45

Source: WHO, 1991.

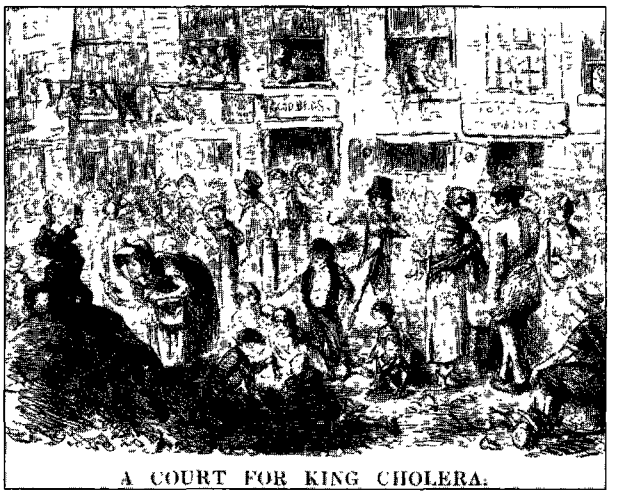
The lack of adequate sewage in tropical countries leads the people to use the same water for the irrigation of vegetable gardens and for drinking, cooking and washing. This constitutes an ideal breeding ground for diarrhoeal diseases (more particularly, cholera) and malaria.

HISTORICAL BACKGROUND

It is commonly accepted that the first management of water resources, in the perspective of human health, dates back to the fifth century B.C. when the "Treatise on Airs, Waters and Places" became part of the Hippocratic corpus. As a rule of the thumb, human communities have always avoided marshes and humid places.

The relationship between swamps and malaria, and also to a certain extent, diarrhoea had been established probably since the origin of humanity. Yet, it took humanity until the middle of the XIXth century to realize that water was one of the most important determinants of health and disease. More progress has been made in the understanding of water management during this last century than during the preceeding 2,500 years.

A turning-point...


A COURT FOR KING CHOLERA.

In 1854, a cholera epidemic struck London's population. When John Snow removed the handle of the pump located in the city's Broad Street, a dramatic decrease in the number of new cases among the families who used this public standpost followed almost immediately. The event is usually considered to have been the starting point of a new awareness, establishing water as one of the most important factors in health and disease. It showed that bringing water in quantity to households was insufficient by itself, and that its quality was vital.

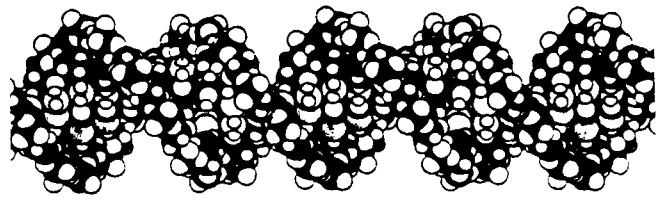
The "germ free" approach

Almost at the same time, Pasteur was identifying the role of the recently named "microbes", causal agents of infectious diseases. A number of new germs were also identified throughout the world by other researchers. The role of vectors such as insects, birds and other animals, in carrying germs to human organisms (such as the bacillus responsible for tuberculosis discovered by Koch, and the plasmodium responsible for malaria) was demonstrated almost immediately afterwards.

Microbiology was established as a scientific discipline. From about 1880, the "aseptic and antiseptic methods", recommended by Pasteur, inspired a number of preventive measures against pathogens. It also stimulated, in almost all countries, the creation of a new profession. "Hygienists", although not required to be medically trained, were in charge of water quality and sewage control based on the "germ free" approach. The concept of "public health management" – and of disease prevention – has developed rapidly ever since.

MORE PROGRESS IN ONE CENTURY THAN IN THE PREVIOUS 2,500 YEARS

1850 - WORLD POPULATION: 1.17 billion



1851 - 1st International Health Congress, Paris

1859 - Darwin: *On The Origin of Species*
1869 - Mendel: Laws of Heredity
- Mendeleyev: Table of chemical elements

1876 - Koch: birth of bacteriology

1877 - Sir Patrick Manson: microfilariae of *Wuchereria bancrofti* (FILARIASIS) are taken up by mosquitoes with a bloodmeal and develop larval stages in the mosquitoes' tissues. Yet, he uncorrectly concluded that the disease was transmitted by drinking water in which mosquitoes had drowned.

1880 - Alphonse Laveran: the MALARIA parasite
- **Evans: discovery of the first pathogenic trypanosome (in India, where he was responsible for the "surra" in horses and camels)**

1881 - 1st vaccine, Pasteur: against anthrax

1886 - Camilio Golgi observes the stages of the MALARIA parasite in human blood and that paroxyms coincide with the multiplication of blood parasites.

1888 - Hertz: electromagnetic waves

1894 - Alexandre Yersin and Shibasaburo: the PLAGUE bacillus

1895 - Roentgen: X-rays

1896 - Branly, Marconi, Popoff: wireless radio transmission

1897 - Sir David Bruce's publication on the "NAGANA", or trypanosomes (known to be related to SLEEPING SICKNESS later, in 1902) shows these parasites are transmitted through tsetse flies to infected cattle and dogs.

1898 - Paul-Louis Simond: fleas as possible vectors of BUBONIC PLAGUE

1898 - Sir Ronald Ross works on malaria transmission by mosquitoes. He first followed Manson's hypothesis, but later corrected it, advancing that FILARIASIS was transmitted through mosquito bites ("bird malaria", *Culex* mosquitoes).
- **Grassi: human MALARIA shows same stages in *Anopheles* mosquitoes as bird malaria does in *Culex* mosquitoes.**

1900 - Sir William Leishman: the LEISHMANIA parasite

1902 - Forde: trypanosomes in the blood of SLEEPING SICKNESS patients

1905 - Einstein: Special Theory of Relativity

1906 - Leiper draws attention to the GUINEA WORM infection as a major tropical disease "but singularly neglected" (although first described under the name of DRACUNCULOSIS by Linnaeus in his "Systema Naturae", in 1758)

1907 - P. M. Ashburn and F. Craig: DENGUE virus in Philippines

1912 - FILARIASIS transmission correctly described

1914 - Opening of the Panama Canal: first large-scale environmental engineering relateto water and health, due to Gorgas. Its construction had been interrupted in the late 1880s because of the death of 52 000 workers, out of a total workforce of 85 000, due to yellow fever.

1925 - Lindberg crosses the Atlantic by plane

- **Blacklock, Sierra Leone: simulids as vectors of ONCHOCERCIASIS**

1928 - Sir Alexander Fleming : penicillin

1940 - MULLER: DDT

1948 - First World Health Assembly: effective creation of the World Health Organization

1950 - Wiener: Cybernetics

1951 - WORLD POPULATION: 2.5 billion

1953 - Watson and Crick : structure of the DNA molecule

1955 - Start of global DDT campaign against MALARIA under WHO auspices: eradication in many countries of the temperate zone and high levels of control in countries of tropical Asia

1969 - FIRST HUMAN ON THE MOON

1974 - Start of the WHO Onchocerciasis Control Programme

1975 - Introduction of *Bacillus thuringiensis* to control mosquito and Blackfly larva

1978 - WHO: global eradication of SMALLPOX achieved

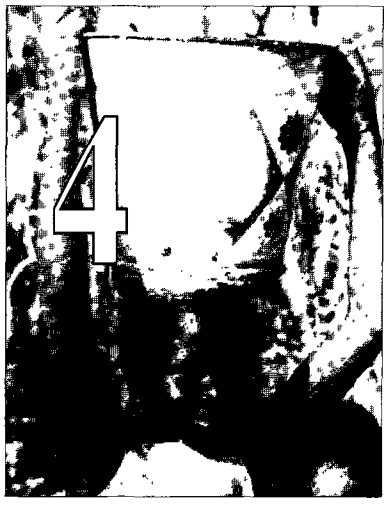
1981 - The U.N. Water Supply and Sanitation Decade is launched

1987 - WORLD POPULATION: 5 billion

2000 - Reference Year for the Global Strategy "Health for All"

XXIst Century Great Challenges: population growth, urbanization, industrial pollution, scarcity of natural resources — including water, global climatic changes, increased mobility of people, of world trade and transportation, increased levels of education

2020 - WORLD POPULATION: 7.2 billion (expected)

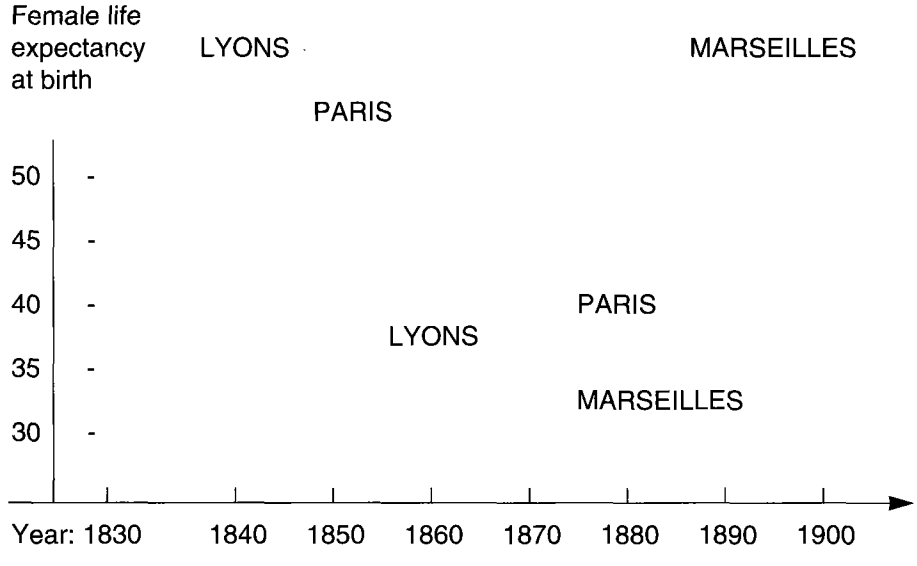


WHERE IS HEALTH CARE GOING?

About one century after the "germ free" approach of water in relation to health, the rapid transformation of lifetstyles in the Northern hemisphere (urbanization associated with industrialization, generalized immunization, better nutrition and housing) makes it difficult to evaluate the benefits associated with water quality alone. Yet, some data collected in France from around 1850 to 1900 may help provide some epidemiological insight on the trends in the improvement of public health through satisfactory water supply.

A study made on female mortality in Paris, Lyons and Marseilles, three French cities, indicates that mortality first declined in Lyons around 1850, followed by Paris ten years later and, then, by Marseilles in the 1890s, and that such decline coincides with the establishment of water distribution systems. Unfortunately, strong evidence of similar trends has not yet been identified in other countries.

Timing in improvements in water supply and sewerage



This figure illustrates the time sequence of the gains in female life expectancy in Paris, Lyons and Marseilles, according to data collected by Preston & Van de Walle. In their opinion, mortality decline is related to the multiplier effect of the completion of both generalized water supply system and a sewage system in Lyons by 1855. Progress was slower but continuous in the service delivery in Paris during the period 1855-1900. The lack of satisfactory water supply in Marseilles until 1898 would explain the great difference in the mortality trends of its population compared to the two other French cities during the same period.

Source: Prost, A. 1989. Mortality decline in three cities of France during the 19th century (personal communication — using data from Preston & Van de Walle, 1978).

Recently, however, in a study made on urban areas in Brazil (Merrick, 1985), it has been estimated that access to piped water accounted for about one fifth of the reduction in child mortality between 1970 and 1976.

The almost 150 year campaign for a hygienic environment with its thoroughly documented impact on cholera and typhoid, and with the decline it generated in mortality rates, has led to the acceptance that safe water is one of the basic needs for human life – and good health.

Safe water, a basic need

By the mid 1970s, it was universally recognized that access to safe water was a basic need. At that time, development studies showed that provision of domestic piped water supplies, either in the dwelling or close by, could save many lives and have a great positive impact on the population's quality of life. Safe water is no longer merely considered as a "normal" element of comfort, but as an essential component to ensure the minimum level of well-being and health of people.

Primary health care

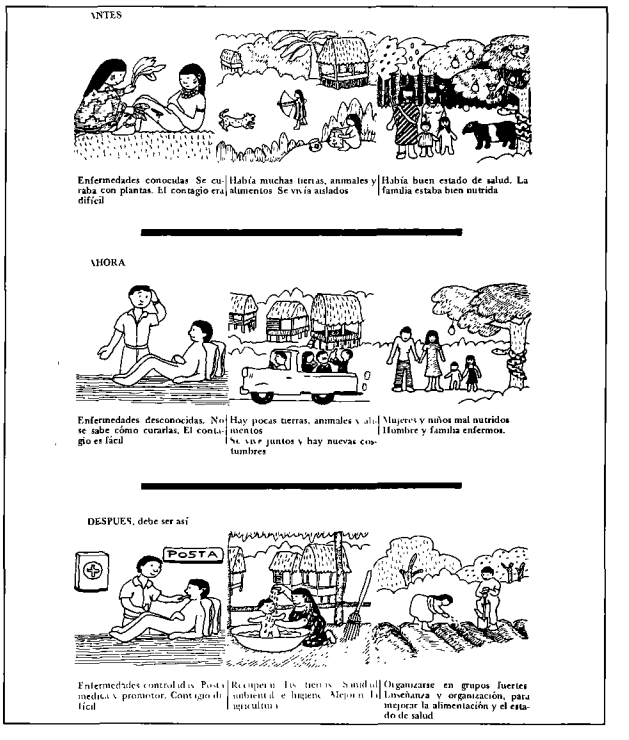
In 1975, during its World Conference, the International Labour Office proposed a policy development based on the satisfaction of essential needs. Basic needs were defined as the minimum level of well-being that a community should establish for its poorest members. At the family level, they include access to paid labour in order to ensure an income in cash (lack of 'cash' is often a problem in rural areas of developing countries where people have to overcome this challenge to get basic equipment, such as shovels, blades, etc., through other means than money) or else to improve their income, food, housing and clothing. Access to safe water and sanitation was considered as much a part of basic services as education, health services and transportation.

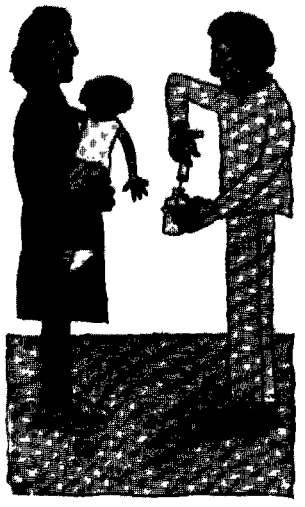
The concept of basic needs developed rapidly in terms of a strategy based on the global approach of primary health care. An International Conference, organized jointly by UNICEF and WHO, was held in Alma-Ata (USSR), in 1978, at which the Member-States of the two organizations signed the "Declaration of Alma-Ata", also known as the "Health for All Declaration".

The primary health care strategy is based on an intersectoral approach consisting of the development of eight essential sectors, simultaneously wherever and whenever possible. They are as follows:

- first aid, care for the handicapped
- mother and child care, including family planning
- water and sanitation
- immunization
- education for health and community participation
- nutrition
- prevention of communicable diseases
- essential drugs.

Communities are thus encouraged to design their own educational tools so as to make them appropriate to their culture and their environment as is the case of this page from Primary Health Care Manual by a Jivaro group living in the Peruvian Amazon jungle. In 1984, their Health Programme covered about 35,000 people scattered in an aqueous area of 22,000 km².





Unfortunately, the economic recession that marked the same period led to priority being given to sectors that were likely to produce more rapid economic and financial returns. The resources were insufficient to implement the complete package of primary health care interventions. The comprehensive approach of the primary health care strategy had to be replaced by a selective one, more centered on cost-effectiveness.

A more selective approach

It was argued that the cost per infant death averted through water supply and sanitation programmes was 10 to 15 times higher than the cost per infant death averted through a selective package that includes oral rehydration therapy, basic immunization, malaria treatment and promotion of breast-feeding.

Estimated annual costs of different systems of health intervention

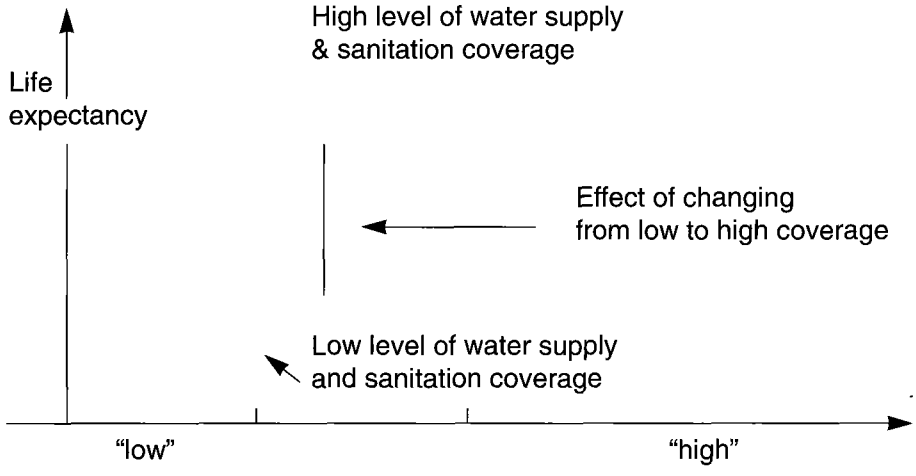
Intervention	Cost per capita (US $)	Cost per infant (I) and/or child death (C) averted (US $)	
Basic Primary Health Care	2.00	700	(I)
Mosquito Control for Malaria	2.00	600	(I)
Water Supply and Sanitation	30-54	3600 - 4 300	(I, C)
Nutrition Supplementation	1.75	213 - 3 000	(I, C)
Selective Primary Health Care	0.25	200 -250	(I, C)

Source: Walsh & Warren, 1979

What has been called "the threshold-saturation theory" led to the conclusion by some that whereas in rich areas improvements in water supply and sanitation would result in major expenses in more complex sewerage systems, treatment plants, etc, in the poor regions, such improvements would have little effect on prevalent morbid conditions related to or arising from conditions such as malnutrition and infectious diseases.

As a result, a number of development agencies shifted investments and resources towards immunization, nutrition supplementation, mosquito control for malaria, etc., rather than water supply and sanitation.

The threshold saturation theory



Source: Prost, A. 1989 (adapted from Shuval & al,, 1981)

Water management revisited

Simultaneously, it emerged that water-related diseases had spread at the same time as irrigated areas had doubled throughout the world (from 1950 to 1970). Increasing concern for water management in the tropics led to a crucial question being raised: "Was the health of the populations concerned actually improving as a result of the massive development schemes ?"

From the systematic approach to the system approach

Around the 1970s, the objective of a newly borne science, ecology, was to give a global understanding to the environment. An awareness of the interaction between living systems made clear that none of them, whether water systems or insects systems or bacteriological systems, evolves independently. The new ecological approach drew light on a new concept. "Interdependency" was given priority as the key-word of the new paradigm.

Co-evolution, a better understanding of living systems

The new concept of "coevolution" helped to highlight the interdependency of human health with the environment, and to understand phenomena such as the increase in the prevalence of schistosomiasis from 1-11 per cent in 1934 to 44-75 per cent in 1937 in populations dwelling near the first Aswan dam in Egypt. Later, it was also discovered that irrigation in Upper Egypt had created, through the extension of dormant water surface, an ideal location for breeding sites, or "econiches", for *Anopheles gambiæ*, the mosquito vector of malaria. Previously, *Anopheles gambiæ* had been virtually unknown in this area, but its proliferation became the direct cause of about 130,000 malaria deaths registered in 1942-43.

The same kind of phenomenon was observed one year after the completion of the Akosombo dam, in Ghana. In 1968, 90 per cent of children aged 10-14 years in the shoreline villages carried *Schistosoma* parasites, whereas the carrier rate had not exceeded 10 per cent before the dam construction.

However, large dams and reservoirs were not implicated in the new situation until the concept of interdependency was understood. Some projects of massive development intended to provide populations with greater amounts of food did not improve health through better nutrition but did result in some other dramatic consequences. In Burkina Faso, for example, the irrigation of 1,200 hectares of rice fields, in the Loumana plain, coincided with an outbreak of onchocerciasis: 15 per cent of the women and 20 per cent of the men went blind. People deserted the settlement, and five years later the irrigation system was dilapidated due to lack of maintenance. Alarming reports of this nature were increasingly documented. Since then, we have increased our knowledge and learned again that we cannot be out of step with nature. We must be part of it, and when we upset the 'balance of nature' disasters inevitably follow.

A more sensitive approach

The 1980s were called "the lost decade for development" by some pessimistic thinkers alarmed by the number of symptoms of the destruction of the biosphere emerging during this period. Floods, droughts, epidemics, hunger and malnutrition and other massive discontinuities were evident. But this decade alsobrought greater wisdom. Challenged by the apparent disagreement between those professionals who were more "water-oriented" and those pleading for projects based on a comprehensive approach that would take into account human activities, developers eventually achieved much progress in the understanding of the relationship between health and water as a basic component of our living environ. The approach that is now recommended for water-engineering in tropical regions places the *man-water relationship in an ecological perspective. It promotes* sustainable development through the observation of interactions between human activities and their impact on the natural environment. The new concept now is to cooperate with rather than fight constantly against a so-called "hostile" nature. Thus, modern health professionals now seek to reconstitute to the greatest possible extent a balance prevailing in the natural world.

Washing and bathing in the river are "risk" activities. The boy's swollen abdomen shows he is infected with schistosomiasis.

Epidemiology, a reassessment of the health risks

Epidemiology helped to draw a comprehensive picture of the relationship between health and water as a necessary component of the human environment. Consequently, it was due to the epidemiological approach that a more "human-centred" classification of categories of disease related to water could be established.

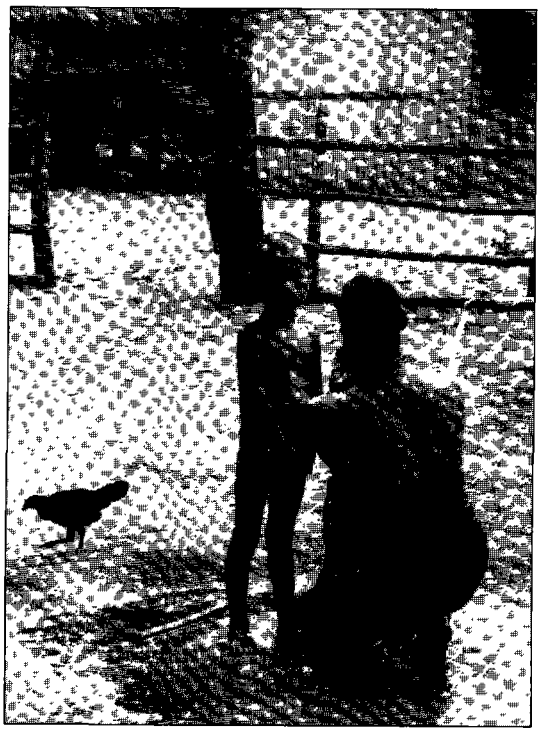
The types of water-related human activities are now understood to be as important as is the type of pathogens involved in the transmission of diseases. Hence water supply and sanitation have begun to be designed considering the populations' water activities: uses for drinking and for hygiene; contact during work and recreation; distant effect through the consumption of water products such as fish, for example, and through the growth in water of arthropods and snails harmful to humans.

Interdependency... interdisciplinarity

A fragile balance between humans and their environment has been established throughout centuries, sometimes millenia, through the empirical process often called "learning by mistakes". Today, scientific progress in the understanding of the Earth can help to identify the adverse and beneficial effects of certain activities. For example, whereas increased man-water contacts may favour schistosomiasis, they can also reduce the incidence of water-washed diseases *(see "Health Risks and Water in the Tropics", later).*

The complexity of interactions between humans and their environment makes forecasting health-risks a difficult task. Yet, since the U.N. Water Supply and Sanitation Decade, launched in 1981, this innovative approach based on a stronger cooperation between water-resources engineers and health specialists is now increasingly replacing the old approaches, where the demand for health services among communities living in tropical areas was usually not related to water-induced diseases.

In the Solomon Islands, women show how they used to trap water with bamboos before it was piped to the villages.



In Thailand, basic services are widespread, and their impact is reflected in the overall improvement of the situation of the children.

HEALTH AND THE WATER CYCLE

Public health and population growth

Since 1945, there has been a 50 per cent decline in infant and child mortality as a result of the improvement of public health services. In 1990, the proportion of people 15 years of age and under formed 32.4 percent of the population worldwide. The current dramatic population growth in developing countries puts pressure on natural resources. It is rapidly putting pressure, too, on institutions that have not been designed to cope with this change and of the resulting age structure of the population.

Yet, much needs to be urgently achieved to ensure the quality of life and health of populations living in tropical areas where most diseases associated with water are endemic and long-drawn-out infections. Even when they do not lead to early death, they hinder social and economic development because they can debilitate and disable an entire population. In some cases, disease becomes a way of life for people who may host more than four different infectious agents and, yet, must work or their family will starve. In endemic regions, the high rate of diseases such as malaria and onchocerciasis has rendered impossible the human occupancy of large areas in Africa, Asia and the Amazon region.

Much illness could be prevented by ensuring access to safe drinking water and adequate sanitation. In most tropical regions, domestic sewage remains a major problem, especially in urban areas. In the poor outskirts of cities, water is often without any form of pre-treatment, and shows traces of pollution of the aquatic systems. In addition, water is often polluted during its transportation.

Mastering the water cycle is a way of mastering the health cycle

Distribution of water by artificial means not only modifies the quantity of water people can obtain, but also changes its quality. Where sanitation is adequate, distribution can improve the water quality but the contrary may equally happen. Throughout history, wherever humans have intensified their exploitation of natural resources without caring for their renewal, these were periodically degraded or depleted. Today, our more sophisticated knowledge of the biosphere, together with the pressure resulting from the accumulated degradations of nature that could cause a geo-bio-climatic change, may hopefully lead us to reverse the process.

More pressure on water, more pressure on people

In the developing world population growth puts pressure on the natural water resources, more particularly in the poor communities. In low income families, children are needed as helpers to collect water and firewood, to look after old people and to do a number of household chores. Even if access to education could be virtually ensured for all, many children would be too busily involved in the basic tasks of their families' survival to be able to attend school regularly.

Societies can no longer overstress their water resource-base without paying the price. This will not only involve financial investments, but the development of professional expertise through appropriate education and training, thus ensuring a national capacity to solve their problems.

The comprehensive modern approach

The modern approach to water resources management is based on the contemporary "systems theory" according to which "any system that performs work dissipates free energy and, unless it replenishes its energy stores, it is bound to run down". The living systems in nature are no longer considered as separate entities but as interactive "partners". This new aspect to the relationship between humans and nature has led to a move from care for human health alone towards care for the living systems, or biotopes, that constitute nature itself. Whether biotopes are at the scale of animals, plants, forests, rivers or lakes, their survival in good conditions is recognized as being vital to the common future of life on this planet. The mutual interdependancy between human communities and nature has led to a new attitude in the scientific professions.

Human health is not isolated from environmental health

Health is no longer considered to be an isolated phenomenon reserved for the "lucky ones". It is now understood that it is the result of complex and interdependent biological and cultural factors – in the classical meaning where culture is not just a matter of instruction but also of technological progress, economic hazards, social difficulties (unemployment, cultural shock due to fast urbanization, etc.) and hopes !

Managing life rather than harnessing it

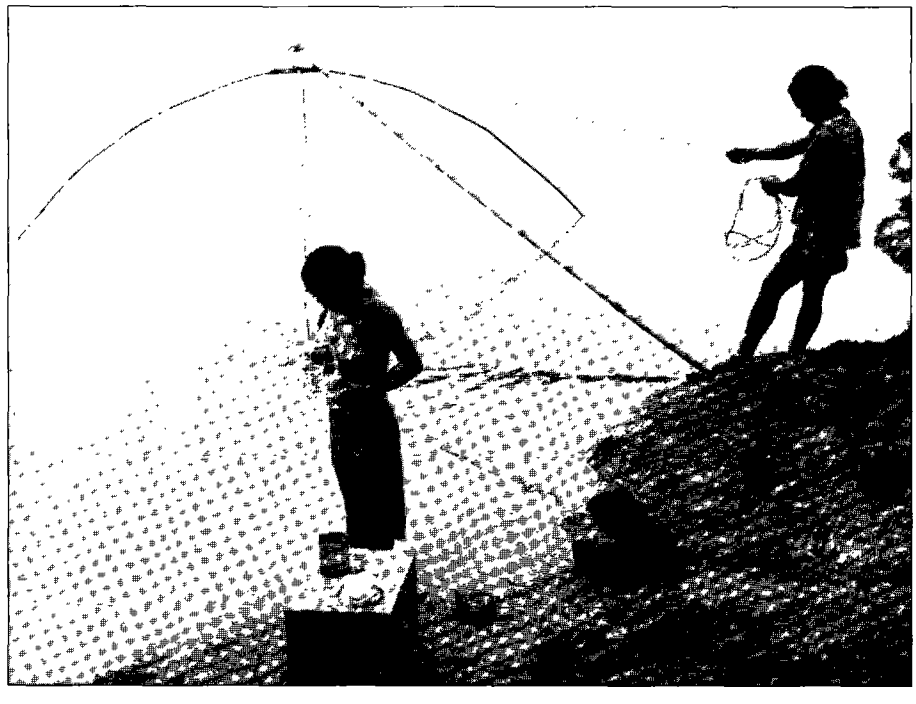
The trend is now shifting from the century-old exclusive concern for the quality of water to the introduction of the notion of the importance to health of water quantity, whatever its quality. It is clear that unnecessarily stringent quality standards may be counterproductive since they may reduce the quantities of water that, otherwise, would be available. Severe quality standards could also delay the supply and increase the cost of water development and distribution.

Better access to water in quantity is likely to help control water-washed diseases, among which feco-oral infections are one of the most crucial worldwide public health problems.

Consequently, for a better understanding of the relationship between capacities and real needs, health specialists recommend abandoning the classical classification of infectious diseases by the category of pathogen, or organism which causes them, such as protozoa, bacteria or viruses, because it has now proven more efficient to group water-related infections according to their transmission routes, like comprehensive systems. Thus, the diseases associated with water can be managed according to the ecology of the man-water system they belong to. For example, it has been argued that, in many places, the endemic transmission of diarrhoeal diseases can be both water-borne and water-washed. But since it is recognized that most of the transmission is water-washed, better access to water in quantity is more likely to result in greater control.

"Stewardship", a better use of resources

This new attitude is often described as a "stewardship" of the potential interactions between humans and their natural environment. It means that the actual phase of a community in its natural and cultural conditions is taken into consideration. The "stewardship" approach helps to avoid misuse of resources, that further marginalizes poor communities. It allows a shift of resources to other vital sectors, such as nutrition and oral rehydration methods, and in doing so balances the benefits of a safe water supply.



HEALTH RISKS AND WATER IN THE TROPICS

There are four categories of diseases associated with water:

Water-borne diseases

Water-borne diseases can be of bacterial, viral or parasitic origin. In this case, water acts as a passive vehicle for infective agent and the effort of health workers will consist of improving the quality of water. But diseases which are related to the quality of water are no longer the most important category in terms of mortality factors. Yet, although limited, they represent all pathological conditions related to water. In water-borne diseases, transmission occurs by consumption of contaminated water.

The infective bacterial agents include, for example, *Salmonella* (typhoid), enterobacteria, the bacterium *Vibrio choleræ*, *Leptospira.* Viral agents can be those of hepatitis A, poliomyelitis and enteroviruses; and parasites, *Amoeba*, *Giardia lamblia* and other intestinal protozoa.

As a matter of fact, water-borne diseases are not exclusively dependent upon water for their transmission. Viruses are rapidly and more often transmitted through interhuman contacts. Their presence in water – in which they do not multiply – is merely an indicator that they have already spread in the community. Bacteria can use various routes of entry: contaminated food is a much more common source of infection than contaminated water. Vegetables, for example, are involved in the transmission of typhoid fever and cholera and this calls for shifting attention from drinking water to include the water used for irrigation.

Rural education posters on nutrition and food safety in a rural health centre in Kenya.

Diseases associated with water quality (1), quantity (2), consuming (3) and proximity (4).

1. WATERBORNE*	BACTERIAL	Salmonella (typhoid), Enterobacteria (*E. coli,* Campylobacter), Cholera, Leptospirosis, etc.
	VIRAL	Hepatitis A, Poliomyelitis, Rotaviruses, Enteroviruses
	PARASITIC	Amoebiasis, Giardiasis, *Intestinal protozoa,* Balantidium coli
	ENTERIC	e.g., a proportion of diarrhoeas and gastroenteritis
2. WATER-WASHED*	SKIN	Scabies, Ringworm, Ulcers, Pyodermitis
	LOUSE-BORNE	Typhus and related fevers
	TREPANEMATOSES	Yaws, Bejel, Pinta
	EYE & EAR	Otitis, Conjunctivitis, Trachoma
3. WATER-BASED*	CRUSTACEA	Guinea Worm, Paragonimiasis
	FISH	Diphyllobothriasis
	SHELLFISH	Flukes, *Schistosomiasis*
4. WATER-RELATED*	MOSQUITOES	Malaria, Filariasis, Yellow Fever, Dengue, Haemorraghic Fever
	TSETSE FLIES	Trypanosomiasis (Sleeping Sickness)
	BLACKFLIES	Onchocerciasis

* Definitions by White *et al.,* 1972

Water-washed diseases

This category is a new and important concept. It refers to those infections that decrease as a result of increasing the volume of available water. Diminishing health risks will consist of focusing on increasing the *quantity* of water.

Infections includes diseases that are sensitive to hygiene practices, more especially external otitis (external ear infection), skin and eye infections. This category of disease involves a person-to-person transmission due to lack of water for personal and home cleanliness. An infectious skin disease such as pyodermitis, for example, is the first disease to be strikingly reduced when water is made available in unlimited quantities. It might be used as an early indicator of the beneficial health impact of water supply projects. In the eye disease category, there is no evidence that water has a significant role in conjunctivitis. Yet, lack of water is associated with an increased – perhaps doubled – risk of trachoma, a blinding condition.

Even more surprisingly, it has been observed that water quantity also influences diarrhoea and other conditions that were previously considered to be exclusively dependent on the water quality.

Water-based and water-related diseases

These categories are of broad interest in irrigation projects and reservoir construction. Two diseases are at the forefront: **malaria** and **schistosomiasis**. Their dominance in risk-forecasting, based on sound epidemiological evidence and historical episodes, has relegated other diseases to low priority status. This is not very valid and others, such as **onchocerciasis, dengue, yellow fever** and **Japanese encephalitis**, need to be urgently included in policy decisions. In the case of yellow fever, for example, serious epidemics remain a threat to public health in the tropical zones of Africa and Latin America.

Water-based diseases are related to *contact.* A necessary part of the life cycle of the infective agent takes place in an aquatic organism. In other words, transmission occurs through an intermediate host that can be, for example, the freshwater snail of schistosomiasis, or a crustacean in the case of Guinea Worm.

Water-related diseases involve the *proximity* of water. The pathogen is transmitted by insects which breed in water or bite near water. Mosquitoes are responsible for malaria and filariasis, yellow fever, dengue and haemorhagic fever; tsetse flies for the sleeping sickness (or trypanosomiasis), and blackflies for onchocerciasis.

Global estimates of vectoral diseases associated with water

Diseases	Vectors	Population affected
African trypanosomiasis	tsetse flies	50 million people at risk 25 thousand infected
Dengue	*Aedes* mosquitoes	over 1 million people infected per year
Dracunculiasis	*Cyclops* (crustacean)	over 1 million per year in Africa alone
Filariasis	Mosquitoes (several species)	905 million people at risk
Malaria	*Anopheles* mosquitoes	2,210 million people at risk
Onchocerciasis	*Simulium*. Black flies	86 million people at risk + about 18 million infected per year
Schistosomiasis	Freshwater snails	500 million people at risk + about 200 million infected
Yellow fever	*Aedes* mosquitoes	epidemics in tropical zones of Africa and America

Source: Global estimates relating to the health situation and trends, WHO/HST/87.1

Changing ecological conditions

The greater the surface water available, the more easily mosquitoes and freshwater snails can develop and proliferate. Changes in the water environment induce changes in the mosquito populations which are much more diverse than the snail populations. New strains adjust to changing ecological conditions, and may be more or less efficient vectors of the parasite.

Moreover, the rapid spread and increase of genetic resistance to insecticides in malaria vectors has induced a new step in the evolution of insects, a man-induced one. By 1985, about 90 species of mosquitoes, mainly disease-vectors, were recorded as insecticide resistant in certain areas. Hence priority needed to be given urgently to new strategies aiming

Insecticide resistance was first noted in Greece, in 1944, when a mosquito species, *Anopheles sacharovi*, became resistant to DDT. Its public health importance was increasingly confirmed in Italy when, in 1947, the housefly and the mosquito, *Culex molestus*, in turn developed resistance to DDT. Then, the number of species of arthropods, resistant to DDT and of public health importance, was to rise from two in 1947 to one hundred and fifty-five by 1980. The tide of evolution did not stop, nor did it remain limited to these species. Today, insecticide resistance is wide-spread among an impressive number of taxa such as flies, bugs, fleas, cockroaches, ticks, bedbugs and human head and body lice.

at reducing the sources of mosquito proliferation risks. The impact of irrigation is uneven and cannot be foreseen with certainty. For example in the Kano Plateau, Kenya, there has been a reduction of the number of man-biting mosquito species, but a replacement of outdoor biting species with indoor biting mosquitoes, thus quadrupling exposure to malaria transmission. On the contrary, in the irrigated rice area of the Vallée du Kou, Burkina Faso, the density of *Anopheles* mosquitoes is two times higher than in the surrounding dry savanna zone. However, the transmission of malaria is significantly lower. This can be explained either by a reduction of the life span of the mosquitos in the irrigated ecosystem, or a change in the *Anopheles* strain, or both.

Ricefields may produce the highest densities of anopheline mosquitoes, but surprisingly tropical ricefields are often free of dangerous species. Today, rice growing is not associated with the most serious malaria problem areas of the world.

Every minute, two children die from the effects of malaria somewhere in the tropics... The World Health Organization estimates that 270 million people are affected by malaria and that a yearly average of 90 million are from the African Region.

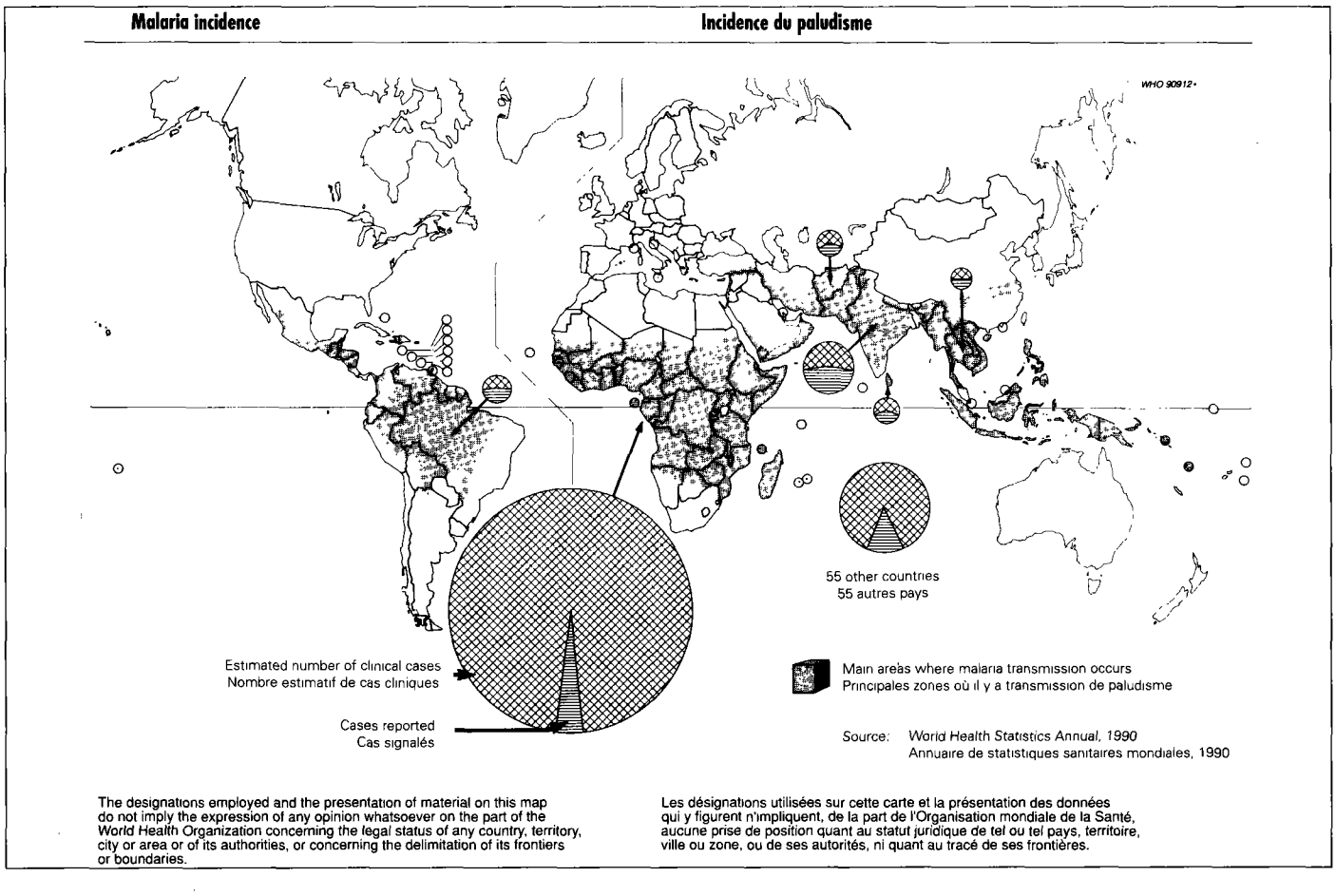
MALARIA

Almost half of the world population at risk

Malaria by far tops the list of the most serious tropical diseases: almost half of the world population, in more than 100 countries, is threatened by malaria. In 1990 alone, more than one million lives were lost due to malaria throughout the developing countries, including 800,000 below five years of age in Sub-Saharan Africa.

Urbanization, jungle settlements and land reclamation, refugees and displaced persons are currently creating massive population movements that, in addition to new forms of economic activity and resistance to classical remedies and to insecticides, have created an extremely difficult situation to manage. Yet, the privilege of humankind is the will to change situations, even the most apparently hopeless ones. In this view, a new world strategy against malaria is necessary.

This new world mobilization against malaria is based on increased water management in order to ensure the choice of vector control methods according to the intensity of the disease among populations concerned and, simultaneously, on improving case management with early diagnosis and rapid treatment. This implies that the strengthening of health systems in order to control of malaria cannot be separated from reducing poverty and under-development.



Malaria deserves a very cautious approach

It has been observed that irrigated agriculture and reservoir construction usually result in a more intense transmission that is more regularly spread over a long period of the year. The lack of seasonal variation in the water flow facilitates a more intense proliferation of the mosquito larvae on the stagnant water surface and thus, a more regular reproduction of the insects. Yet, major waterworks do not only increase the area of surface waters. Often, many are also designed to control floods. Floods can be effectively more harmful to health than reservoirs and canals, even if their effect on agriculture and housing, not to mention their disruptive effects to normal life, are disregarded.

The containment of the Yang-Tsé and Huang-Hé rivers in China, for example, has both put an end to a recurrent series of catastrophes and significantly contributed to the reduction of the incidence of malaria to very low levels. Thus, in Shandong Province, located at the mouth of the Huang-Hé, an average of only 75,000 cases of malaria has been reported annually since the late 1950s, except for 1960 (over 2 million cases) and for 1971 (3.2 million cases) when major floods overflowed the dikes and sometimes ruptured them. Drainage of the Rhine Valley was one of the major factors that led to the disappearance of malaria in northeastern France, in Germany and in the Netherlands.

Symptoms of malaria

Malaria is due to the presence of parasitic protozoon named "Plasmodium" (*P. falciparum, P. malariae, P. ovale,* or *P. vivax*) within the red blood cells. They are transmitted by the *Anopheles* mosquito. As the mosquito feeds, the Plasmodia in the blood of an infected person multiply in its stomach and then invade its salivary glands. Then parasites are injected into the bloodstream of the people the mosquito bites. From the bloodstream Plasmodia migrate to the liver and other organs where they multiply. Their incubation is variable (it may last from a few days days to ten months). Thereafter, parasites return to the bloodstream where they invade the red blood cells. Their rapid multiplication resulting in the release of batches of parasites is the cause of the shivering, fever and sweating that are the characteristic symptoms of malaria. In addition, the loss of healthy red cells results in anaemia that becomes progressively worse if untreated. Anaemia, already so common in pregnant women of developing countries suffering from malnutrition, is a factor of high foetal mortality and not the least, in low birth-weight that is life threatening to the new-born infant.

Chloroquine, mepacrine and proguanil are the drugs classically administrated as preventive and curative treatment.

Malaria has a much wider geographical distribution than schistosomiasis and contrary to the latter, the repetition of the infection does not worsen the individual's health condition. At short intervals, repeated infections with malaria stimulate the immune response and thus contribute to the maintenance of a high immunity which counters the onset of severe clinical symptoms. There is now convincing evidence that the severity of clinical malaria is not related to the number of infective bites, but to the immune status of the victim.

Children's health is tomorrow's wealth.

This disease among schoolchildren has long-term consequences since the infection can dramatically affect the children's growth and their school performance. In addition to the blood in the urine, the children suffer from an enlarged liver or spleen. Infected children are usually pale, listless, anaemic and lacking appetite. Once treated, children from 10 to 14 years of age may gain between two and three kilos in about six months as they rapidly resume development.

The visiting PHC team can 'test and treat' schoolchildren in Zanzibar (left).

Schistosomiasis is associated with an increased risk of bladder cancer, which is the leading cause of death due to cancer in Egypt among men, predominantly rural workers, between 20 and 40 years of age.

Prevention now uses new rapid diagnostic tests in the rural areas of Egypt (right).

SCHISTOSOMIASIS

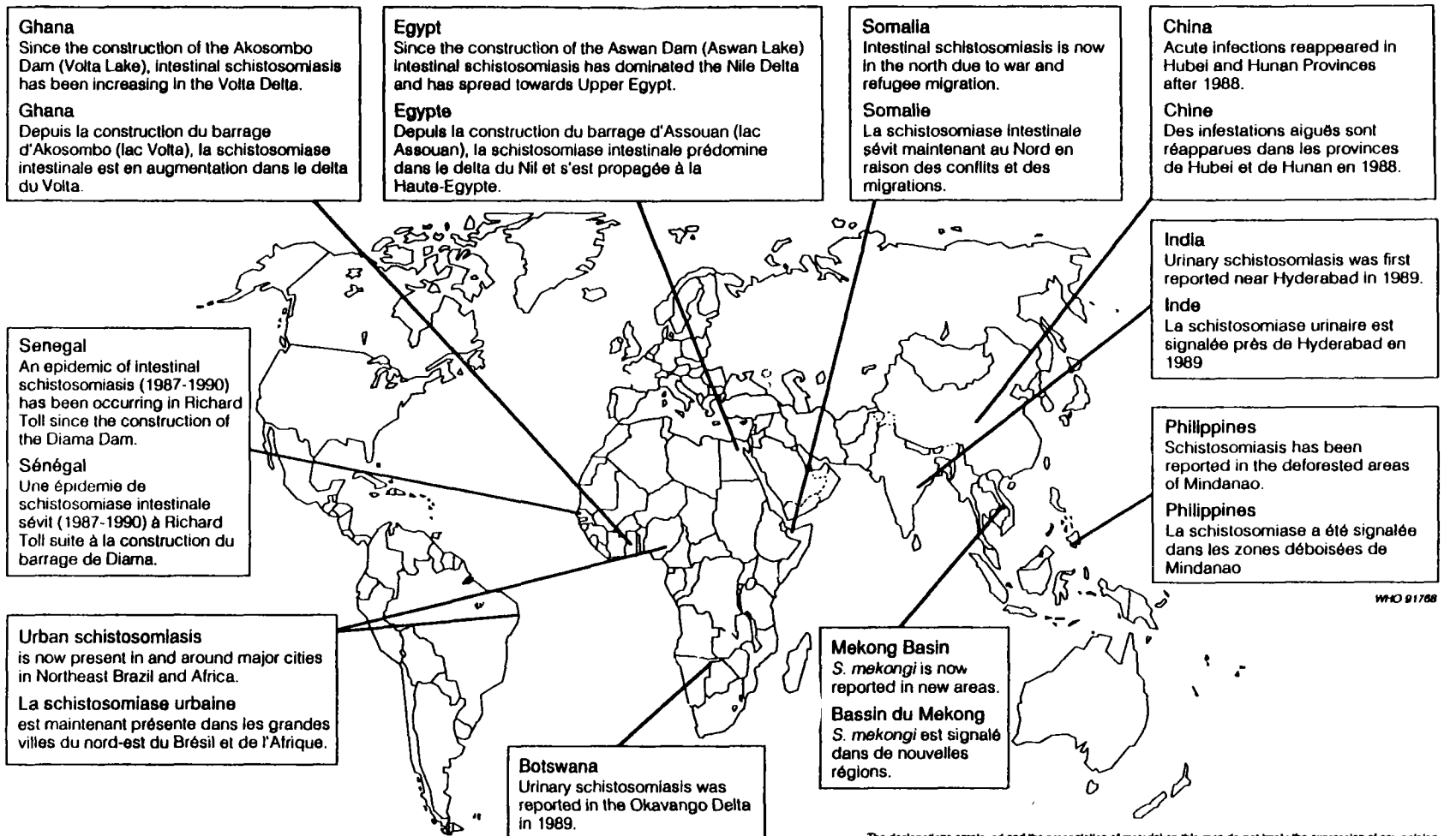
Schistosomiasis, or **bilharziasis** as it is often known (after its discoverer, Theodor Bilharz), is transmitted through freshwater snails. It is such a common threat affecting humanity that it ranks second among human parasitic diseases in terms of socio-economic and public health importance in tropical and subtropical areas, immediately behind malaria. In terms of prevalence, it is considered the major risk in the rural areas of Central China and Egypt. In the mid 1980s, the World Health Organization estimated that about 200 million people were infected with schistosome parasites and 500 to 600 million more people at risk to be infected. Schistosomiasis is endemic in 76 developing countries. In many societies, the urinary form of the disease is so common that it is regarded as a sign of maturation in children. In reality, the blood in the urine is the result of damage of the bladder caused by eggs deposited by the schistosome.

It is mainly a rural and occupational disease that particularly affects those living amidst poverty, ignorance and substandard hygiene in poor housing, and with little sanitation. People contaminate the environment with the parasite schistosome by their unsanitary habits. Thus, altogether, schistosomiasis can potentially threat the health of as many as 600 million people as they perform domestic daily activities related to water, from fishing and farming to washing, bathing and swimming. The latter explains why in many areas, a large proportion of the children is infected by the age of 14. Swimming, a recreational activity much appreciated by children living in tropical areas, makes schistosomiasis a disease widely spread among them because the more numerous their contacts with infected water, the worse is the infection.

No wonder that the increased population movements and the concentration of the rapidly expanding population in tropical countries' peri-urban areas (especially in northeast Brazil and Africa) constitute a concentration of risk. The more people infected with the schistosome parasites, the higher chances for the disease to develop to its worst. When health scientists claimed that the control of the disease due to the schistosome parasites *is feasible* and that the disease is caused *by people* and not snails, it almost created a revolution. Self-responsibility is not always easy to face – more especially when it is related to our own habits. It is difficult to accept that we are often sick because of those habits – including smoking and inappropriate diet.

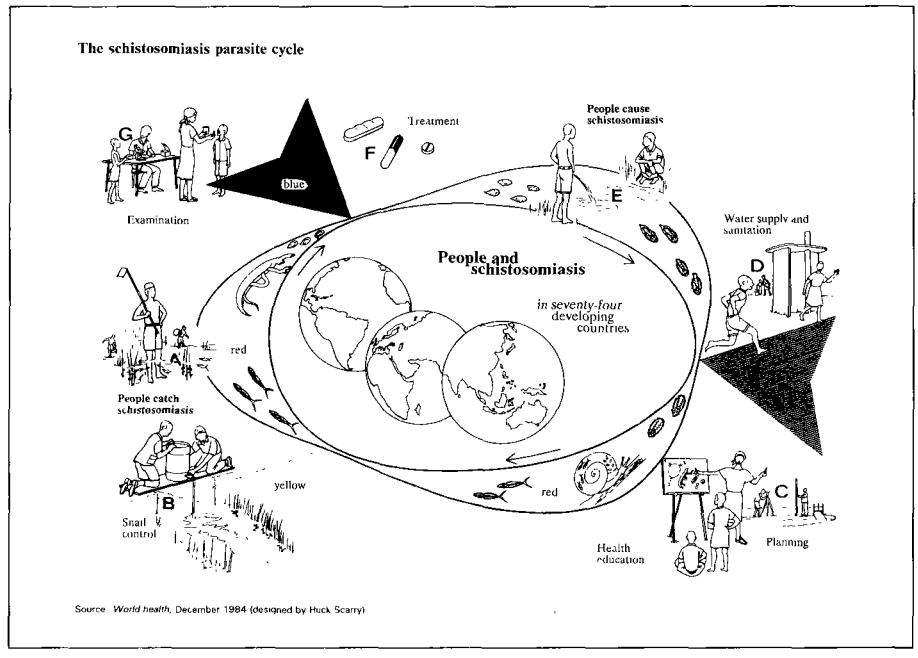
Schistosomiasis – changing with the environment – Highlights from 76 countries

La schistosomiase évolue avec l'environnement – Exemples marquants pris dans 76 pays



Source: World Health Organization/Organisation mondiale de la Santé, 1991

Although animals may be infected with these parasites, especially in Asia, the transmission of schistosomiasis can be best understood if "*considered man-oriented*" rather than from the standpoint of snails: Schistosoma worms live in the blood vessels that line the intestine and the urinary bladder. The eggs, produced by the female worms, are eliminated in the faeces or in the urine, through the coating of the vessels, intestine and bladder damaging them. In water, the eggs break open and give way to the young parasite, called a *miracidium* which swims rapidly in search of a freshwater snail where it develops in 4 to 7 weeks, and multiplies into a new form, the *cercaria*, that breaks out of the snail into water. As the long forked-tailed cercaria penetrates the skin of a person (using secretions from its special glands), its tail falls off. It takes it only 48 hours to get through the human skin to the blood vessels and, within several weeks, the young parasite transforms itself into a male or a female worm – which leads to a new cycle of egg production.



But whether we admit it or not, human parasites are usually an indication of a lack of individual cleanliness and hygiene and, therefore, of habits reflecting a lack of health understanding,which as far as schistosomiasis is concerned has greater importance than ever before. The more numerous population, the more chances for the parasite to proliferate.

The eradication of the disease is not considered to be a realistic target, but the reduction of its prevalence so that the disease is no longer a major public health problem is definitely feasible. It can be achieved by reducing people's contacts with infected water and provision of potable water, together with appropriate chemotherapy for treatment of infected people. Among the resources available for the control of the schistosomiasis, three drugs (included in the "Model List of Essential Drugs" established by the World Health Organization) are effective and safe :

- Oxamniquine, used exclusively to treat intestinal schistosomiasis in Africa and South America, was adopted as a large-scale treatment in Brazil where it considerably reduced the prevalence of the disease and, more especially, its consequences among schoolchildren.
- Metrifonate, originally developed as an insecticide, that is used to treat urinary schistosomiasis.
- Praziquantel, that is effective against all forms of schistosomiasis.

But schistosomiasis is one of those diseases that can be rather easily controlled through the deployment of primary health care's essential elements, namely health education, water supply and sanitation, maternal and child health, and drug treatment. Ideally, in a number of endemic areas the comprehensive approach of primary health care could reduce the prevalence of schistosomiasis by up to 75 per cent within two years. Nevertheless, surveillance and maintenance should be maintained for ten to twenty years to ensure the control of the disease.

DIARRHOEAL DISEASES AND CHOLERA

Diarrhoeal and enteric diseases: major killers

In developing countries, diarrhoeal diseases (together with acute respiratory infections) are the leading cause of children mortality. In 1990 alone, according to the World Health Organization, there were 1.2 billion diarrhoeal episodes... which have killed about 4 to 5 million children under five years of age. Every year in tropical countries, children less than three years old may each suffer an average of two to four episodes of diarrhoeal. One-third or more of this age group is still killed by diarrhoeal diseases, constituting the major killer of under fives.

Lack of sanitation, where waste-water makes contact with water used for drinking, cooking and washing, constitutes the breeding-ground for diarrhoeal diseases. It is unfortunately a common way of living in the rural and urban slums areas of the tropical countries, where people have no other choice.

As it stands, diarrhoeal diseases along with schistosomiasis are so commonly spread in these regions that their episodes are still accepted in many places as part of the normal process of growing up. On the contrary, diarrhoea hinders this process because it generates a tragic vicious circle.

Counteracting dehydration is now feasible. The joint massive efforts of the World Health Organization and UNICEF have permitted the wide delivery of a simple method of oral rehydration, the ORS (oral rehydration salt) formulation, and the education of mothers so that they will no longer follow such harmful practices as starving the child "to rest the bowels", but on the contrary will continue breastfeeding, adopt appropriate weaning practices during and after the illness of their child and boil water used for drinking and cooking.

The integration of diarrhoeal disease control into the existing programmes of primary health care, once again, is a strong support for the reduction of the toll of diarrhoeal diseases on children. About a decade ago, one-third of the beds in children's hospitals in endemic areas were usually occupied by diarrhoea patients receiving expensive intravenous fluids, antibiotics and other drugs. This created a heavy burden for the countries' limited public health budgets. Now the intravenous fluid therapy is provided only for cases of severe dehydration.

The World Health Organization stresses the need to encourage mothers to breastfeed their children, because of the natural immunity and the nutritional benefits provided by mother's milk.

Research in developing countries has shown that infants fed on milk formula are four times more likely to suffer from diarrhoea, five times more likely to be weaken by a persistent episode that lasts more than two weeks and twenty times more likely to die from diarrhoea than are babies fed by mothers milk alone. The toll is due to the lack of basic hygiene: in most cases, water used with milk formula is not boiled and, therefore, infective agents remain active.

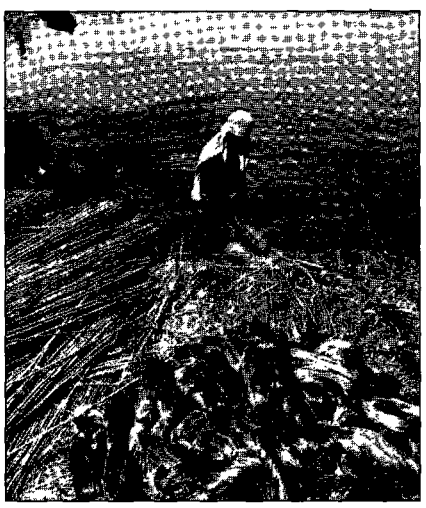
Cholera outbreaks at a catastrophic pace

More than 90 per cent of cholera cases are mild. They are often difficult to distinguish clinically from other forms of acute diarrhoea. The infection is caused by a bacterium called *Vibrio cholera*. It becomes endemic where the temperature, humidity, rainfall and population density are high. Such conditions for its persistence are particularly concentrated in the coastal regions, in the main delta regions and along rivers. In January 1991, an epidemic of cholera arose in Peru. From there, it spread rapidly to Brazil, Colombia and Ecuador, then jumped into Central America. Rapid intervention from the world community helped to stabilize the situation. At the same time, the disease was sweeping through Africa. In July 1991, ten African countries reported, altogether, a toll of 45,159 cases and 3,488 deaths. Asia reported 6,776 cases and 68 deaths, while Europe a single case.

Cholera, another disease of under-development

The rainy season is often linked with peaks in cholera cases. Thus, the situation may worsen with each new monsoon season, – or summer in Africa. This is more especially the case in Africa where the pandemic is entering in its fourth decade. The reasons why cholera has progressed more rapidly in Africa than in Latin America are linked with a lack of health infrastructure, especially in densely populated human settlements where water supply and sanitation are deficient, and hygiene is poor. Consequently, food is easily contaminated. The rapid progression of cholera in Africa witnesses that it is a disease of poverty and under-development. Its absence of progression in Chile reflects probably the high level of coverage of the population with water supply systems (more than 80 per cent).

The alarming number of cases reported as of mid-July 1991 gives an idea of the situation of this emergency. It calls for increasing the efforts to educate the public and to train a greater number of health care workers to use ORS to prevent death from rehydration whereas the long-term solution consists of improving the quality of water supply and sanitation.



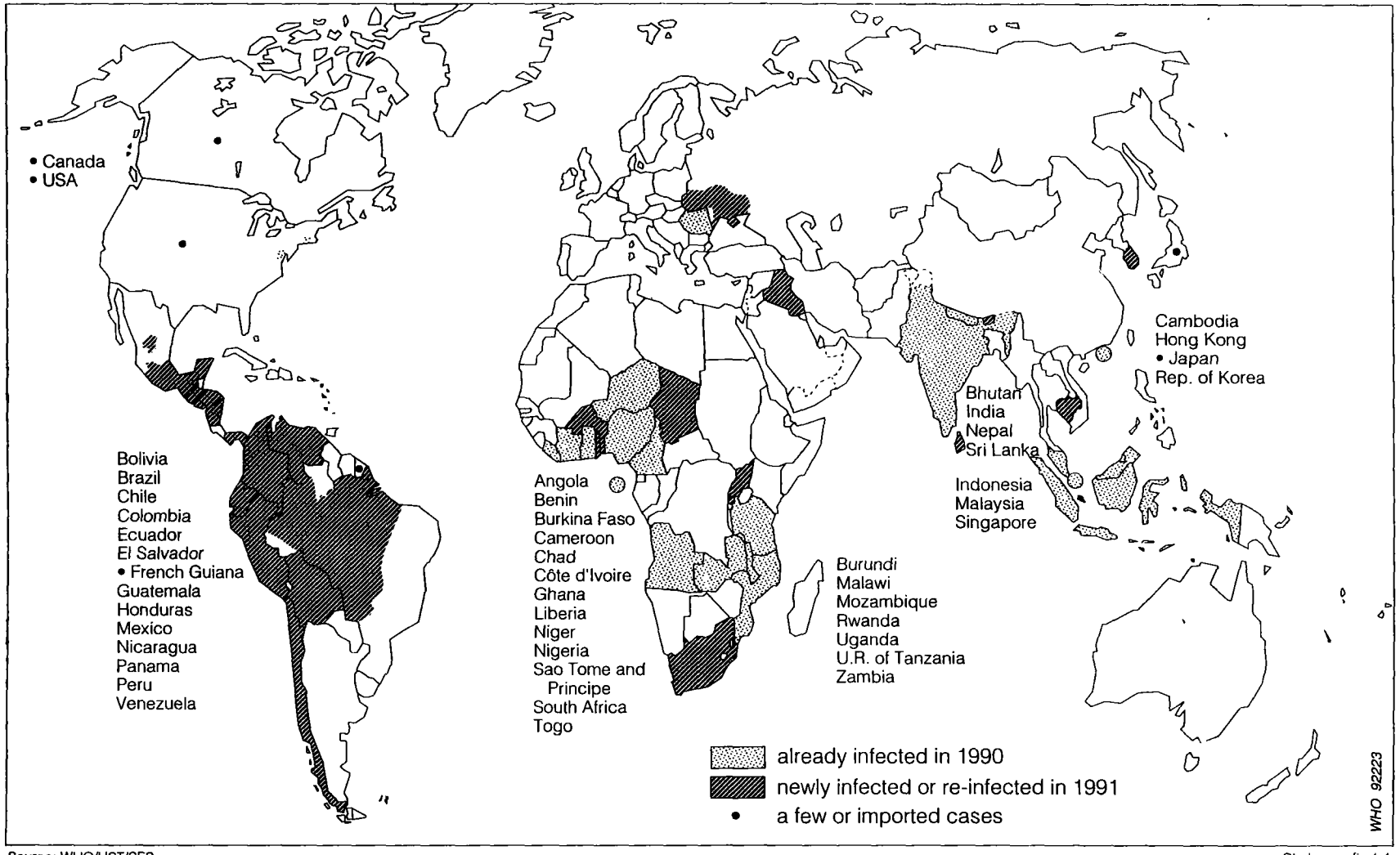
Cumulative figures of cholera cases and deaths for 1991, as reported by countries to WHO*.
Global update as of 1 March 1992:

	Cases	Death
AFRICA		
Angola	8 412	247
Benin	7 474	259
Burkina Faso	537	61
Burundi	3	0
Cameroon	3 560	729
Chad	13 409	1 313
Côte d'Ivoire	604	116
Ghana	13 095	409
Liberia	132	40
Malawi	8 088	245
Mozambique	6 624	273
Niger	3 227	365
Nigeria	56 352	7 289
Rwanda	466	28
Sao Tome et Principe	3	1
South Africa	12	0
Togo	2 396	81
Uganda	279	28
United Republic of Tanzania	5 676	572
Zambia	11 789	996
THE AMERICAS		
Bolivia	186	12
Brazil	1 299	20
Canada	2 i	0
Chile	41	2
Colombia	11 979	207
Ecuador	46 284	697
El Salvador	1 037	34
Guatemala	3 530	47
Honduras	11	0
Mexico	2 690	34
Nicaragua	1	0
Panama	1 177	29
Peru	321 034	2 896
United States of America	25 i	0
Venezuela	13 (8 i)	0
SOUTH-EAST ASIA		
Bhutan	422	19
India	4 262	79
Indonesia	6 202	55
Nepal	31 120	875
Sri Lanka	68	2
WESTERN PACIFIC		
Cambodia	770	97
Hong Kong	5	0
Japan	93	0 (66 i)
Malaysia	201	2
Republic of Korea	112	4
Singapore	34	0 (4 i)

i imported

* Europe and Eastern Mediterranea excluded.

Countries, or areas within countries, reporting cholera in 1991



Source: WHO/HST/SES

Choleragrafix 1.4

DENGUE

A growing threat

In the mid 1980s, the World Health Organization estimated dengue, also known as the "break bone fever", to be a threat to more than 340 million people. The number has been growing ever since. Dengue was almost unknown except in Asia until the great movement of population during the 1940s. It almost created havoc in Cuba during the 1970s. Since then it has remained engraved in public health archives, and it is no longer considered a minor disease in terms of public health importance. Where urban areas expand into the countryside, where the transmitting mosquito, *Aedes aegypti*, is present, dengue may develop rapidly.

In Asia, peasants ploughing a ricefield with the help of buffalos are much exposed to diseases associated with water.

Symptoms last for a few days. They include severe headache and pains in the muscles and the joints, fever, sore throat, running of the eyes and severe eruption of the skin. It is seldom fatal but infected people are left debilitated and require long periods of convalescence. Aspirin and codein relieve the pain, and calamine lotion helps in easing the itching irritation of the skin. Because mosquito abatement is financially still often unrealistic, a dengue vaccine is needed to provide the control of the disease. Unfortunately, as yet, the immunopathological mechanisms causing the disease are not sufficiently known to develop the vaccine.

JAPANESE ENCEPHALITIS

Japanese encephalitis (also called viral encephalitis and polio-encephalitis) is caused by a virus closely related to the Dengue virus (the understanding of both would benefit the immunization strategy for each disease). It is currently expanding throughout the rice-growing regions of Asia where its epidemics create disarray and fear that are comparable to the situation created by poliomyelitis before the development of polio vaccines. The virus infection of the brain is transmitted by a mosquito-bite. It is particularly damaging to the grey matter of the cerebral hemispheres and the brainstem.

The available vaccine requires several administrations and its production is still costly. Hence researchers are challenged to develop an inexpensive and highly immunogenic vaccine that would produce life-long immunity through a single innoculation. Such a development would help the most vulnerable and less affluent populations of the world.

POLIOMYELITIS

Since the introduction of polio in the 1950s, poliomyelitis has been almost eradicated in the majority of developed countries. The last case in the Americas may have been observed in 16 April 1991 in Colombia. Yet it remains uncontrolled in the tropical countries of other continents. A total of about 2 000 million people are at risk in about 70 countries of the tropics. Until the early 1980s, when surveys of lameness in schoolchildren were launched, it was believed that the incidence of the paralytic disease was very low in these countries. Since then, it is recognized that large epidemics have been recorded in many developing countries.

The infectious virus of poliomyelitis is excreted in the faeces of an infected person. Symptoms begin to appear about a week to twelve days after infection. In most cases, only the throat and intestines are infected and the symptoms are similar to those of influenza. In non-paralytic poliomyelitis, in addition to these symptoms, muscle stiffness appears in the neck and the back. In the worst cases, the infection affects the central nervous system and the milder symptoms are followed by weakness and eventually paralysis of the muscles. When it affects the muscles of the respiratory system, breathing is affected and requires a respirator, or the disease becomes rapidly fatal.

Were it not for the burden of poverty, the control of poliomyelitis through both immunization and appropriate sanitation would be technically possible to eradicate poliomyelitis from the world.

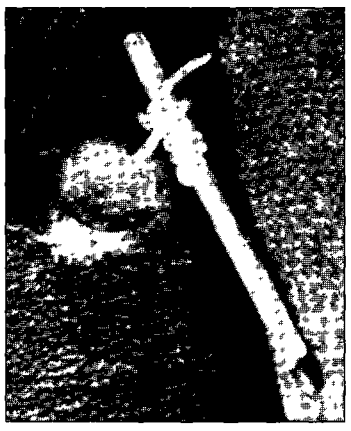
FILARIASIS

Its various forms affect some 300 million people throughout the tropical regions. Among the eight filarial parasites accounted for infecting humans, *Wuchereria bancrofti* and *Brugia malayi,* transmitted by mosquitoes, infect about 250 million people mainly in Africa, Egypt, the Indian subcontinent, South-East Asia, China, the Pacific Islands and the Philippines.

The parasite is a long threadlike worm that lives in the lymphatic vessels and lymphatic connective tissues where it provokes inflammation. Eventually, the lymph vessels are blocked. This causes swelling (known as "elephantiasis") of the arms, legs and genitals.

Another filarial parasite, *Loa loa*, is transmitted by a type of horse fly in some African regions. Adult worms move around the subcutaneous connective tissues, producing swelling, and sometimes cross the white of the eye – which causes great discomfort.

DRACUNCULIASIS, or GUINEA WORM



This tropical disease is transmitted to man by contaminated drinking water. About 65 million people are at risk and 15-18 million infected.

The white threadlike adult female of the *Dracunculus medinensis,* 60 to 120 cm long, lives in the connective tissues under the skin where it releases its larvae into a large blister on the arms or on the legs. When the limbs are immersed in water, the larvae escape and are eaten by copepod *Cyclops*, in whose body they continue to develop.

Treatment consists of injections of phenolthiazine, that kill the adult worms.

ONCHOCERCIASIS or "River blindness"

An estimated minimum of 86 million people are at risk from 'river blindness' and 17.8 million persons are infected per year, mainly in Central Africa and Central America. The effects of the disease caused by the worm *Onchocerca volvulus*, transmitted by the black fly or *Simulium damnosum*, are terrible. At the beginning, the infection usualy develops unnoticed. The larvae develop slowly. But the worms may live about twelve years and thet produce millions of embryos that invade he skin, causing itching. Fibrous nodular tumours grow around the adult worms settled in connective tissues and deep organs. When they invade the eyes, they can progressively cause total or partial blindness – namely the river blindness of Africa.

The blackfly breeds in fast-flowing river waters, rich in oxygen and nutrient matter and the worm that develops inside the fly does not survive when the average temperature of the atmosphere is less than 18º C; hence the disease is transmitted principally in tropical countries.

Because of the heat, farmers work naked from waist up and with bare legs that are thus exposed to blackfly attack. In some regions of Africa, the number of infected people is so high that it is common to see a young child leading a string of adult men through a village. Although few of them are rarely over 35 or 40 years of age, they usually look old, skeleton-like and with sightless eyes.

The macabre procession of people suffering from onchocerchiasis. In the past, fearfull for their sight, villagers abandoned their homes with the exception of a few old blind persons (see back cover).

WATER AND POPULATION

Diseases associated with water and poverty

The population living in the developing countries (excluding China) is estimated about 2,485 million. In the mid 1980s, according to WHO, only 1,425 million of these had access to reasonably safe water supply. Disparities are important between urban and rural areas, and even more dramatic when it comes to the more populous ones. The situation worsens in the least developed countries.

Coverage in water supply (percentage)

Region	Urban areas	Rural areas
Africa	78	30
Central & South America	90	62
Western Pacific including China	91	82
South-East Asia	79	72
Eastern Mediterran.	98	49

Coverage in sanitation (percentage)*

Region	Urban areas	Rural areas
Africa	54	21
Central & South America	79	37
Western Pacific including China	99	97
South-East Asia	50	13
Eastern Mediterranea	62	20

* The figures do not imply that waste is properly treated.

Source: World Health Organization. International Water Supply and Sanitation Decade — End Decade Evaluation Report, 1991.

Many people still live without water piped directly into the house. This has direct and important implications on health since it restricts the use of water to wash clothes and eating utensils, for cooking and for personal hygiene. People instead must carry water for sometimes a long distance and even queue at the tap. In addition, public water supplies are often contaminated by sewage in poorly maintained water distribution systems. Moreover, sewers are not always equipped for te hygienic removal of fecal matter; they often run directly into the rivers, the lakes and coastal waters from which low-income populations draw their water or fish for their food.

Ill health and water in crowded cities

In densely populated areas, the impact of water pollution on health, more especially on child health, is extremely important. High concentrations of heavy industries, usual in such areas, cause much pollution of air and water that generate a very high level of premature deaths, ill health and sometimes deformations, among infants and children.

Diarrhoeal diseases often exacerbating or causing malnutrition, have a particularly high prevalence in the mortality in children under two years of age. The scarcity of water, often contaminated due to the lack of sewers for disposal of human wastes, in addition to poor housing conditions that draw a high density of insects and rodents, poor personal hygiene and general poor hygienic conditions are typical of the urban slums.

Population movements and water

Migration is a factor of growing importance in public health. Diseases which, about a decade ago, were considered as primarily rural diseases have become endemic in urban areas. This is due to the migration of masses of refugees and people seeking work that has led to unplanned urbanization, sometimes promoted by land speculation.

The environment of poverty

New road or embankment works, hastily made, create small lagoons that favour the transmission of diseases related to water, such as malaria, yellow fever, dengue and schistosomiasis. The same risks occur with the accumulation of stagnant water pools around the illegal settlements, houses or shacks built by squatters on unoccupied sites. In addition, people in lower income groups often choose dangerous or polluted sites because they are the cheapest and the best-located sites available to them. Connections to water (and electricity) are usually illegal, precarious and often of dubious quality.

Although they have hardly the time and energy to take responsibility for their own waste water disposal, various projects have shown that the promotion of behavioural changes can be achieved.

Human pressure on coastal zones

The coastal zones include the continental plains on land and the continental shelves in the ocean. They amount to 8 per cent of the earth's surface. Population growth puts an increasing pressure on all coastal zones. Some have compared the extent of the damage already caused in the shallow water of many coasts with the deforestation of tropical rain forests. The impact of the damage will affect future generations of our planet. It already and directly affects the people living in the tropical regions and more especially the most underdeveloped countries.

In 1982, in Nouakchott, Mauritania, an estimated 64 per cent of the population (then totalling more than 250,000 people) was living in largely self-built settlements.

Two-third of the slum population of São Paulo live in areas prone to floods and landslides, 98 per cent of the house have no access to sewers or septic tanks, and 80 per cent have no drinking water.

In Bombay, 65.5 per cent of the population living in the low-income area suffers from gastrointestinal disorders.

In **the Caribbean,** the enclosed water bodies of the bays in Cuba receive effluents from petrochemical and chemical industries, fertilizer production food processing, etc. In some areas, mercury contamination is particularly serious. In **West and East Africa,** though industrial pollution is not dominant, some places receive effluents from light chemical industries, slaughter-houses, food processing, leather and textile production. In **Southern Asia,** pollution in coastal waters comes from three main urban areas: Bombay, Calcutta and Madras. It includes contaminants from most types of light and heavy industries. In **South China**, industrial waste-water containing a high concen-tration of heavy metals, pesticides and petroleum hydro-carbons is released in vast quantitites in the coastal waters. In the **South Pacific,** mining is the most characteristic industrial activity. It results in the pollution of river and coastal waters with silt, particularly in Papua New Guinea and, to a lesser extent, in New Caledonia and Fiji.

According to the United Nations estimates, the current world's population of about 5 billion may double during the next century and by the year 2000, 75 per cent of the world's population will live in a strip not wider than 60 km along the continents. Already the highest density and number of people are found in the coastal zone. Since the phenomenon is accompanied with the highest rate of population growth, the consequences will worsen and may even be beyond our imagination.

We are only beginning to understand the environmental degradation of coastal water and its disastrous impact on both human health and marine life both because it is relatively recent and because deterioration is not as obvious under the surface water as it can be on land.

Due to prevailing poverty, enormous quantities of untreated or inadequately treated sewage are discharged into the marine waters near major population centres. The consequences are multiple: eutrophication, depletion of the water oxygen, increased turbidity, increased growth of algae and infectious agents. Although large-scale industrial pollution with heavy metals and man-made persistent organics is widespread in the Northern hemisphere, it is still not common in tropical coastal waters. Yet, "hot spots" are evident, in addition to land erosion resulting from land reclamation, conversion of mangrove forests and coastal wetlands into agricultural land or fish/shrimp ponds.

Manifold impacts on health

The situation is such that human health is now increasingly threatened both through contact with water and through the consumption of sea-food. Important algal blooms (red tides of dinoflagellates and blooms of blue-green algae) and jelly-fish outbursts are increasing in most tropical coastal zones and this seems in relation with the growing incidence and scope of outbreaks of debilitating intoxication and paralytic poisoning in people earning their living through fishing. Though rarely fatal, the poisoning may have long-term effects. Sea-food is often contaminated by pathogens. Consequently, outbreaks of cholera, dysentry, viral hepatitis, poliomyelitis and typhoid have become more frequent.

Think wet

Along the coastal zones of our planet, until very recently, could be found the most productive and ecologically diverse biomes. This intensive biogeochemical activity is being threatened at an extremely rapid rate. The accelerated destruction of coastal habitats will inevitably lead to an important loss of food-protein. This means more malnutrition among populations already suffering from poverty. People living on the tropical and subtropical coasts depend much more on fish protein than in temperate countries. Mangrove elimination has many direct detrimental effects on coastal fish production.

In India, eight out of the ten commercially most important fish and shellfish species use the mangrove as spawning and breeding grounds. In Puerto Rico and US Virgin Islands, about 60 per cent of the fisheries are directly connected to coral reefs which are increasingly submitted to destruction (coral is extracted as building material, removed by tourists or destroyed during fishing due to the extensive use of explosives, poison such as lindane, DDT or strong bleach, and electric shocks). The effects are disastrous to maintain on a sustainable level the biodiversity and therefore the fishery, and consequently the precious source of fish protein for human nutrition.

Fish may represent the only source of proteins among the poorest people. It enables children to grow normally. Only small quantities of fish are necessary to bind their proteins with those contained in the vegetables, cereals and tubers constituting the basic diet in Africa and Asia, and thus, in so binding together animal and vegetal proteins, to enable the child's tissues to grow. In their struggle for life, low-income populations of the coastal zone in the tropics are led to overexploitation that is rapidly destroying their resources. This kind of environmental degradation is increasingly affecting not only the health of the poorest populations but their very survival if better planning and management, and more appropriate technologies, are not urgently introduced.

In 1985, according to the Food and Agricultural Organization of the United Nations (FAO), 40-100 per cent of animal protein were obtained from fish by 60 per cent people living in the developing world.

In Asia alone, over one billion people depend entirely on fish protein.

Three Orang Asli die after fish meal

KLUANG, Mon. — Three Orang Asli children died of suspected poisoning after eating *ikan buntal* in Kampung Punan yesterday.

They were Suhaimi Kepayang, five, his brother Nizam, six, and their sister, Comi, seven.

Their pregnant mother, Karang Marefin, 30, and eight year-old brother, Nizar, who both ate the fish are in the intensive care unit of the district hospital here.

A spokesman for the district's Orang Asli Affairs Department said that the half-kilo fish was caught by Karang from the Sungai Endau, near the Orang Asli settlement, about 5pm yesterday.

SUSTAINABLE HEALTH: MAKING IT WORK FOR FUTURE GENERATIONS

Appropriate technology

It is recognized that the improvement of health contributes to increased productivity and to the wellbeing of communities. This also implies that literacy should be increased in order to reach people with relevant information. When it is culturally adapted to the local culture, information on health becomes more easily acceptable to the community and an effective means of adult education.

Appropriate technology does not apply simply to "technically sound" technology. According to the World Health Organization, "it involves technologies and methods that are scientifically sound, adapted to local needs, and acceptable to the community (which means culturally acceptable) and that can be maintained by the people themselves, in keeping with the principle of self-reliance, with the resources the community and the country can afford".

The appropriate technology approach is often based on a correct understanding of traditional skills. This requires a keen sense of observation. Judicious timing is also necessary to introduce a complementary approach to "large-scale techniques". The integration of the resource-based knowledge of local people with modern technological know-how relies on flexibility: adapting and being adopted and updated to changing economic and social circumstances. Indigenous populations and tropical villagers generally have a deep knowledge of the relations between man and his environment.

Appropriate technology constitutes an important step in working more closely in the perspective of a sustainable development, that is to say ecologically-sound development.

Building a new lifestyle

An important effect of the active participation required of a community in its own development scheme is that it reflects on the community's health-related behaviour for many years afterwards, on its responsible attitude and on its level of self-reliance due to the new skills the people gain by working together with water technicians and health workers.

Bringing water and sanitation to villages conveys an idea of both wealth and health. Cooperation developed between a community and health workers, teachers, agronomists and water-engineers may have double-fold results: the eradication of a number of contagious diseases and a better social coherence, sometimes at very little cost.

Community participation

The concept of primary health care is essential for the health development of tropical countries, especially in poor rural areas and slum-outskirts of big cities. In many instances, better education, proper nutrition, the provision of drinking water and sanitation, good housing, and a suitable working environment have made a more significant contribution to improving the level of the populations' health. The number of factors influencing the presence of diseases outside the so-called health sector indicates the need for intersectoral action. This makes communities active and decisive partners.

It also means that water resources should be considered from a total integrated management perspective — the hydrological cycle must be remembered. Violation of indigenous communities' traditional laws will result in disaster. Diseases associated with water demonstrate clearly that health cannot be equated with medicine, hospitals and doctors alone, nor can it be isolated from national socioeconomic development planning.

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– School posters: 10, 33.

The International Hydrological Programme

The developing nations of the humid tropics of the world will represent nearly one third of the earth's population by the end of the present decade. In the 21st Century, these nations will probably pass the developed countries in numbers of people. Such a population shift will alter existing international economic and geopolitical relationships.

With this major change looming on the horizon, coupled with the need to treat the tropical resources wisely, the United Nations Educational Scientific and Cultural Organization (UNESCO) and the United Nations Environment Programme (UNEP) joined with twenty-two other organizations in July 1989 to hold the International Colloquium on the Development of Hydrologic and Water Management Strategies in the Humid Tropics. The International Hydrological Programme of UNESCO was the lead organization.

The Colloquium developed strong evidence that the present situation, including the question of tropical forest depletion, is not only in need of serious consideration, but that the potential for vastly increased negative human impacts will be quite significant if they are not adequately considered now. It was noted that although the characteristic of the humid regions is an overall abundance of water, this very abundance – and the variability of its distribution – is one of the leading contributors to the difficulties.

This non-technical volume on health aspects is one of several publications having their origin in the Colloquium. An executive summary of the Colloquium, *Water-Related Issues and Problems of the Humid Tropics and Other Warm Humid Regions* was released shortly after the Colloquium was held at Australia's James Cook University. A formal scientific text embodying the Colloquium papers and supplementary material is being prepared. Additional popularized volumes on selected aspects of water-related problems in the humid tropics and other warm regions are planned.

Further information on any of these publications can be obtained from the International Hydrological Programme, Water Sciences Division, UNESCO, 7, place de Fontenoy, 75700 Paris, France.

MAB Programme Activities in the Humid Tropics

Improving the scientific understanding of natural and social processes relating to man's interactions with his environment, providing information useful to decision-making on resource use, promoting the conservation of genetic diversity as an integral part of land management, enlisting and coordinating the efforts of scientists, policy makers and local people in problem-solving ventures, mobilizing resources for field activities, strengthening of regional cooperative frameworks. These are some of the generic characteristics of the Man and Biosphere Programme – one of the UNESCO's sister environmental programmes to IHP.

MAB, launched in the early 1970s, is a nationally based, international programme of research, training, demonstration, and information diffusion. The overall aim is to contribute to efforts for providing the scientific basis and trained personnel needed to deal with problems of rational utilization and conservation of resources and resource systems along with the problems of human settlements.

MAB activities are undertaken in cooperation with a range of other international programmes and organizations. IHP-MAB linkages include joint sponsorship of collaborative field research and training initiatives, such as the role of land-inland water ecotones and their role in landscape management and restoration. Associative links between IHP and MAB are also relflected in synthesis reviews and publications such as this one within the IHP Humid Tropics Programme Series. Other collaborative initiatives between MAB and IHP concern work on eutrophication and its practical control in lakes and reservoirs, the special water problems of the cities, water awareness in planning and decision-making, and water and nutrient balances of tropical rain forest ecosystems subject to disturbance.

The World Health Organization

As defined in the WHO Constitution "health is not the mere absence of disease or infirmity, but a state of complete physical, mental and social wellbeing". This calls for an intersectoral approach to health. With leading scientists and research institutions, WHO has developed the concept of primary health care which was launched during the International Conference held in Alma Ata in 1978. Provision of adequate quantities of safe water is one of the key elements of the Primary Health Care Approach. The strong emphasis on community participation has stimulated the involvement and the cooperation of sectors of national and community development such as education, agriculture, public works, communications and others. It has catalysed the coordination of countries and communities' efforts to design development projects that integrate community participation and at a cost that the community and country can afford.

Health in the tropics is of main concern to WHO. The toll of diseases related to water in these regions is increasing together with the population growth and the economic and ecological crisis.

When these diseases do not kill, they are debilitating and thus constitute major obstacles to development. Health of the population who lives in the humid tropics depends heavily upon the sound management of their natural environment and the dissemination of appropriate messages in health education. Hence WHO cooperation with UNESCO and UNEP is of particular importance to overcome the water-related diseases that, in the tropics, remain a scourge and are essential obstacles to sustainable development.

Scientific understanding of interactions between land, vegetation, oceans, atmosphere and human actions is one of the IHP's priorities in the humid tropics. By definition, the problems are multidisciplinary, and the IHP encourages an integrated approach in studying the various links and linkages that make up the world water cycle. This is accomplished by globally and regionally coordinated cooperative efforts of networks of experts and organizations, facilitated by the establishement of regional administrative centres — "centres of centres".

In the long run, of course, IHP wants to see the application of hydrological research results to integrated water management strategies. These include: improving agricultural productivity, providing water for irrigation and people, controlling urban water problems, and developing land-use practices that meet these needs, and at the same time reduce flood damage and the degradation of soils and water. It is expected that good water management in the humid tropics will also bring benefits to areas outside the region. Sustainable development and management is the key to long-term survival.

The Humid Tropics Programme, September 1991.