

ENVIRONMENT AND PUBLIC HEALTH

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Summary

The environment is a key factor in determining the health of populations. Environmental pollution has become a worldwide concern. Two phenomena seem to be ineluctable: a global environmental change due to greenhouse effect and an increase of pollutions in soils, air and waters. The ecological and human consequences are still visible; it is highly probable that global climate change will have profound implications for the health of individuals and communities. The problem of providing the entire population of the planet with good-quality drinking water is quite urgent. Chemical and microbial pollution of water resources requires major investments to develop and improve the collection and treatment of waste water with an increasingly focused objective of reducing traces of undesirable hazardous micropollutants. Recent epidemiological studies have identified serious health effects of combustion and transportation derived air pollution; current policies should result in reduced concentrations of air pollutants and improved outdoor air quality. Efforts should be done also for indoor air pollution both in private and public environments. Noise is one of the most insidious pollution in our way of life ; health effect are numerous but not well described and prevention is now a major challenge. Until recently, most of the countries did not take into account the environmental pollution or destruction and their consequences on public health. The goal of international bodies and national governments should be now to learn to manage natural resources and not pollute air, water and soils for continuing to

improve the health of the population.

1. Introduction

When approaching the topic of environment and public health it is initially necessary to decide if environment will be considered in his broad acception including both social and psychological dimensions with the dramatic consequence of social threats like poverty, unemployment, insecurity, bad housing ... These issues are not taken into account in this paper because the scope would be too large, but they are not ignored by the author and some references are made along the text.

Thus this paper deals only with the relationship between the physical environment and public health, excluding, for the same reason as above, the environment at the working place.

The environment is a key factor in determining the health of populations (McMichael & al. 1999). Even if some progresses have been made serious threats are looming. Global economic activities, the escalation of travel and trade, and the changing use of technology all have significant implications for the environment. Erosion of life support systems at a global level has become a serious and pressing public health issue. Climate change poses new and unknown threats to human health and environment (McMichael & al. 1996, Intergovernmental Panel on Climate Change, 2007).

Whereas all are affected by environmental degradation, it is the poor – especially women and children – who bear the main burden. And directly linked to the environmental burden is the increased burden of ill health (Brundtland 1999). The message of the World Health Report (1999) is that the global community has the knowledge and the tools to address the unfinished health agenda of the 20th century (Acheson 1992).

A key message of *Our Common Future* (World Commission 1987) and of the Rio Conference on the environment in 1992 was the need to address health and environmental problems in the context of economic policies and practices. The environment moved on from being a cause for the marginal few to becoming a key issue once the scientific evidence came in and the economic implications of environmental degradation were properly understood. The same approach now needs to be applied to analyse the role of sound health policies and interventions (Brundtland 1999).

Focused investments in education, healthy work conditions, environmental sanitation, and a safe water supply are extremely effective in improving health and well being, as well as in increasing productivity and economic growth (World Commission 1987). Countries succeed because they have created mechanisms to ensure that health priorities and needs are clearly expressed and effectively fed into the democratic decision making process (WHO 1997).

In 1989 the World Health Organisation initiated a strengthening dialogue between the environment and health sectors at national and local levels. The adoption of the European Charter on Environment and Health in 1989 set the policy principles for effective environmental and health action (WHO 1989). It also indicated the need for reliable

technical and scientific input.

2. Hazards and Risks Perception

A hazard is a substance, a radiation or a microorganism having the potential to cause a harmful effect. Thus "hazard" summarizes the intrinsic stressor's characteristics (toxicity, physicochemical properties, degradability), and this is relatively simple to understand for the public: γ rays are more dangerous than α or β , a chemical substance is more toxic than another one, *Vibrio cholerae* is more pathogenic than *Aeromonas* from the same family etc

Risk is defined as probability that a substance or situation will product harm under specified conditions. Risk is a combination of two factors:

- the probability that an adverse event will occur (such a specific disease or type of injury);
- the consequences of the adverse effect.

For the first factor the presence of a hazard is necessary and a contact or co-occurrence of this hazard with a receptor (individual or population), called "exposure". Exposure applies to physical (e.g. radiations, heat) and biological (pathogens, ...) stressors as well as to chemicals.

For the second factor the physiological status of the receptor is important: for the same exposure some more sensitive individuals (like children, old people, immunocompromized populations etc ...) may declare severe symptoms since "ordinary" individuals will not be affected.

Thus risk is very difficult to explain to the public and media prefer to refer to "dramatic situations" or "very toxic or pathogen hazards" than to explain the necessity of exposure and sensitive populations for having chances to see harmful consequence of this situation. Risk takes also into account the probability for many hazards to induce effects only in the future (long term toxicity) which is not well understood by the public.

Thus "risk assessment", activity performed by federal agencies, is not well understood. This activity derived from further setting of threshold limit values for workers and acceptable daily intake for chemical residues and food additives is now applied for different kinds of hazards in a situation of lack of knowledges for many of these hazards. According to different scenarios of exposure and taking into account predictable effects, federal agencies use some models to develop assessment strategies. According to an international framework, human risk assessment is composed of four steps:

- description of the hazard;
- characterization of its effects (dose-effect and dose-answer relationship);
- characterization of exposure;
- risk calculation for identified individuals or populations.

Part of the complexity of risk assessment is due to uncertainty. If the risk assessor is able to identify the various sources of uncertainty and then to quantify this uncertainty with an acceptable level of confidence, guidelines values are derived for different levels of risk (10^{-6}

⁴, 10^{-5} , 10^{-6} full live of exposure for example) and stakeholders may use these results according to the prevention principle.

If the scientific knowledges are insufficient for producing values with an acceptable level of confidence, the stakeholders more and more take into account the "precaution principle". When knowledges will be better, the risk assessment must be completed and regulations could be derived according to the prevention principle.

All these levels of complexity are not easy to understand for a non specialized individual, thus the perceived relationships between environment and health are more linked for the general public to mediatic campaigns than to rationality!!

3. Faring Classical Hazards

Increasingly humans find ways to transform the natural resources of the planet to meet not only our basic life – sustaining needs of food and water – but to improve the quality of our human existence. We continuously seek to improve our physical comfort and to satisfy our intellectual, cultural and social needs.

Until a century ago, with a few local exceptions, our behaviour did not have a noticeable impact on the environment. This situation changed drastically in the past century. During this period the world's population more than tripled, placing unprecedented demands on natural resources to produce goods sustenance and shelter in a context of both non-renewable and renewable limited natural resources. This causes also a lot of pollution linked to dispersion of chemical compounds in the air and in waters and soils.

3.1 Water

During the 20th century the world population tripled, but water use for human purposes multiplied more than six fold! (Cosgrove & Rijsberman 2000). The most obvious uses of water for people are drinking, cooking, bathing, cleaning. This domestic water, through crucial, is only a small part of the total. Worldwide, industry uses about twice the water of households. Far more water (7 fold) is needed to produce food and fiber. Indications are now clear that we are approaching and have surpassed in many places (e.i. Aral Sea) the limits of how much we can divert. Until recently water resource management focused almost exclusively on redistributing water to when and where people wanted it for their use (domestic, agricultural, industrial). But there are many signs that water is running out and this engineering approach has to be reconsidered because of the damages caused to the ecosystems from which it is withdrawn. So we need to look at what water is used for and to manage these competing claims in an integrated framework, because of many contradictory uses of a limited resource.

From rainfall one part (green/water) is stored in the soil and then evaporates or is incorporated in plants and organisms, the other part (blue/water), renewable surface water runoff and groundwater recharge, is the main source for human withdrawals and the traditional focus of water resource management.

From the blue water (about 40 000 cubic kilometres a year) roughly 10 % are withdrawn

(diverted or pumped) for human uses; from this amount about 50 % are consumed; the remainder returns to streams and aquifers, usually with significant reductions in quality. During a long period it was considered that these data clearly demonstrate that there is no problem. But we know now that a large fraction of rainfalls is unavailable where human demands are small (Amazon basin!) or during very short periods (monsoon period in Asia), or is polluted and of lower value for downstream functions or essential for the terrestrial ecosystems (forest, lakes, wetlands, coastal lagoons).

3.1.1 Water Resources

Rapidly growing cities, industries and use of chemicals in agriculture and production of energy have undermined the quality of many rivers, lakes and aquifers. Thus they are health hazards, threaten down-stream irrigation areas and destroy ecosystems. Because of inadequate management, water quality is deteriorating at an increasing rate throughout a large part of the world.

The problem of providing the entire population of the planet with good-quality drinking water is quite urgent. It is the all-important and top-priority for mankind. To solve this problem, first of all, we need to define the strategy of water consumption and water management.

Drinking water supply sources having the most reliable protection from anthropogenic impact are artesian wells and underground waters. Usually the concentrations of the substances dissolved in underground waters are much higher than the admissible concentrations for drinking water. The presence of these substances is determined by natural geological factors. On the other hand, we must remember that high-quality and healthy water will contain a wide spectrum of active substances, as well as natural organic compounds. It is these components dissolved in the water that create its taste, smell, clarity and physiological properties.

The second source of drinking water supply is fresh surface water. However, the development of the industrial sector, agricultural complexes, methods of mass transport, utilities, communal infrastructures, the growth of cities and settlements all result in the mass pollution of surface water. The composition of waste water is more and more complicated because of the synthesis of new chemicals, often having toxic, carcinogenic or mutagenic properties, resistant to biological removal. In practice, the self-purification of water reservoirs by the natural process is virtually impossible.

The third source of drinking water supply can be seas and oceans, where the average salinity is about 30 g/l. Three main desalination technologies are viable: distillation, membrane technology, and electrochemical methods. The desalinated water is not drinking water. It is necessary to make adjustments to modify the salt composition. Such waters ought to be "conditioned". This is hardly the best option, but it is important in those cases where there is no alternative source of fresh water.

The three basic causes responsible for the quite significant investments in the field of technologies and water management are:

- the preservation of the quality of the environment;

- the protection and maintenance of plant and equipment used for supplying water to populations;
- public health.

Public health truly represents the major cause, while the other two are closely linked since the quality of resources constitutes a key component of the quality of drinking water, and the state of repair and reliability of equipment also present major risks of impact on drinking water.

Over 2 million people, most of them children, die every year of diarrhoeal disease linked to inadequate water supply and hygiene, while a further million die of malaria. China alone has 30 million cases of chronic fluorosis and 1.5 million hepatitis A. Improved water supply, sanitation and personal hygiene significantly reduce the spread of water-related diseases. Better water resources planning and management have a similar beneficial impact on the incidence of malaria, schistosomiasis and other vector-borne diseases (WHO 1992).

Preventing disease helps alleviate poverty. The 1.1 billion people without access to even improved water sources and the 2.4 billion without basic sanitation include the poorest people in the world – and some of the unhealthiest. A first step towards alleviating poverty is to acknowledge the many components, as well as acknowledge the major contribution of water and sanitation to poverty alleviation and to a development.

Safe water, adequate sanitation and hygiene education are basic human rights that protect health, enhance a sense of well-being, and improve economic and social productivity. Water-related leisure activities, such as sports and spas, contribute to healthy lifestyles and to longevity.

Life comes from water and water is indispensable to life. Water thereby constitutes one of the most important chemical elements, and any impairment of its quality inevitably not only impacts on the relevant ecosystems, but, in man, also increases morbidity, if not mortality, and therefore induces a drop in life expectancy. The food chain is also responsible for transferring, sometimes through bioaccumulation, pollutants from the aquatic environment to major predators which include the human species.

Water is an excellent solvent capable of dissolving a very large number of molecules in concentrations that are sometimes sufficient to trigger biological or biochemical effects on organisms. The physico-chemical composition of water is extremely diversified depending on the geographic location, the depth of the sampling and the period; this precludes any generalisation of the phenomena, and allows us to observe pollutions which can be highly punctual or extremely diffuse over very large areas. Each water supply site or each system supplying water for human consumption has its own characteristics of water quality in terms of organic and mineral components, so that observations should not be generalised. Additionally, the characteristics of the resource are linked to the various influences acting upstream across the whole catchment area.

For the first time humans are confronted with a completely new, unexpected and not quite comprehended problem of fresh water deficits. The future development of civilization is under a real threat of catastrophic deficit of fresh water, as well as many other raw

materials (oil, gas, coal, metals, etc.).

Some attempts to elaborate priorities in preservation and functioning of viable natural processes were defined in documents of the UNCED Conference in Rio de Janeiro (June 1992) and the World Summit on Sustainable Development in Johannesburg (August 2002).

"Every inhabitant of the planet has a right to pure drinking water" was the formula proclaimed by the UN. Unfortunately, the declaration has not been supported with particular deeds. Resources of "the mineral of life" on the globe are distributed in an extremely non-uniform way. Unwise and inefficient management, pursuit of profits, neglect of ecological problems, and severe competition among monopolies have resulted in the exhaustion of water resources and strong pollution of most of the surface and underground sources of drinking water. In fact, nearly all this polluted water finally makes its way to rivers, seas, and oceans.

More than 40 countries of the world in the Middle East, Africa, South East and Australia currently suffer from an absolute water deficit. One-fifth of the population in Europe and America drink polluted water that does not meet international standards. According to official data of the World Health Organization, about 80 % of diseases on the globe are related to the consumption of low quality drinking water.

The major problem lies in the management of quantities. Of course, there is a real difficulty in managing major influx caused by swell and flooding, but beyond this, there are also the major issues related to situations of water stress and shortage in the world. To try and solve these problems, man installs storage dams, develops seawater desalination plants, transports huge volumes over very long distances, makes optimum use of underground reserves which are sometimes very difficult to replenish, and develops technologies and processes for reusing wastewater.

All these actions have a direct or indirect impact on human health. Resources are contaminated by bacteria, viruses and protozoans, some of which are pathogenic or opportunistic, and attention should also be paid to what becomes of bacteria resistant to antibiotics and their risk of transmission. An increasing build-up of cyanobacteria can be observed in stretches of water especially in the eutrophication phase. Some of these cyanobacteria produce hepatotoxins and neurotoxins which cause animal death as well as accidental death in man. The management of quantities entails the development of dams, and the addition of phosphorus and nitrogen contributes to these toxic risk phenomena. It is therefore necessary to control eutrophication situations by reducing the addition of nitrogen and phosphorus, and by promoting oxygenation and developing innovations in terms of preventing the proliferation of cyanobacteria without resorting to biocides which could cause cell lysis and the spread of toxins in the water. The control of iron and manganese in sediments is also a major issue.

As regards global phenomena and physico-chemical variations, resources are deeply disrupted by the presence of punctual and diffuse discharges which very often contain hydrocarbons, solvents, persistent organic pollutants (POPs), heavy metals, residues from medicines and plasticizers. This pollution requires major investments to develop and improve the collection and treatment of wastewater with an increasingly focused objective

of reducing traces of undesirable micropollutants. Purification systems which have been optimised for the reduction of global parameters like COD, BOD and suspended matter will need to eliminate nano- or micrograms of molecules per litre, which will require them to shift towards the same kind of technologies as those used in drinking water plants. However, this assumes that the residues and wastes from these treatments can be eliminated at an acceptable cost.

As regards effects that are ecotoxicological and potentially a health hazard to exposed populations to them, the most complex issue consists in evaluating the biological risks of these complex blends of trace compounds. It has in fact been shown that endocrine disruptive effects are the cause of reproductive damage, hormonally associated cancers, and malformations of genital organs in exposed fauna. The analysis of the risk is not yet possible for man, but there is major concern about these many substances in every developed country (alkyl phenols, phthalates, bisphenol A, PCBs, oestrogens, lead, etc.).

These issues are therefore extremely delicate to tackle as they have to take into account health and environmental constraints as well as the levels of risk acceptability both in terms of public health and economic development.

It is therefore obvious that the best sustainable policy consists in reducing where possible emissions from watersheds in order to restore a sound chemical and ecological standard to surface water and groundwater, as required by the European water directive.

It is absolutely necessary for evaluations of the environmental impact to be carried out on molecules available on the market, and the European programme REACH should it become reality. This is a positive element which will help consolidate existing databases and the inclusion of environmental risks from the design stage of new products. Motivations for the development of green chemistry will be major points for the protection of water resources, but consumers must also be able to have simple and inexpensive means to ensure they do not discharge many undesirable molecules into drains, and so dispel the highly negative concept of the "all sewage solution".

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Bibliography

Cheson D. The road to Rio: paved with good intentions. *BMJ*, 1992, 304:1391-2. [A discussion of the difficulties to transform political promise into reality !].

Afsari A, Matson U, Ekberg LA. Characterization of indoor sources of fine and ultrafine particles: a study conducted in a full-scale chamber. *Indoor Air*, 2005, 15:141-150. [A comprehensive study on the particulate pollution from indoor sources].

Alarie Y, Schaper M, Nielson GD, Abraham MH. Structure-activity relationships of volatile organic chemicals as sensory irritants. *Arch. Toxicol.*, 1998, 72, 125-140. [A fundamental review of volatile organic chemical pollutants and their irritative properties].

Bornehag C-G, Sundell J, Hägerhed-Engman L, Sigsgaard T. Association between ventilation rates in 390 Swedish homes and allergic symptoms in children. *Indoor Air*, 2005, 15:275-280. [An example of the link between domestic activities, ventilation rates and respiratory symptoms in children].

Brundtland. Environment and health: Europe's partnerships can be a model. *Brit. Med. Journal*, 1999, 318:1635-6. [A discussion of the European approach of the environmental health management].

Bruce N, Perez-Padilla R, Albalak R. Indoor air pollution in developing countries: a major environmental and public health challenge. *Bulletin of the World Health Organization*, 2000, 78:1078-92. [A major source of information on indoor air pollution in developing countries].

Butte & Heinzow. Pollutants in home dust as indicators of indoor contamination. *Rev. Environ. Contam. Toxicol.*, 2002, 175:1-46. [A major source of information on the use of home dust for determining the nature of indoor contaminants].

Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society (ATS). Health effects of outdoor air pollution, Part 1. *American Journal of Respiratory and Critical Care Medicine*, 1996, 153:3-50. Part 2. *American Journal of Respiratory and Critical Care Medicine*, 1996, 153:477-98. [The most famous review on the health effects of outdoor air pollution].

Cosgrove, William J and Franck R. Rijsberman. *World Water Vision – Making Water Everybody's Business*. World Water Council, Earthscan Publications Ltd., London, U.K., 2000. [A review on the state of the art of water resources management].

Intergovernmental Panel on Climate Change. *Climate change*, Paris, 2007. [A fundamental document on climate change recognized as very important with the Nobel Prize].

Kovats RS, Haines A, Stanwell-Smith R, Martens P & Menne B. Climate change and human health in Europe. *Brit. Med. Journal*, 1999, 318:1682-1685. [One of the articles dealing with forecasts on the predictable effects of climate change on human health].

Lucier GW, Hookge Eds. Symposium on the health effects of acid aerosols. *Env. Health Perspectives*, 1989, 77:3-315. [A fundamental document on the health effect of air pollution].

MacCally M & Cassel C. Medical responsibility and global environmental change. *Ann. Int. Med.*, 1990, 113, 6:467-473. [How to involve medical doctors in the prevention and control of the human health consequences of global climate change].

McMichael AJ, Haines A, Slooff R, Kovats S. (eds.) *Climate change and human health*. Geneva, WHO, 1996. [A comprehensive introduction to the topic of the health consequence of global climate change].

McMichael AJ, Bolin B, Costanza R, Daily GC, Folke C, Lindahl-Kiessling K. & al. Globalization and the sustainability of human health – An ecological perspective. *Bioscience*, 1999, 49:205-10. [One of the first articles about the challenge of sustainability of human health].

Organization for Economic Co-operation and Development: *The state of the environment in OECD member countries*, Paris, 1979. [The first issue of a series of reports on the state of the environment and its degradation published by OECD].

Rink H. Investigations of cataract risk factors. *Dev. Ophthalmol.*, 1987, 15:66-76. [How the increase of UV irradiation due to ozone layer depletion may induce an increase of cataract's incidence].

Samet JM, Cohen AJ. Air pollution and lung cancer. In: Holgate ST, Koren HS, Samet JM, Maynard RL, editors. *Air pollution and health*. San Diego (CA): Academic Press, 1999. [A very useful review on air pollution consequences on health, especially for lung cancer].

Scale. *Baseline report on research needs in the framework of the European environment and health strategy* (COM 2003), 2004, 338 final, <http://www.brussels-conference.org>. [An example of the research needs in the field of environment and health at the European level].

Scher. Opinion on the report "*Emission of chemicals by air fresheners. Test on 74 consumer products sold in Europe January 2005*", 2006, http://www.ec.europa.eu/health/ph_risk/committees/04-scher. [A review of

aerosol consumer products, their contents in volatile chemical and health risk assessment].

Steensberg. Environmental health decision making the politics of disease prevention. *Alsquest & Wiksell Ed.*, Copenhagen, 1989, 327pp. [A dissertation on the prevention of environmental health problems].

Tarnopolsky A, Hand DJ, Barker SM, Jenkins LM. *Aircraft noise, annoyance, and mental health: a psychiatric viewpoint*. In: Proceedings of the Third International Congress on Noise as a Public Health Problem. Freiburg, West Germany, 1978 Sep 25-29. Rockville: The American Speech-Language-Hearing Association, 1980, Apr. 38:588-93. [An relatively old document on noise for illustrating the fact that, 27 years later, the knowledges did not progress very fast]

World Commission on Environment and Development. *Our common future*. Oxford, OUP, 1987. [The first report on the risks associated to global climate change].

World Health Organization. *Environment and health: the European charter and commentary*. Geneva, WHO, 1989. [The document to be put into force by each european country for managing health and environment].

World Health Organization. *Our planet, our health, report of the WHO Commission on Health and Environment*. Geneva, WHO, 1992. [The contribution of W.H.O. to the RIO summit in 1992].

World Health Organization. *Health and environment in sustainable development*. Geneva, WHO, 1997. [A contribution from W.H.O. to the future management of the development].

World Health Organization. *World health report 1999*. Geneva: WHO, 1999. [A review of the world health data].

World Health Organization. *Disinfectants and disinfectant by-products (Environmental Health Criteria 216)*. Geneva, WHO, 2000, 27, 499. [A review on the different disinfectants for water treatment and associated risks].

World Health Organization. *The world health report 2002 Reducing risks, promoting healthy life*. Geneva, WHO, 2002, 240pp. [An actualized review of the world health data].

World Health Organization. *Health effects of transport-related air pollution*. Geneva, 2005, 190 pp. [A review of health effects of air pollution due to motor vehicles].

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