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3.2.3 The significance of climate change for water-related diseases

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SUMMARY: Even today one third of the world population suffers from water scarcity, both in terms of water quantity and water quality. Global climate change will affect the distribution and accessibility of safe water and thereby substantially influence the incidence of water-related diseases and deaths, especially in developing countries. Changing temperature and precipitation patterns will lead to a higher frequency of extreme weather events. Drought periods as well as flooding will cause a deterioration the quality of watersheds and, subsequently, of water abstracted for human consumption. These mechanisms threaten to cause rising incidences of water-related diseases (i.e., water-borne, water-washed, water-based and vector-borne diseases). Societies face huge challenges to minimise the negative effects of climate change on human health.

The availability of water plays a central role for both individual health and for the health, wealth, and economic development of societies (*Fig. 3.2.3-1*). In the more affluent parts of the world, clean water, hygiene and the resulting health of the population are taken for granted. However, this is not true for a major part of the world population. It has to be feared that, as a consequence of global climate change and despite all the efforts of the United Nations (UN) and its organisations (WHO, UNICEF), this situation will worsen. The consequences of climate change may even affect the water supplies of developed countries. This is why the UN refers to the situation as a world water crisis (UNITED NATIONS 2003). Most probably the quantitative and qualitative water crisis will be the most immediate and menacing consequence of global climate change.

Water scarcity

Water scarcity comprises the two fundamental factors of inadequate water supply, which may threaten human health: Firstly quantitative scarcity of available and usable freshwater, secondly scarcity of water, which is qualitatively capable of being used by humans for drinking, bathing, washing, cleansing, irrigation, cooling etc.

Water-associated disasters, e.g. flooding, form a third type of water-related danger, which may directly affect human health. This aspect will also briefly be addressed (see Chapter 1.12, 3.1.10 and 3.2.8).

Quantitative water scarcity

The precipitation that falls on land surfaces is the predominant source of water required for human consumption, agriculture and food production, and industrial waste disposal processes. It has been estimated that 54% of accessible runoff water is appropriated by humans.

As the *per capita* use of water increases due to changes in lifestyle (leisure and domestic practices) and as population increases, the proportion of appropriated water is increasing. This, coupled with spatial and temporal variations in water availability, means that from a global perspective the water for human use is becoming increasingly scarce (UNITED NATIONS 2003).

Today more than 2 billion people are affected by water shortages in over forty countries: 1.1 billion do not have sufficient drinking water and 2.4 billion have no provision for sanitation. Only half of the children in the developing world have access to clean drinking water, and even fewer have access to sanitary waste facilities.

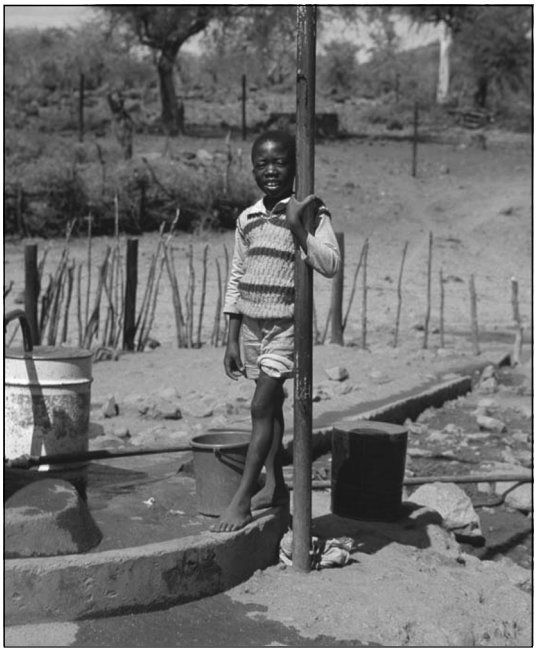

Fig. 3.2.3-1: The continuous availability of water in adequate quantity and quality is of critical importance for health, wealth and development (Foto: Stephan Tungler).

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In Africa the situation is critical. 38% of the population do not have access to a safe water supply, and only 24% have tap water in their household (*Fig. 3.2.3-2*). In 2000, in Equatorial Guinea, the Democratic Republic of Congo, Eritrea, Guinea, Guinea-Bissau, Kenya, Madagascar, Mauritania, Rwanda, Sierra Leone and Chad less than half of the population had access to a safe water supply. In Ethiopia less than a quarter had such access. The difference between rural and urban population is also marked: In rural Africa, only 44% of the population have permanent access to safe water (UNITED NATIONS & WHO 2000).

The average person in the developing world uses 10 litres of water a day. Water is collected mostly by women and children, who walk on average 6 km to get it. In rural sub-Saharan Africa, 44% of women and girls spend at least 30 minutes per day fetching water. At present, many developing countries, mainly situated in Northern and Southern Africa, and the Middle East, have difficulty in supplying the minimum annual *per capita* water requirement of about 1,700 m^3 of drinking water necessary for the active and healthy life of their people. At present, half the population of developing countries lives in water poverty. This situation is particularly grave in many of the cities of the developing world.

Qualitative water scarcity

Qualitative water scarcity signifies the shortage of water of a quality, which is appropriate for human purposes. The quality may be damaged by both chemicals and micro-organisms.

The most frequent sources of chemical pollution are human waste, industrial waste, and agricultural pesticides and fertilisers. Major forms of chemical pollution include industrial organic substances, acidifying substances from mining aquifers and atmospheric emissions, heavy metals from industry, ammonia, nitrate and phosphate pollution and pesticide residues from agriculture, as well as sediments from human-induced erosion and salinisation (UNITED NATIONS 2003).

Infections, which are caused by the use of faecally contaminated water, are called waterborne infectious diseases. Cholera and typhoid fever are classical examples of highly infectious diseases, where only a few organisms are needed to cause severe diarrhoea. Additionally, shigellosis, hepatitis A, amoebic dysentery and other gastro-intestinal diseases are recognised to be regularly waterborne.

More recently, pathogens of non-faecal origin, which are able to proliferate under the specific ecological conditions of water supply systems, have received increasing attention. Legionella, Mycobacterium and Pseudomonas belong to this group. Their proliferation is favoured by raised temperatures (> 25°C), stagnation and the presence of nutrients.

Water-related disasters

Throughout the last decade of the 20th century, 2,557 natural disasters have been registered all over the world, of which 90% were water-related events. Over 665,000 people died as a result of these. The vast majority of victims (97%)

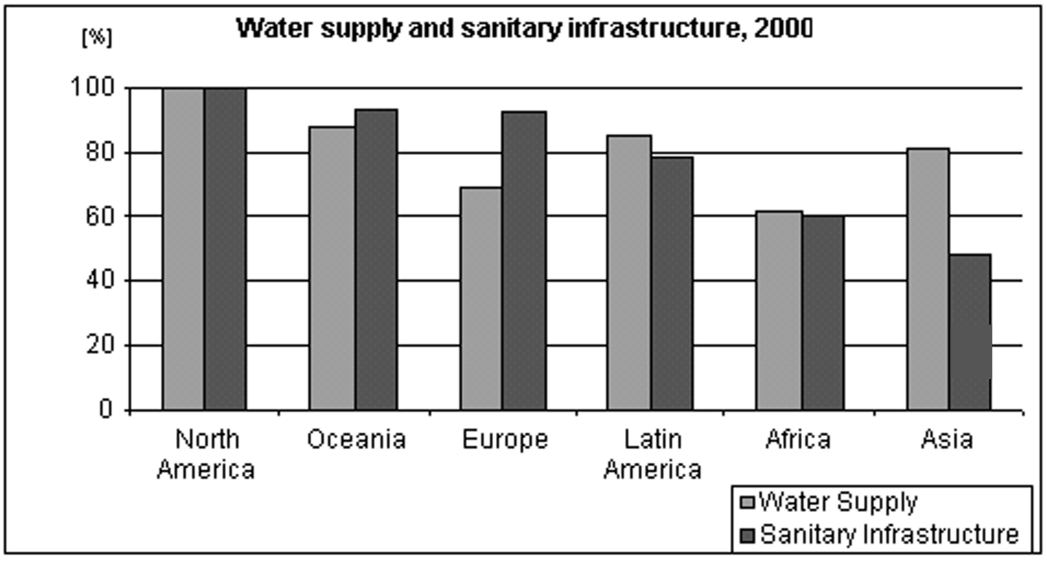

Fig. 3.2.3-2: Amount of population with access to safe drinking water and sanitary infrastructure, 2000, for WHO regions (Source: WHO 2000).

were from developing countries. Growing concentrations of people and increased infrastructure in vulnerable areas such as coasts and floodplains and on marginal lands mean that more people are at risk. While poor countries are more vulnerable, in every country it is the very poor, the elderly, women and children who are especially hard hit during and after disasters. Often societies already affected by a natural disaster are even more vulnerable to the next event. Worldwide, floods are the most frequently reported disaster event. In the year 2000 alone 153 such events occurred.

During floods, in addition to direct physical impacts (drowning, freezing, isolation, damage by water masses or flotsam), the deterioration of the quality of water for human consumption may also have adverse health effects, due to the flooding of both sanitary infrastructure (e.g., sewage treatment plants) and drinking water supply infrastructure (e.g. tanks, purification plants). Additionally, pipe breaks, which regularly occur as a result of undermining, Earth slides and damages to tunnels and bridges permit sewage water to enter drinking water pipes. During the last few years, the problems caused as a result of the Oder and Elbe floods demonstrated that even advanced water infrastructures of European societies may be hit severely.

Droughts however still claim the greatest number of victims (UNITED NATIONS 2003). During droughts, quantitative water scarcity is the predominant health-adverse dimension.

The health consequences of quantitative and qualitative water scarcity

The availability of water in adequate amounts and quality manifoldly affects human health. Under extreme quantitative scarcity the people affected die of thirst within a few days.

More frequently, water scarcity has indirect adverse health effects in that it restricts personal and domestic hygiene. Inadequate washing procedures and frequencies may prompt water-washed diseases, such as trachoma, relapsing fever, and typhus. Water scarcity can therefore lead to increases in disease, poorer food security, conflicts between different users and limitations on many livelihood and productive activities.

It has been estimated that half of the population of the developing world is exposed to chemically polluted sources of water that increase disease incidence. In China, about 85% of all cases of illness associated with chemical contamination of water supplies are linked to pollution by sewage. Enhanced rates of cancer mortality have been tied to the lack of adequate sewage treatment. The poor, many of whose livelihood systems depend directly or indirectly on water resources, feel the impact of such pollution disproportionally (WU et al 1999).

The most recent estimates of the global burden of disease (GBD) suggest that around 6% of GBD is linked to basic hygiene (water, sanitation, food, personal hygiene). This rises to about 15–20% in the 0–4 age group (BARTRAM & HUEB 2000). In 1995, around 19% of deaths among children less than 5 years old in all developing countries were caused by diarrhoea.

However, these estimates do not take account of more severe infectious outcomes that can be transmitted or prevented through unsafe drinking water supply (such as infectious hepatitis or typhoid fever); neither do they take account of water-washed, water contact, nor water-based diseases, i.e. vector-borne or non-infectious diseases (BARTRAM & HUEB 2000). Taking these into account, an estimated 80% of all sickness and disease in the world is attributable to inadequate water supply and sanitation. Transmission of disease may occur through the ingestion of water, scarcity of water, insufficient personal, domestic and agricultural hygiene, through contact with water, through vectors breeding in the water and through contaminated aerosols. At any time it is estimated that half of the world's hospital beds are occupied by patients suffering from water-related diseases. Every year, 2.2 million people in developing countries, most of them children (1.8 million), die from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene. In the past decade diarrhoea has killed more children than all people lost to armed conflicts since World War II. Children in developing countries typically have four to five bouts of diarrhoea a year. Even when they do not kill, these diarrhoea episodes can physically and mentally stunt children, affecting them for the rest of their lives. By lowering immunity levels, diarrhoea increases mortality rates from other opportunistic diseases, especially respiratory infections. A high percentage of children suffer from intestinal infections caused by parasites as a result of poor hygiene and inadequate sanitation. Parasites consume nutrients, aggravate malnutrition, retard children's physical development and result in poor school attendance and performance.

Numerous studies have demonstrated that both the spectrum of water-related diseases and the frequency of water-related infections are increasing. There are many reasons why human water-related pathogens emerge or re-emerge, but most have a common theme and may be grouped under a few general headings. These comprise changes in human behaviour (mobility, demographic change) and vulnerability, new technologies (e.g., sewage treatment alternatives and reuse, water-cooled air conditioning plants, changing industrial and agricultural practices) as well as scientific advances (antibiotics and insecticides, improved methods of detection and analysis), environmental change including climate change and

deforestation, water resources development projects and the increasing complexity of piped water systems (WHO, WMO & UNEP 2003).

Changing runoff conditions, caused by climate change, but as well water resources development projects, which shall amongst others avoid seasonal or regional water scarcity, may prompt new water-related health risks. Reduced stream velocities, stagnation and low water level promote water-based infectious diseases such as schistosomiasis, and water-related vector-borne infections such as malaria and dengue fever, as the alternate hosts find improved living conditions (RIVM 2000).

Aggravated water scarcity as a result of climate change?

Facing the evident trends towards an increasing frequency of extreme weather events it is very probable that flooding and droughts also will increase. For Lima (Peru) the impact of increased precipitation activity for human health has been demonstrated. During the 1997–98 El Niño season, the number of cases of diarrhoea diseases in children doubled (Checkley et al. 2000). Unanimously, ENSO (El Niño Southern Oscillation) has been blamed for the incidence of water-associated infectious diseases (Hales et al. 2000, Jaenisch & Path 2002).

For some rivers a tendency towards reduced low water runoff (see Chapter 3.1.5) has been verified. Due to increasing quantities and concentrations of pollutants and higher water temperatures the water quality will doubtless deteriorate. Population growth and economic development increases the pressure upon inland waters. Within 50 years, about seven billion people in 60 countries will be affected by water scarcity. Climate change is expected to contribute substantially (20%) to the increasing global freshwater shortages in the 21st century (United Nations 2003). Already for the year 2000, WHO estimated climate change to be responsible for about 2.4% of all diarrhoeal diseases (WHO, WMO & UNEP 2003).

Even for Europe the consequences of climate change on the incidence of water-associated diseases have been predicted (Kovats et al. 1999). Under the realistic assumption that the risk of floods will increase, the functioning of drinking water treatment facilities and sewage plants might be disrupted and thus toxic substances and pathogens could reach watercourses and drinking water. The same has to be expected through the mobilisation of chemicals and the damage to water pipes by landslides. In the case of flooding, particularly the risk of infections, which are caused by pathogens, which enter into the human body via small skin and mucosa lesions (e.g., leptospira), is drastically increased. In some parts of Eastern Europe there is no area-wide water supply coverage, or the supply is discontinuous. Concerned residents are extremely vulnerable to the reduction of available freshwater. For instance, constant water supply disruption increases stagnation and thus proliferation of micro-organisms in the water pipes. Additionally, the related and unavoidable water pressure variations increase the risk of surface water entering into the pipes.

For the highly developed drinking water supply structures of Western Europe, North America and Australia it has to be feared that extreme precipitation events may affect the raw water quality in the watersheds and may overstretch the drinking water treatment technologies. Consequently, an increased number of water-borne disease outbreaks may occur. In the USA, lack of importance given to the protection of watersheds and the sewage water system can increase the risk of contamination under extreme precipitation events. More than 950 US counties run combined sewage plants, which in the case of extreme precipitation release untreated sewage water into a receiving water course, which itself serves as a drinking water resource (National Health Assessment Group 2001). For the USA, a relationship between the increased incidence of water-borne diseases and extreme precipitation events could clearly be demonstrated for the 1948-94 period. More than 50% of all water-borne disease outbreaks occurred after events of extreme precipitation (Curriero et al. 2001).

Conclusions

Does climate change pose a substantial health threat? Without any doubt, but the extent of the impact varies and depends, among others, on place of residence, age, gender, health care system, and public health infrastructure. The health effects of climate change can predominantly be traced back to temperature changes, extreme precipitation events, air pollution and infectious diseases. Compared to current health risks the additional individual health impact caused by climate change may be small. The additional global burden of disease of this global phenomenon, however, will be substantial. Particularly regions and populations with already existing environmental or socio-economic problems will experience an above average risk. With regard to water, the sea level rise, floods, droughts and El Niño effects are seen as hotspots of climate change and health. The health consequences of global climate change will also be a huge challenge to the establishment of »health justice«, as energy consuming developed countries are mainly responsible for the climate change, whereas poor countries shoulder the highest health risks (Patz & Kovats 2002)♦