Appendices

A1 A column: Mirror images

Let's start at the end. The end of man's life, here and now. In most cases Death comes to the Dutch after a long life. And since all endings are difficult, many troublesome years precede. But repeatedly doctors and hospitals succeed in fooling poor old Death. Until at a given time all resistance proves in vain. For after 70 or 80 years the curves for many serious diseases and causes of death increase sharply. This is the era of the competing illnesses and causes of death: heart- en vessel disease deny the several forms of cancer their toll, and at their turn pneumonia and Alzheimer's disease try their best. Scylla and Charybdis welcome their victims. This is also the era of the replacing illnesses and causes of death: if medical shrewdness convicts a certain cause of death, many others are greedy to take its place. It seems to be the struggle with the Hydra of Lerna. Nevertheless we succeeded in expanding the life expectancy to 75 years for men and even more than 80 years for women. And expansion is still feasible to 85 till 90 years. Much was due in this respect to the suppression of infant and children's mortality. At the start of this century one in ten new born died before the age of one and again one in ten of the survivors deceased before the age of five. And those 20% were still favourable compared to a century before, when it was double.

We end with the beginning. The beginning of life, as it looked in 1800 in this country and until recently in the poorest developing countries (and still in a few, like Afghanistan, Congo and Madagascar). Dozens of diseases surround the child before and during its birth. Diarrhoeal diseases, diphtheria, whooping cough, measles, tuberculosis, malaria, (traffic) accidents, avitaminoses, starvation, iron and calcium deficiency, it is an innumerable list. So, the images are mirror like. What happens here at the end of life, played there at its very beginning: competing and replacing illnesses and causes of death. But the course of events that elapsed here, a slow improvement in circumstances and reduction of risk factors, happens there now at express speed. The positive changes tumble over each other: vaccinations, water supply, waste transport, increased food supply, improved diet, policlinics, tuberculosis control, etc. For, just as it is here useless to improve only one factor in an elderly life, a real take off was there only possible after many improvements started to coincide and reinforce each other.

That causes an amusing phenomenon: all experts and development assistants claim the victory. The engineers are sure that things only started to improve after their arrival, the doctors are of the same opinion and the economists can prove that their influence was decisive. Yes, Success has many fathers and Failure is an orphan. Truth is, of course, that an upward spiral could begin because many beneficial factors were thrown together in an incubator. That's why India and China could halve their infant mortality in less than 25 years, an achievement that took us one century. Here, the several favourable factors appeared slowly on stage, one by one, and the large medical breakthroughs even came last.

Pieter Bol

A2 Sewage and the City

Cloaks and folks

The triumph of sanitary engineering

Introduction

Wastewater, especially if polluted by faeces, is a source of disease and misery. It is still responsible for the death of millions of people per year in the world. In The Netherlands the problem is minimal due to (future) engineers like you. But the majority of the 6 billion people in the world today have no adequate sanitary facilities and furthermore even more people have no idea of the cycles that connect waste water with ill-health. It has taken thousands of years for public hygiene to evolve, but in the last two centuries there has been an explosion of insight, corresponding measures, with the resultant present health and life expectancy. Let's begin at the beginning with man as nomad.

Not mad in paradise

It is not so that nomads are not affected by their own waste. Other groups and animals contaminate downward flowing water. But also returning to water sources that have been used before and been polluted comprises a health risk. Especially excrements should be dealt with prudence.
Deuteronomy……

But it is evident that with sedentary communities waste and excrement would become a far greater problem. Even though there was no perception of the health hazards involved, the stench and the vermin were more than enough to bear. The larger an agglomerate, the bigger the problem of disposal. But getting rid of refuse can stay rather easy during a long time, since a quadratic growth of the town populace renders only a linear increase of the radius. That is what we would think. And that is so for faeces, it can be used as fertiliser, but all the other rubbish like from demolition sites, pottery fragments, bones and rags just became part of the soil on which was steadily was demolished and rebuilt. In this way the level of the city was continuously raised. A 'tell' in the Middle East could become many metres higher during a span of some thousand years and also the Troy that Heinrich Schliemann came across had 'grown up'.

Were there toilets and sewers in ancient times? Yes and no. Toilets with a drainage system and with large pots for flushing were found in Sumeric palaces from the end of the third millennium BC, thus Water Closets. But these facilities were for the elite. Ordinary people just

threw their excreta, if they had not already collected them for fertilising, out of the window onto the street. With or without a shout of warning at the passers-by. In the eighteenth century cities of for example Spain and England this was still common practice.

The in many respects refined cities of ancient Egypt were dotted with piles of rubbish and a terrible stench. Swarms of flies guaranteed the spread of eye diseases like trachoma. Several cities in the flowering Indus civilisation (2300-1700 BC) had extended sewage systems and the streets had rubbish bins built of bricks. The Hellenistic culture was really not so advanced and only when we get to the Roman empire do we find anything that resembles our proper facilities.

Rome's sewage system

Cities need to drain water. Rain water that does not easily subside in a city environment and water from toilets that are flushed and other kinds of wastewater. Already in the fourth century BC Rome had a main underground sewage canal that discharged into the Tiber, the Cloaca Maxima. In the second century this system was so well lined with blocks of lava that it could be used up until the beginning of the last century.

The goddess Venus Cloacina was the patroness of the slaves who had to keep the system clean. The main sewage canal streamed out into the Tiber and because of the discharge problems created by high tide the Romans became familiar with the phenomenon of 'Rückstau'.
And then the famous toilets. An historical misconception has saddled us with an image of public toilets spread around everywhere. But in reality there were mostly primitive facilities for each house or block of houses and the poor also used open places in the city. But public toilets did exist and we can still admire them in Pompeii, Herculaneum and Ostia, but also in Aleppo and Efese.

One sat in two rows pleasantly facing one another, flowing water carrying the stools away. That is in the toilets in the bathhouses where sufficient overflow water was available. Water flowed in a duct in which sticks with skewered sponges lay. With these one could clean oneself and then rinse the sponge out ready to be used by the next person. Some toilets had a round hole in the front whereby one could clean oneself while sitting. There were also water vats for washing one's hands.

There are conflicting theories amongst archaeologists, historians and classicists as to whether the Romans were just wanting comfort and control of nuisance or whether they had deeper hygienic insights. Dr. Gemma Jansen thinks the first. And probably we have to go all

the way to the second half of the 19th century to find the already extensive sewage systems in Europe being built according to scientific insights.

When we visit excavated cities like Pompeii or Herculanaeum we are surely impressed by the many public and private toilets and sewage systems. In some towns like Pompeii there were even quite a lot of toilets on the upper storeys of houses. And just like today some cafes have the daily newspapers or internet to attract customers so then some bars had a good toilet to offer. But the modern visitor does not walk around in the excavations surrounded by the colours and aromas of the everyday reality of the year 79. Writers of that time, like Juvenal, complained bitterly about the stench and the filth in an overcrowded Rome. They describe the filthy streets, the corpses and the animal excrement in the public domain. And the emptying of chamber pots out of the windows of upper stories. If a pot by chance also descended and wounded a free citizen, then the victim could claim medical costs and loss of income from the thrower.
It is therefore dangerous to interpret an archaeological observation from the viewpoint of our hygienic insights after 1850. Psychologists have a name for this: projection. Most important is how one dealt with such facilities in that time; on the other hand: it is also possible to be hygienic without such facilities (see further). The customary proximity of the Roman toilets to the kitchen, the use of a shared sponge as toilet paper, the open connections giving rats and other vermin access and the primitive emtying of the cesspool with the resultant contamination of the surroundings are all factors that are contrary to hygiene.

The stench caused by the absence of a water seal or a U-trap must have been terrible. And finally the sewage systems were not always underground, effluent was often just led away in open gutters.

Back in the muck

The collapse of the Roman Empire meant a real regression not only in the supply of water but also with the removal of wastewater. The streets of the Medieval cities were full of rubbish, where pigs and chickens took their pickings. The ‘trippen’ were invented, wooden planks that were attached under the leather shoes. The authorities tried to turn the tide with regulations and fines. Beneath is a list of the chapters of the White Book of the Town of London (1419).

That this had to be ordered repeatedly, in a wording becoming ever stronger and with increasing punishments, goes to show that it was to no avail. The problem: where to put the garbage and how to get it there. It was a time when gangs of workers were not yet hired to do communal work. Refuse, like fire fighting and town defence was an ad hoc task for arbitrary groups of citizens. Only at the end of the middle ages cities like London created a waste disposal service.

Nuisances

Town records are full of complaints of dung heaps in the street, the casting of offal, or dirty water, the slaughter of beasts and the throwing of dead dogs or cats into public places. People were supposed to keep clean the parts of the street in front of their own houses and to have their rubbish carted away. A road sweeper in the ward of West Cheap, London, is mentioned in 1299 and later, in 1364, there were official inspectors called 'Scavengeours'. Actual removal of rubbish in fourteenth century London was done by 'Rakyers' [mud rakers]. An official carter at Coventry was supposed to receive 1 d. from each hall and ½ d. from each shop (1420). Filth was thrown into rivers and town ditches, but fish survived in London town until the reign of Henri VIII. References occur to public lavatories in Leicester, Coventry and Doncaster as well as London. Attempts were made to keep clean sources of water used for victualling trades. For piped water, baths and washing.

Liber Albus (The White Book of the City of London 1419)

If Swine shall be found in the Streets or in the Fosses (moats), or in the Suburbs, they shall be killed, and he who kills them shall have them; and he who shall wish to rear them, shall be at liberty to rear them, out of the King's Highways, in his own house.

That no leper shall be in the City, or shall come there or make sojourn there……

That such Pigsties as are in the Streets shall be removed; and if Swine shall be found in the Streets, they will be forfeited.

Also, Four Men elected and sworn to take and kill such Swine as shall be found wandering about within the walls of the City, to whomsoever they may belong……

The Porters of the Gates of the City sworn that they will not allow Lepers to enter the City……

That Men and Women of ill fame shall be removed by the Alderman…… That Women of evil life shall not use hoods that are furred, except with the wool of lambs or the fur of rabbits, etc……

Etc. etc.

(Source: W.O. Hassall: How they lived. Oxford: Blackwell, 1962)

Among the few mediaeval buildings that still exist, castles are predominant. We see that the toilet is often added on hanging over the moat while the kitchen is usually found in the basement, so that the water just a few metres away can be drawn up through the window. Such things make one understand that more than half of the people died before their fifth birthday, often from diarrhoeal diseases, especially in the summer. It is doubtful whether 500 years ago, even if the hygienic insights had been already evolved, technical capability would have been sufficient to build an effective sewage system. It is no coincidence that it was specifically in the second half of the 19th century that tens of thousands of kilometres of sewage canals were laid in the urban soil, after the start of the systematic training of engineers in the first half of that century.

This made it possible that the Prince of Wales in 1865 opened the start of the building of an extensive London sewage system that ten years later totalled 83 miles and served a surface area of a 100 square miles. His late father Albert, the spouse of Queen Victoria, had not been engaged in hunting game or women. He was an enthousiastic advocate of public hygiene and sewage systems were his hobbyhorse. Drawings of his London sewage system are preserved still to this day and some of the parts executed are still in use. Sadly enough the London Cloaca Maxima discharged directly into the river Thames that seriously contaminated the river downstream.

Growing insights and knowledge

It was only in the second half of the 19th century that a mammoth alliance between engineers and doctors emerged. Their aim was the amelioration of sanitation in the society; we call them ‘Hygienists’. They had a surprising ally: the cholera, imported into Europe in 1830, occurred in waves, each time claiming millions of victims. The Hygienists, though, despite their clear and well-founded knowledge, insights and ability, had a very hard task convincing the government to invest extensively in sewage systems. For the inhabitants of well-to-do neighbourhoods, where the waste problem had often already been solved, were not too interested in providing paupers in completely unknown quarters with the same facilities, at the price of extra taxes. Since the right to vote was restricted to the rich, there was an impasse. Provisions for the poor had no electoral basis.

Nevertheless there were improvements. How come? The Amsterdam professor of sociology Bram de Swaan has interpreted this as a conjuration (defusing) measure to check social uprisings. 19th century society fostered many seeds of revolt and revolution and revolution is a very unpleasant method (for all parties involved) to settle a social conflict. He states that the elite chose for appeasement and financed the underground hygiene infrastructure. The Dutch novelist Bordewijk calls such a policy: containment of social volcanology. One should realise how exorbitant the investments were in money terms. Particularly if compared with other

governmental expenditures, for the budget of the state was very low, even when calculated at present day values.

Since then investing in good sewage systems and their maintenance has been continued, you know everything about it. All this work contributed to impressive results in public health: this you also know. Therefore let's take a look at the world beyond The Netherlands and the state of the sanitary conditions there.

Elsewhere, otherwise

In Japan 80% of the sewage is not contained in systems under the ground. The wastewater often flows through the villages and towns in gutters. But the people don't bath in the water or use it for the kitchen. One just navigates one's way through it all, dressed neatly in a suit or a kimono. Japan has the highest life expectancy in the world and a very high education level. The conclusion: if a population is highly developed less than ideal conditions can be foiled. But if there is not much understanding of hygiene, water and sewage facilities have to be made foolproof.

Now to neighbouring China. The American writer Mark Salzman describes in "Iron and silk' (1986) how while visiting China he went on the river with some fishermen. They relieved themselves over the railing and then washed themselves. They then dipped steel wool in the river water which they chewed, to clean their teeth and then gargled. All of this happened with the same water. He refused to take part in this ritual and they looked upon him as an unhygienic barbarian.

Why couldn't he use the water, unlike his companions? Because, from the immunological point of view he was an 'clean' island in a sea of dirt. This is the price that westerners have to pay for being continually protected: they are being permanently instructed about safe water and the careful preparation of food. The diarrhoea that westerners suffer from in third world countries is also know as 'turista' or 'Montezuma's revenge'

How come an indigenous person, living in "unhygienic conditions' manages to become adult? The countless switches in the immune system have by this time been activated and he has escaped the inevitable fate of his brothers and sisters, nieces and nephews: death by some infectious disease, mostly faecal-oral.

In India, China's neighbour, the people in the countryside use all kinds of small plots of land as a toilet. In the big cities the poor people have no other choice than to use an open space. These spaces eventually become built upon or are fenced off. So much so that some years ago there was a demonstration in Delhi by poor women carrying banners with the text 'We

have the right to defecate'. In this same country washing the body with water is seen as holy. The yearly ritual of thousands of people bathing in the holy river the Ganges, is a colourful sight but also dangerous. The cleansing river is, in the microbiological laboratory, an enormous open sewage containing not only the seeds of cholera.

Africa. Professor Sjaak van der Geest, medical anthropologist in Amsterdam, tells us:
"During field research in Ghana I came across a whole culture round toilets and latrines that had often gone unnoticed by anthropologists. Also there we find much secretiveness and silence round this theme and the poor get the short end of the stick: their 'facilities' are abominable. Also, I noticed that 'a loss of memory' prevailed round the subject, after use of the dirty facilities you suppress that nasty experience. "

The Dutch doctor Bas Kalwij studied the situation in a village in El Salvador. The relatively reasonable latrines were not used. They were rather remote, dark, and the women felt unsafe. In the mornings the men were the first to wash, discharge etc. in the river. Then it was the women's and children's turn for the 'morning toilet'. They stayed there for hours, doing the washing and exchanging news. Swapping this social intercourse for the water pump and the toilet was not a very real option. Diarrhoea was preferable. Dr. Kalwij saw no end in sight in treating diarrhoea.

And finally Peru, that was afflicted by a cholera epidemic in the early 1990's. This was not the first time, but for the 20th century variant of the cholera bacteria, the Vibrio El Tor it was a primeur. One of the sources of the bacterium was a very popular raw fish dish with lemon juice. But that fish comes mostly from the coastal waters into which sewage is discharged. Investment in public sanitary facilities had been skipped in the years previous to the epidemic due to unrest, chaos and shortage of money. This problem is on the increase also in south East Asia.

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Short articles for Mappae Mundi

The following texts were written by Pieter Bol for**: Mappae Mundi**; humans and their habitats in a long-term socio-ecological perspective. Myths, maps and models. Jubileumboek van de Koninklijke Hollansche Maatschappij der Wetenschappen (1752-2002) (B de Vries en J Goudsblom, red). Amsterdam: Amsterdam University Press, 2002 (ISBN 90 5356 535 3).

A3 Cities and length of life: a wave-like pattern

Some 6,000 years ago the first cities arose. Did they bring mankind better health and hence a longer life? There is no simple answer to this question. Before discussing this matter, we divide time in five eras.

Pre-history till about 4,000 BC
4,000 BC -0
0-1850 AD
1850-2000 AD
The coming one hundred years

Next, we choose a demographical entity that is most clearly depicting the length of life in groups. Life expectancy is a complicated entity that is difficult to handle for non-demographers. Median age of death is the best alternative: the age at which half the individuals of a birth cohort have died. E.g. 50% of the birth cohort of 1925 in The Netherlands will have died by the end of the year 2002. The other half will die in a period stretching to the mid-21st century.

In prehistoric nomadic societies, median age at death was only a few years, ranging from 1 to 5. This was even the case in nomadic groups studied in the 20th century AD. Death was due to climatologic and physical circumstances like floods, fires, drought, hurricanes, volcanic eruptions, earthquakes and heat and cold. Lack of food was always a main cause of death. Predators were a not futile threat, homicide as well. But also in that era, infectious disease caused the most havoc. These were not the large epidemics of later eras but infections from the individual's own micro flora or contagion from tribe members. Early in life, mothers and others hand down potentially dangerous micro organisms to the infants, sometimes even before their birth. E.g. bacterial meningitis, that until recently killed 1 out of 10 nomadic children before the age of five, is caused by bugs from the direct family. Even today quite a percentage of the deaths in the developed countries are due to non-epidemic infections. The best example is the sixth cause of death in the USA: pneumonia (mainly in the elderly), mostly from their own micro-flora.

The early cities provided an enormous advantage to their inhabitants in terms of longevity and comfort. Their organisation meant protection against armies and brigands, centralised food storage was some guarantee for survival, and differentiation and specialisation in labour stimulated the production of luxury goods and proper cloths and houses. The potential hazard of high numbers and crowding with respect to infectious diseases was not yet a disadvantage that counterweighted the aforementioned advantages. For the early cities were islands embedded in their countryside. This means that their inhabitants were not easily massacred

by bugs arriving from far away. Trade routes, of course, provided every now and then the micro-organisms of smallpox, pestilence or cholera and thus caused waves of mortality. But this was a haphazard process since the long distance transport was scant and quite a few contagions ‘on their way’ to a city died out before reaching it. Median age of death was well over 20 in some Sumerian cities.

A dangerous era arrives when at one hand cities become as large as to harbour hundreds of thousands or even more than one million inhabitants and at the other hand traffic intensifies, goes faster and reaches for the outposts of the earth. This makes the vast population vulnerable to contagious diseases for in the large centres there is a to-ing and fro-ing of pathogenic micro organisms. Rome is a good example of this turning point in city history. It was a spider in a vast web of land and sea transport (“All roads lead to Rome”). E.g. there was an extended and lively grain trade with Egypt. Contemporary authors like Juvenal were amazed by the unhealthy aspects of the capital; unhygienic streets, stench and an enormous risk for acquiring diseases are described. This made Rome a place were one lived much shorter than in the rest of Italy. Median age of death was about 5 years.

From then on big cities became black holes that couldn’t sustain their number of inhabitants and constantly absorbed large numbers of people from the near or further country side. This population machine, composed of an expelling country side and an absorbing city, has lasted for about two millennia. Seventeenth century London had a median age of death in between 5 and 10 years, which was also the case in Dutch towns of that time.

The 18th and 19th centuries with their advancement of science and the start of the Industrial Revolution, provide a complicated picture. The enormous inflow in cities led to miserable conditions, as described by Charles Dickens. But for the first time in history (medical) science, engineering and the (political) will to improve the hygienic and living conditions had developed sufficiently and coincided to change the fate of city dwellers for the better. Actually, median age of death improved in both the rural and urban populations, to begin with North America and Europe. E.g. in The Netherlands this median was 37 years in 1850, over 55 in 1900, and over 77 in 2000. In these parts of the world there is not much difference between rural and urban areas.

In 2,000 the urban population of the world had reached the 50% mark. 88% of the world population lives in the present developing countries, a percentage that will grow till 94-95% in the next century. So the ongoing urbanisation is mainly a process that takes part in countries that are often poor in budget and infrastructure. The problems of mega cities are enormous. People die from dust in the air in Bombay, smog suffocates Mexico City and Los Angeles, water supply is a nightmare in Lima and criminality flourishes in Lagos and Johannesburg. The fact that present day Rome and London are healthy places to live in, is no guarantee that

the bustlingly growing cities of the third world will be a safe haven in the next century. It can be feared that in some of the large cities the present *global* median age of death that is already over 60 years (!) will not be reached or even decrease. A situation that would mirror the declining health of Rome, 2000 years ago.

Dr. P. Bol. Tekst bestemd voor het boek ‘Mappae mundi’ (2002)

Ref**:** Wills C. Plagues. Their origin, history and future. London: HarperCollins, 1996.

PS Until a few hundreds years ago the necessity of the influx into cities was due to the high mortality in cities. Since, decreasing birth rates in the cities, till very low levels, are the chief reason (Linton, 1969; Braudel, 1969).

(Example: Italy has at the moment the lowest birth rate of Europe: 0.7 child per woman in the appropriate age class. In present day Rome - where once the term 'proletarian' was minted - this number is even lower)

A4 Man... a late life form

Man is a late phenomenon on this planet. Animals are also, and even plants were late as well. Earth had already completed billions of ellipses around the sun before *Life* was born or introduced. It is unclear how first life forms looked like but we presume they had much in common with our present mono cellular bacteria. After that big leap, it took aeons before multi cellular creatures developed; history of life has a time scale with mainly mono cellular organisms.

Plants and animals thanked their life to these ancestors but, moreover, had to fill in their physical form and functions according to the rules set by the microbial world. Without much exaggeration one could state that the former were the moulds from the templates of the latter. Or: microbes dictate the freedom and limits of macrobes. A statement like “We are not alone in this world” is an understatement. For we are to a large degree at the mercy of the age old inhabitants. We are sometimes tolerated, and other times decimated, but always in a complicated interaction with the microbial world, the base of life.
During the last 200 years, man has greatly changed the balances between him and the micro-organisms. To his advantage - he thinks. But what is the impact of new weapons like antibiotics and vaccines, created by an undeniable intelligence, on a life support system that has in it self the wisdom of at least 800,000 evolutionary years? There might be much more in the checks and balances provided by the tiny creatures that also in mass outnumber any life form on earth.

In another contribution is an essay on the advantage of the counteraction by micro-organisms.

Ref: Wills C. Plagues. Their origin, history and future. London: HarperCollins, 1996.

A5 (Neo)Malthusianism and AIDS

Thomas Malthus' book on population of 1798 was based on a study of the English population covering hundreds of years. His hypothesis had been, since mortality was so abundant, that the population was in a steady decrease. It was not so at all, and since territory was fixed and agriculture only moderately elastic, this induced his vision that the growing numbers would sooner or later meet their limits. For, as agricultural output showed a linear growth at its best, the people tended to double their numbers every generation, thus growing beyond sustainability. The four horsemen of the Apocalypse: starvation, war, diseases and natural disasters, would then wipe out the surplus. So, environmental pressure keeps the population at bay.

Malthus didn't want to predict disaster, but he wanted to prevent it. He stated that a check on the population growth would provide the logical solution. He didn't direct himself to the happy few, since these could easily permit themselves a large offspring, but he addressed the masses of the poor ("At the table of Life, not everyone is served"). How should they limit their numbers? By marrying late and by restraining themselves, i.e. to refrain to a large degree from sexual intercourse. Other means of birth control were absolutely out of the question, according to the moralist Malthus. The neomalthusianism of the 20th century corrected this, and was zealously propagating control devices.

This was wise, since Malthus' advise was completely impractical. For it is only growing prosperity, educational level and awareness that induces a decrease in birth rates (as part of the demographic transition). One can't expect the poor, uneducated and oppressed to start birth control, particularly not with his Spartan methods, witness as they are to high (infant) mortality. In fact, they share the original view of Malthus: the mortality is so high that a decrease of population is bound to be the result.

Apart from proposing impractical tools, much of his analysis unveiled real basic mechanisms. But up to now, in developed countries the agricultural and industrial output kept pace easily with the demographic growth, which itself showed an asymptotic curve thanks to the demographical transition. Dozens of underdeveloped countries however find themselves in a 'demographic trap'.

One-sided interference like medical care, not coinciding with a parallel economic growth, have brought them into a vicious circle. The fast population increase absorbs the means for economic expansion and a stagnating economy and marginal incomes do not create an incentive for birth control. It is in these countries that the fastest increase of the world population takes place. Here, despite more interference, like medical and military intervention and food and post-disaster aid, Malthusian doom is impending.

The AIDS epidemic seems to some to be one of the large plagues that Malthus indicated as necessary scythes to cut the superfluous growth. The largest impact, so runs the argument, is seen in countries with the feeblest sustenance base. So the disease hits where it is most necessary, for it redresses numbers to a level more realistic according to the economical means available.

This is a vision that is - apart from a quite often-concomitant racist connotation - totally missing the point. Let's first look at numbers. Since the epidemic was noticed 20 years ago, about 40 to 50 million people have been infected by HIV; half of them have died in the meantime. The yearly death toll at the moment is several millions, a calculation that is complicated by the fact that most victims die from diarrhoeal diseases and tuberculosis. So, much mortality hides under the cover of such diseases. But in a world where we count less than 60 million deaths per year and more than 120 million births, AIDS is not offering any 'solution' to any problem.

For AIDS hits society right in its heart. Regarding both age classes and societal classes, its impact is right in the middle zone. In any developing country the young adults, and among them particularly the middle cadres, form the backbone of society. Their massive dying means: old people without support and forced to care for their grandchildren, plus many orphans without care, not unlikely to develop AIDS themselves. Such a situation is not at all a stimulus for birth control. In most societies with a high impact of AIDS, like Uganda and South Africa, births still more than counterweight the deaths, the net increase is still positive. But by the selective elimination of the middle groups, the economical base is utterly menaced, and in the South of Africa already near collapse. So, much different from being an instrument favouring population control, AIDS has an impact that puts demographic transition out of reach in the most severely afflicted areas.

Dr. P. Bol, secretary to the 'Permanente commissie AIDS', Gezondheidsraad 1991-97. Text for 'Mappae mundi', 2002

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A6 Pestilence: a bug in a flea on a rat (A disease creates a landscape 1)

Pestilence is a horror that has been eminently described by Boccaccio in his introduction to the *Decamerone*. The causal bacterium, *Yersinia pestis*, is introduced in the victim by the bite of a flea. A contaminated flea boards the bacteria in its proximal stomach where they form clusters and prevent the meals of the flea to reach its digestive system. The fleas, craving for blood, can leave the rodents they dwell upon, especially if these are dying in large numbers, and throw themselves on man. When biting, they vomit the bacteria into the blood. This might have happened when in 1346 in Odessa on the Black Sea crates were opened that had travelled all the way from Mongolia. They contained furs of giant marmots that were intended for making the large wheel hats that can still be seen on the paintings of Bosch.

The Black Death, a term only minted in the 17th century, dates back from times unwritten. It is unsure whether the Athenian plague (430 BC) described by Thucydides was pestilence. The Justinian plague of 542, that destroyed the Byzantine ambitions to restore the Roman Empire by conquering the western part, was presumably an epidemic of smallpox. The 14th century pestilence epidemic in Europe lasted from 1346-1350. During its course the traditional bubonic form had every now and then erupted into lung pestilence: direct contamination from the lungs of a victim to the lungs of other men. The epidemic killed at least a fourth of the population, which had an enormous impact on economy. Land labour became precious, property and capital changed hands and towns had to reorganize their economy. This meant a strong stimulus for the impending capitalist revolution, which created the modern world.

In several European countries there are still barren landscapes that never recovered from the blow in the mid-14th century. In Germany they are called “Wüstung”. When in a region many key persons like priests, tutors, bankers, blacksmiths, and merchants fall away, the society can collapse entirely. This state can be beyond repair, the remnant population wanders off, and the effort to repopulate the region occasionally was without success. If the present AIDS epidemic will continue its present ominous course, many a ‘Wüstung’ might be the result in some African rural areas (see Malthus).

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A7 The advantage of disadvantages

World literature is for a large part the account of man about his struggle with the conditions set by this world. The writings are sometimes lamenting, sometimes victoriously vibrating. But this newcomer, this Ulysses, can he really oversee the assets of the ‘hostile’ elements that he meets everywhere on this planet?

From the times of the Portuguese king Henry the Sailor, 20 generations ago, we have accounts of seamen getting ill and dying from scurvy. A disease caused by vitamin C deficiency, so lack of a food component. For man, unlike most mammals, is not able to construct this vitamin from his food. Moreover, we know of malaria, yellow fever, bilharzias and cholera, and many more diseases, killing scores of people who went abroad to find trade, adventure, or a new place to live.

Disastrous for individuals and groups, but what about mankind? Possibly this was a blessing in disguise. But for the resistance from the realm of disease, western man would have overrun the world in a few centuries, introducing new economies in a short time and starting a population explosion much earlier. This could have meant not 6 billion but for instance 15 billion people on a heavily over demanded planet by now. Or, to put it differently, the number of 6 billion would have been reached earlier, e.g. in 1800 when Malthus already worried about the then 1 billion people.

What could this imply? The stretching of the time scale by unfavourable conditions has provided valuable time to think, discuss and find solutions. Coping with some large problems is a process that requires time; it often takes two or three generations and - as it seems - cannot be speeded up. An example is the Industrial Revolution; if we postulate the take off about 1760, then it took 80 years (3 generations) until in 1840 a reasonable standardisation of e.g. screws and bolts was reached. But also before the enormous social change came into a more quiet pace.
An example from our time. The AIDS epidemic was noticed in 1981. Since, tens of billions of dollars have been pumped into scientific investigations in order to develop a vaccine. Ten thousands of investigators work continuously to reach this goal. For time is valuable; but, also, the most decisive factor. Despite all investments, it may still take decades before an effective and payable vaccine will emerge, maybe from an unexpected side, maybe even by serendipity.

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A8 Anthrax (a disease creates a landscape 2)

Everywhere in Europe one can find spots in the country side that are said to be ‘bewitched’. When situated in meadows they have been often planted with shrubs or trees, to prevent cattle from treading the soil. Death lures there, they say. Is this another superstition of our not so well educated ancestors? It is not. Digging - please, put on protective clothing - will often reveal a decayed carcass. For if a cow died from anthrax, it used to be disposed of in a ditch, in more recent years covered with unwashed lime. This seems to be an effective method to prevent further contagion in the herd.

But the anthrax bacterium, *Bacillus anthracis*, is able to form spores. These are well protected little packages with the essential element of the bacterial cell: its DNA. This slumbering form can be kissed to life by favourable circumstances. After many decades and according to some scientists even after centuries. Spores in the soil can be transported to the surface by soil dwellers like worms, after which they can stick to growing grass. Eating this grass will cause mild bowel problems, but more severe is the contamination of a wound or the respiratory tract. Without treatment the resulting septicaemia is invariably fatal.

This property was used by the Spanish armies for an early kind of biological warfare, already in the 16th century. Metal shraps and ground glass were mixed with fat from animals that had died from anthrax and fired at the enemy. A horrible wound was followed by a terrible death. World War 1, in many ways the mother of modern warfare, showed anthrax to be a difficult weapon. Efficient spreading and protection of the own population were troublesome. Nevertheless, all major armies still study the strategic possibilities of anthrax. In 1973, an explosion in a laboratory where anthrax bacteria were grown near Sverdlovsk (Jekaterinenburg) in the Sovjet Union caused contamination of a large surface. This forbidden landscape is a sad ‘bewitched’ spot, like quite a few other landscapes that are deserted because of nuclear contamination.

A9 The different landscapes of disease

Man has shown the ability to spread to extremely different environments, adapting to the new habitats as far as his genome permitted. Physical, chemical and biological influences threatened his health. Let's consider in this respect the several landscapes mentioned in this chapter.

The tropical forests have always been a rich storehouse full of parasites and micro-organisms of an often vehement virulence. Until recently their large disease pressure kept the population at bay. Many illnesses there are caused by arthropods, like malaria, yellow fever, dengue, filariasis, onchocerciasis (river blindness), and leishmaniasis. But also diarrhoeal diseases like typhoid and amoebiasis thrive there, just as do tuberculosis and leprosy. Fungi have a fair chance in the moist conditions.

The savannahs are an environment favouring Guinea worm infections and trypanosomiasis (sleeping disease). We don't know how old Lyme's disease is, but high grass and deer form a perfect combination for its spread.

Mountains mean a decrease of exposure to arthropods that bring malaria, yellow fever or dengue. But altitude sickness and blindness due to cataract (by intense UV light) are new dangers as well as goitre from iodine deficiency (which is rare at sea coasts). Parasites like giardia can dwell in high regions.

The moderate and cold climate zones offer many micro-organismes an unfavourable environment outside their hosts and victims. This seems the main reason why many germs there developed a moderate virulence since killing off their host too eagerly would mean an ineffective spread. So evolution favoured the less virulent forms, compared to their like in the tropics. Microbial pressure may have been less in these regions to some degree, but disadvantages were present in the form of cold, food shortage and (vitamin) deficiencies, e.g. scurvy.

NB Nearly all the aforementioned diseases bear no connection with cattle, whose influence should not be overestimated.

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A10 Diamond's hypothesis

In 'Guns Germs and Swords' Diamond states that the transition to the sedentary state exposed man to many new pathologic germs, mainly from his cattle. This implies a large disadvantage of the sedentary life and a cradle for the large pestilences. However, his vision neglects the enormous pressure from pathologic micro-organisms on nomadic groups. Infectious diseases do not have to come in waves in order to cause havoc. And, apart from domestic animals, fellow people and an overwhelming animal and aquatic reservoir provide all sorts of germs. Cattle was not a decisive factor in the disease burden of man, cattle breeding coincided even with developments which meant a large improvement in life expectancy.

In prehistoric nomadic societies, median age at death was only a few years, ranging from 1 to 5. This was even the case in nomadic groups studied in the 20th century AD. Death was due to climatological/ physical circumstances like floods, fires, drought, hurricanes, volcanic eruptions, earthquakes and heat and cold. Lack of food was always a main cause of death. Predators were a non-neglectable threat, homicide as well; parasites formed a constant pest. But also in that era, infectious diseases were the predominant cause of morbidity and mortality. These were not the large epidemics of later eras but often infections from the individual's own microflora or contagion from tribe members. Early in life, mothers and others hand down potentially dangerous micro-organisms to the infants, sometimes even before their birth. E.g. bacterial meningitis that was until recently killing 1 out of 10 nomadic children before the age of five, is caused by symbiotic bugs from the direct family. Even today quite a percentage of the deaths in the developed countries is due to non-epidemic infections. The best example is the sixth cause of death in the USA: pneumonia (mainly in the elderly), mostly from their own micro-flora.

Despite the disadvantage of newly emerging diseases, as stressed by Diamond, the early cities provided an enormous advantage to their inhabitants in terms of longevity and comfort. Their organisation meant protection against armies and brigands, centralised food storage was some guarantee for survival, and differentiation and specialisation in labour stimulated proper housing and clothing. The potential hazard of high numbers and crowding with respect to infectious diseases was not yet a disadvantage that counterweighted the aforementioned advantages. For the early cities were islands embedded in their countryside. This means that their population was not (yet) easily massacred by bugs arriving from far away. Trade routes, of course, provided every now and then the micro-organisms of smallpox, pestilence or cholera and thus caused waves of mortality. But this was a haphazard process since the long distance transport was scant and quite a few contagions 'on their way' to a city died out before reaching it. Median age of death was well over 20 in some Sumerian cities; the well

known infectious diseases were still the main cause of death, while other causes were kept at bay within degree.

A dangerous era arrived when an one hand cities became as large as to harbour hundreds of thousands or even more than one million inhabitants and on the other hand traffic intensified, went faster and reached for the outposts of the earth. This made the vast population vulnerable to contagious diseases, for in the large centres there was a to-ing and fro-ing of pathogenic micro-organisms. Rome is a good example of this turning point in city history. It was a spider in a vast web of land and sea transport (“All roads lead to Rome”). E.g. there was an extended and lively grain trade with Egypt.

Contemporary writers like Juvenal were amazed by the unhealthy aspects of the capital; unhygienic streets, stench and an enormous risk for acquiring diseases are described. This made Rome a place were one lived much shorter than in the rest of Italy. Median age of death was about 5 years.
From then on big cities became black holes that couldn’t sustain their number of inhabitants and constantly absorbed large numbers of people from the near or further countryside. This population machine, composed of an expelling countryside and an absorbing city, has lasted for about two millennia, till well in the 19th century. Seventeenth century London had a median age of death in between 5 and 10 years, which was also the case in Dutch towns of that time.
Literature: Diamond 1997, Wells 1998

A11 European expansion

European expansion implied a two way flow. Europeans made acquintance with diseases and shortcomings hence and they brought diseases with them.
An unsettled dispute concerns the outbreak of syphilis in the 90's of the 15th century in Europe. It is uncertain whether Columbus brought the spirochete which causes this disease to Europe in 1493, his pilot Pinzon being the first victim. But, whatever the source, expanding world trade brought the disease to Asia, introducing it even in Japan in the 16th century. An important counteraction to European expansion and settlement on foreign shores have been infectious diseases like malaria, cholera, amoebiasis, and shigellosis.

They formed a perpetuous attack on the sailors and settlers, as can be read from the tombs of the last five centuries in graveyards far away from Europe. But also vitamin C deficiency (scurvy) ment a check on their numbers. Cause of transportation and environmental problemds, not many of these pests did reach Europe or settle there. E.g. cholera only settled in Europe after the introduction of fast sailing ships, bringing the microbe to the estuaries of Thames and Elbe in their ballast water.

But the reverse picture has been detrimentous to many populations. The Americas were free of smallpox, tuberculosis, meazles, cholera and yellow fever, for instance, but they received the full load of these scourges in the course of the 16th-20th centuries. This decimated their populations in many areas. Well known is the influence of smallpox on the success of the Spanish armies in Mexico and Peru in the 16th century. Half way the 19th century meazles killed nine out of ten inhabitants of the Fiji Isles Even AIDS, which may originate from Central Africa, has presumably expanded by a detour in Northern America and Europe to Africa again.

Literature:
Diamond, 1997
McNeill, 1976
Wells, 1998

A12 Cholera: an environmental problem

Cholera has been with man since his settlement in crowded communities. The first reliable descriptions date from India in about 300 BC. The disease is caused by the bacterium *Vibrio cholerae* that evokes a vehement diarrhoea leading to a vast loss of water and minerals, which without medical intervention often leads to death. The natural habitat of *V.cholerae* is the saline river estuaries of e.g. Indus and Ganges. The bacterium's toxins impair the host's bowel function and the leaking of salt fluid is providing the bacterium with its desired environment. The host's death is of no evolutionary disadvantage to the bacterium, since the victim will have contaminated much of his surrounding before dying, making more victims.

The disease was presumably restricted to South Asia and Eastern Africa for a long time. It reached Europe around 1830 by two routes. Through the Balkan and Russia, the last stage being made by war ships visiting harbours like Hamburg and London. And, maybe more important, by (tea) clippers that sailed fast enough from the estuaries of India to those of Elbe, Thames and Meuse to provide these with *V.cholerae* from their ballast water. Before, the bacterium would have succumbed in that water before arrival and patients would either have died or recovered before they reached their destination.

Cholera is still a large global problem. The vaccine is extremely insufficient and the only effective measure is sanitation. Which is still a large challenge in many developing countries. In the beginning of the 90's there was a cholera epidemic in South America, caused by the faecal pollution of coastal waters and the consumption of raw fish dishes. Cholera was a manace in the refugee camps in Kenya and Tanzania in recent years and is an increasing health risk in the Northern areas of South Africa.

The American microbiologist Rita Colwell proved that cholera is to a large degree an environmental problem. The bacterium can survive in a slumbering state in certain crustacea, belonging to the plankton in the oceans; each tiny creature can harbour up to 10,000 bacteria. She proved that local warming up of oceans and the resulting expansion of the water deeper into the estuaries, delivers the crustacea deeper inland, where the *V.cholerae* can be released and cause an epidemic. And strong currents like el Niño or la Niña can transport the bacterium over vast distances to foreign shores. Remote sensing of oceans (especially warming up patterns) and local microbiological surveillance in littoral and estuarian areas could contribute to an early warning system and the prevention of epidemics.

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A13 Smallpox

Smallpox: will the virus reign again?

A drama in – provisionary – seven acts

Pieter Bol

Lead: This month the war against Iraq might be launched. It can be considered part of a larger crusade: that against countries and groups interested in the use of weapons of mass destruction. Among these are tools for biological warfare. Will smallpox be one of these weapons? This article discusses the background of this question.

Introduction

Smallpox was man's companion since sedentary life began and large population concentrations came into existence. For this viral infection has to be transmitted in an endless chain from man to man. Because survivors have become immune and are no longer carriers of the smallpox virus. This implies that after an epidemic has raged in a certain region, the virus is not circulating there any more. Only after several years, reintroduction can lead to another epidemic. Smallpox needs a continent or at least a large subcontinent like India for its survival.

In the seventies of the last century the whole world became too small for the virus. Encircled, it was denied effective continuation of its spread: the earth was free of smallpox! Now, officially, there are only two virus stocks: one in the USA and one in Russia. In 1999 it was believed that planned destruction of these last virus strains would definitively eliminate one of the most dangerous germs that has ever existed. But the final blow was not executed in the end of June 1999. And by now many scientists doubt whether the virus is only present in two places on earth. We live in an era of terror, and smallpox is one of the candidates for biological warfare.

Act one: Foe and Woe (till 1721)

Thousands of years ago smallpox became a companion of mankind that would not leave before 1977. Here follows a selection out of the history of this important element in Pandora's box. The experts are not sure about the region where the virus raised havoc for the first time. Some maintain that it was in Egypt and its surroundings and that the disease spread later to India. The mummy of Ramses V (who died in 1157 B.C.) shows pockmarks on the face. But most specialists consider India as the cradle. Many descriptions of epidemics in the last two and a half millennium of Indian history have been preserved, but only the accounts of the last

one thousand years are reliable enough to identify smallpox epidemics. In China the virus struck hard many times.

During a Chinese epidemic in the 13th century half the population seems to have succumbed, a score even worse than a century later in Europe, when the Black Death struck. Chinese from a wrecked ship introduced smallpox in 735 into Japan, which decimated its population. The giant Buddha of Nara was constructed to safeguard the islands from another wave. In India children were counted during censuses only if they had had smallpox, a rule that was applied well into the last century.

Europe became acquainted with smallpox presumably as late as the beginning of our time scale. The term ‘variola’ for the disease was minted by Marius, a 6th century bishop in Avenches, Switzerland, and is derived from either ‘varius’ (spotted) or ‘varus’ (pimple). The spread of Islam was favourable for the virus; it haunted France after the Moors had been slain at Poitiers in 731. In 910 the Persian doctor and philosopher Rhazes described the immunity of the survivors and suggested that this protection might also be created artificially. This clever idea would be realized only shortly later, in China.

Variolation is the intended introduction of smallpox virus in a person who has not yet had the disease. This practice started in China, about one millennium ago. Dried and ground pox crusts were blown high into the nose by means of a blowpipe. This is surprisingly modern: at the moment vaccines are developed that are sprayed onto the nasal mucosa. The Chinese doctors were already aware of the fact that the powder should not be too old, but also not too fresh, for severe complications or death were then impending. Of course some of the treated persons died, but this toll was by no means comparable to that of natural infections. Later the immunization method spread to India and from there to the Islamitic world, also in Africa. In the meantime the application had changed; pox material was introduced into small wounds made in the lower arm. Also then one watched the age of the crusts or pus; and a fatality rate of about two percent was accepted.

The Spanish conquests in the Americas have been favoured even more by smallpox than by the use of guns and horses. In Columbus’ time the virus could not yet reach the American coasts in time. But after three decades the route was known, and the travel swift enough to put persons who were still contagious ashore. Slave traders were extremely afraid of the disease and they preferred to choose in Africa those slaves who had already been pockmarked, by the disease or by variolation (in that latter case the marks were only on the lower arm). The first deliberate use of smallpox was the order of Lord Amherst, commander of the British troops in America, in 1763 to send pox contaminated blankets to hostile Indian tribes. The order was followed but the results are unknown.

Act two: Exorcising Satan with Beelzebub (1721-1798)

At the end of the 17th and the beginning of the 18th century messages about variolation reached Europe. There, smallpox had grown into a scourge that effectively had replaced the waves of pestilence that had mysteriously disappeared. The learned Lady Mary Wortley Montagu, 'femme de lettres', got to know variolation when in Constantinople as the wife of the British ambassador. Every autumn 'pox-ladies' visited many villages and offered variolation to the young who were not yet immune. They transported crusts or pus from patients in walnut shells. Once this had been applied in small slits in the lower arm, the oculation spot was covered with a walnut shell and carefully bandaged in order to prevent spreading to other body parts (mucosal membranes, eyes) and to other persons. The children had to be in good health and were kept in isolation for some time.

Lady Montagu's beauty had been ruined by smallpox at the age of 26 and one and a half years later her brother had died from the affliction. This gave her a strong motivation to have her son variolated in Turkey in 1718 and her daughter, back in London, in April 1721. She published about it. A wave of protests rolled over this 'degenerated mother'. Her pen friend Voltaire defended her, along with some other forerunners in this age of Enlightenment, but the majority of critics were very negative. The turmoil was noticed at the Court; for the former and the present royal houses (Stuart, respectively Hanover) had been heavily hit by smallpox. A test was performed. Six prisoners who had been condemned to death were variolated on the promise of release; they survived. Successively one of them was exposed to natural infection; he stayed free. Then, in April 1722, Amalia and Carolina, daughters of the Princess of Wales, were (in)oculated. The terms '(in)oculation' and 'transplantation' well fitted that century of horticulture. In the same year Cotton Mather introduced variolation in Boston; African slaves had taught him this.

But variolation did not become a great success. The deaths among the variolated and the contagion of people in the surrounding stood in the way. And that in a century when 60 million Europeans *alone* died from smallpox and many millions of survivors had become blind from it. The smallpox was not the least of the diseases that Thomas Malthus hinted at when describing the large plagues that check human numbers. But in the same year of his publication of "On the Principles of Population" – 1798 – another important English publication appeared. This herald, "An Inquiry into the Causes and Effects of the Variolae Vaccinae", was published by Edward Jenner.

Act three: The Guardian Angel (1798-1900)

Edward Jenner (1759-1823) was an English country doctor with great scientific drive. On proposition of a friend, the famous biologist Hunter, he had even been accepted as a member of the Royal Society. The scientific basis for this had been his study of the cuckoo's young. Jenner stated that this young itself worked the eggs and other young birds out of his

stepparents' nest. This now highly irritated many members of the learned circle. Ornithology later on has completely acknowledged Jenner's observations, but for him this has come too late. For when in 1796 he wanted to have a study on smallpox published by the Society, this was prevented. By his adversaries, who commented: "There again, is that cuckoo's young in our ranks!" The result: in June 1798 Jenner published the most important medical essay of the last 500 years on his own, without any financial support. This is together with the denied insights of doctor Semmelweis about puerperal fever, half a century later, an uneasy fact for medical publishers.

Jenner was inspired by the observation among the country folk that people who ever had got cowpox hardly ever acquired smallpox. And in these people variolation normally did not evoke a strong reaction. It was common knowledge that milkmaids had scars in their hands but sweet faces, untouched by smallpox. From this finding, laymen incidentally had tried inoculation with cowpox, like the farmer Benjamin Jesty in Dorset in 1774. But several observations around these trials evoked contradictions and debate. Jenner was however, as a scientifically trained doctor, the first investigator who systematically evaluated the observed facts. He proved that cowpox inoculation evokes immunity by which both variolation and natural infection don't have effect. But he made one big mistake: until his death he stubbornly denied that revaccination was necessary every now and then in order to booster immunity. After some time his enemies had collected quite some ammunition: (dead) victims who had presumed to be immune to smallpox.

The introduction of cowpox vaccination became a big success. Within two years in Great Britain alone 100,000 people had been vaccinated, whereas variolation in the nine years since 1721 had only been given to 1,000 people in Europe and North America. Jenner's booklet was immediately translated in several European languages and into Latin and the practice was spreading like a prairie fire. In 1800 Benjamin Waterhouse introduced smallpox vaccination in the USA. Many European governments under French rule thought this a cheap and proper instrument to get the people's commitment. It was difficult to obtain the right cowpox material. Not many cows developed the udder affliction that produced the desired material. Some virologists think that in the course of time Jenner even has started to inoculate with a deminuated strain of the human poxvirus. If this were true, he would in fact have become a variolation man.

In most countries there was a quick change of policy, which meant the oculation from man to man. Spain, for instance, sent the cowpox to its American colonies on a ship on which twenty orphans formed a living chain of successive vaccinees. Sadly enough, the man-to-man inoculation could introduce other things, like the microorganisms causing syphilis, tuberculosis and viral hepatitis.

As an isolated strategy, the effect of cowpox vaccination was restricted, however. In Berlin, for instance, it was demonstrated that vaccination did indeed prevent children from dying from smallpox, but that the over-all child mortality did not diminish, since more than 30 other infectious diseases were eager to take its place. Paradoxically, in the countryside vaccinations were more popular than in the cities, since in their more spread out populations the epidemics were more often affecting adults.

Strong opponents of vaccination were found among the orthodox Protestants and civil rights activists. Main theme was the eternal dilemma: “Are we obliged to protect ourselves and, moreover, do we have the duty to partake in health campaigns in the interest of our fellow people (in the case of smallpox: by helping in creating a solid herd immunity)?” The adversaries rejected governmental pressure and stressed the mortality by both complications and failed immunity. That last factor improved after revaccination became the standard; for cowpox vaccination does not give lifelong protection.

An example from the neighbour countries Bavaria and Austria. In the former country revaccination was introduced in the beginning of the 1870’s, in the latter not. In 1875 the difference in incidence of smallpox had become 34 fold and in 1895 this was even 374 fold. At the end of the century Austria then started revaccinations.

Act four: Choosing between two Evils (1900-1959)

In 1802 Jenner wrote the prophetic words: ".... … it now becomes too manifest to admit of controversy, that the annihilation of the Small Pox, the most dreadful scourge of the human species, must be the final result of this practice." And slowly this began to become true. In North America and Europe the epidemics grew rare and, when occurring, were immediately bridled. But in the world as a whole there were 50 years ago still 15 million patients annually of who 2 million died.

But the successful diminution of the danger led to a loss of tolerance towards the complications of the vaccination; the fate of virtually every form of effective prevention. An example from Holland 100 years ago, where the government only admitted children to primary schools if they had been vaccinated. This indirect vaccination urge infuriated the orthodox Protestants and they kept their children at home by the thousands, which was illegal since law obliged education. The vaccination complications implied that the government was very uneasy with the question. Year by year the Health Council had to deal with it and never could provide a definite solution. By the fifties the problem had been overcome: no epidemics arose any more in Europe and the vaccination became optional.

Act five: The Genie in the Bottle (1959-1977)

In 1959 the World Health Organization (WHO) decided to fulfil Jenner’s prophecy completely.

It began a campaign of gradual eradication of smallpox. This was intensified after 1967 and ten years later a Somalian cook was the last patient with naturally acquired smallpox. On December 9th, 1979 the WHO-committee signed the document that solemnly declared the world pox free. How could this have been effectuated? Well, in the last regions were the virus still wandered about, all patients were immediately and strictly isolated. Special teams travelled around with pictures of smallpox victims: “Did you recently see such a patient?” Rewards were paid for reported cases.

This strategy, together with a rising vaccination rate among the populations of e.g. India, Pakistan, Bangla Desh, Ethiopia and Somalia deprived the virus of its preys. The eradication was possible since its only reservoir is man, the disease is easily recognized and the incubation period limited. In the mean time other human diseases are on the brink of elimination. Among these are poliomyelitis, hepatitis A and B and dracontiasis (Guinea worm infection).

Of the hundreds of laboratories that had kept smallpox virus strains, only 13 were allowed to maintain their stocks. Which was not without peril as was proven by a dramatic accident in one of these laboratories, in Birmingham (UK). In August 1978 medical photographer Janet Parker was contaminated by the virus and died some days later as the very last smallpox patient. The director of the laboratory committed suicide. This tragedy led to the incentive to reduce the number of laboratories to seven.

Later it was decided to restrict the virus collections to the two main adversaries of the Cold War: the USA and the USSR. In Atlanta the Centers of Disease Control (CDC) guard 400 strains and the Russian lab in Koltsovo near Novosibirsk 200. Several times the WHO decided that the stocks were to be deleted, and invariably the execution was delayed, sometimes at short notice. The last time was in June 1999.

Act six: The chained Demon (1977-2001)

In 1999 the debate became very vehement. Opponents of the deletion stated that man has no right to deliberately eliminate a fellow being, that we cannot reconstruct the virus, and that we must be able to study the whole virus and not only fragments. These studies would serve development of vaccines against other diseases and would enhance our comprehension of the immune system. And, moreover, there is no danger from terrorist abuse (!), they postulated then, and military use has been proven contra productive. They proposed to limit the stocks to one place (the Dutch CDC). Scientists who adhered to the destruction hinted at the *billions* of people that have died from smallpox or were debilitated in the last millennium alone. Also they were not optimistic towards abuse of the germ. And, pointed they out, the vaccine is not made with smallpox virus but with cowpox virus and this has and will have broad application for many different vaccines. Emotions flared up.

A few questions are of importance. Are the 600 strains that are kept in Atlanta and Novosibirsk really the only surviving representants of the smallpox virus? Only 40 years ago hundreds of laboratories all over the world disposed of the virus, and can we be sure that they all were run by obedient and law abiding people? Did they all hand in their stocks? Some of these laboratories are situated in countries that are now labelled by some as 'evil'. The virus can be kept for dozens of years if stored ultra cold or if dry-frozen. Are there no secret military stores? It has been suggested that corpses of smallpox victims in the Siberian permafrost might still contain virulent virus. Russian scientists have investigated this and they report negative results (corpses of the 1918 Spanish Flu victims on Spitzbergen and in Alaska have been studied with positive results, but in them only *fragments* of the flu virus were detected). Last question in this category: what about the witch doctors and medicine men in Africa? They applied variolation with humane poxvirus far into the 20th century. Of course, virulence decreases but imagine that they have found a conservation procedure.

Next question: could the poxviruses of e.g. apes, camels or cows ever undergo an evolution towards the humane poxvirus? Experts and the WHO stress that many mutations are necessary for this and that, haphazardly, these have all to go in one direction, in order to lead to this very unwanted result. But, forlorn in the dusk of history, once the virus has come into existence, long after man appeared on earth. This is a highly unquieting idea.

Last question: is man capable of reconstructing the virus within soon? Well, genetic technology develops so swiftly that this might be feasible within ten years. If that were so, the present debate becomes a farce. Quite revealing is the fact that the USA and USSR, but also Canada and Israel kept large contingents of soldiers vaccinated. This might also be true for the Iraq army, or even total population.

Act seven: Handling the Axis of Evil (2001-?)

From the foregoing it seems not unlikely that terrorist groups have smallpox viruses at their disposal. After the cases of anthrax in the autumn following September 11, 2001, one wonders what possibilities they have to use smallpox virus for biological attacks. During the 20th century military research on the use of smallpox virus for war purposes, has led to the conclusion that it was not fit. But terrorists have their own reasoning and fanatic groups might decide to strike with smallpox. In the New England Journal of Medicine of January 30, 2003 (dedicated to this theme) it is calculated that a concerted release on ten airport terminals might result in a maximum of more than 50,000 patients (www.nejm.org). Does this imply that from these patients the virus will spread over the States like a prairie fire? No, victims will be isolated as much as possible and vaccine will be offered to them. Vaccination during the first 2-3 days after infection (before the symptoms start) is still protective. There is enough vaccine

in the USA, and the stocks can even be used diluted, thus multiplying the supply. Man to man transmission does not occur without being very near to each other or even intimate.

Why, if terrorist attacks might occur, the vaccine is not offered everywhere to everybody? Because the vaccine is, as described above, a rather dangerous one, as a matter of fact the most dangerous of the dozens of vaccines that are now at our disposal. So, scientists are in debate about the risk by biological attacks versus the risk of severe complications or death by the vaccine. If 60% of the population were to be vaccinated, 482 people would die from it (assuming that for 2.72 persons in a million vaccinated the outcome is lethal); and thousands would have serious complications. Even restricting mass vaccination to 10 million health care and emergency workers would result in 25 deaths and many more with dangerous side effects. This, against the background of the possibility that no terrorist attack will be launched at all, would cause a revolt. And again: once terrorists strike there is still ample time to protect the victims and their surroundings.

And there is more: the cowpox vaccine that is applied can cause the spread of this virus to other people. If they have skin diseases or are immune-compromised they can get very serious cowpox infections, and even die from these. All these arguments together explain why the government is not eager to offer you the vaccine at every corner. This is a wise policy, and it shows that we really *did* learn from history. But one can be worried about the insight of the general public. For the danger of smallpox infection is often underestimated and many think that full-blown disease can be easily treated (which is not the case). In contrast, the dangers from the vaccine are generally overestimated. The press will have an important role to bring fear, reasoning and balanced assessment of risks to a plan that enables individuals to take decisions, might the nightmare happen. A determined, well-educated people is the best base for coping with the threats that we experience these days.

Box 1 A most horrible disease

Smallpox is mostly transmitted by droplets and infects via the respiratory tract. Pneumonia is the main cause of death. But many organs can be afflicted and irreversibly be damaged. The incubation period is about 12 days. Before the skin eruptions come up there are unspecific signs like fever and backache. Characteristic are subsequently the pustules on the skin that dry out and fall off, leaving the patient pock marked. Case fatality rate used to vary between a quarter and nearly 100 percent. One third of the survivors became blind. There were may causes of blindness in the last centuries, but smallpox was a dominant one.

Box 2 Variolation and vaccination

Variolation is the application of the germ of *variola*, so the humane poxvirus, to a small skin wound. This causes a local inflammation that evokes total immunity against infections by the virus; normally this immunity does not expire. The method has disadvantages, though. If the material is too old, proper immunity is not reached. And if the material is too fresh, the infection can afflict the whole body, endangering the vaccinee. About two percent of the vaccinated did die. And the vaccinees could infect others in their surrounding (e.g. by their respiratory system), which meant for these just as much danger as the natural infection.

Vaccination (from the Latin: vacca = cow) is the application of the germ of cowpox, which is in cows the cause of udder inflammation, into a skin wound. Here as well a local reaction results, leading to immunity against humane poxvirus; this is called *cross* immunity. Disadvantages: immunity is not lasting lifelong but only 10-15 years. So periodical revaccination is obliged. And in historical times the application of cowpox material from man to man could transmit other infections like syphilis. Moreover, the vaccinees were at (a very small) risk of dying from encephalitis (brain inflammation).

Two books have provided ample information for this article:

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A14 The health aspects of modern urban water management

Dr. P. Bol, medical epidemiologist, T.U. Delft

Introduction: The dangers to public health because of the presence of water in inhabited environments are relatively small in the Netherlands compared with many third word countries: the possibility of malaria returning here even in the middle to long term is almost impossible. Drowning is the foremost threat to public health especially amongst children. Important is sufficient control; water arrangements features once built and completed are often left to their lot or are not looked after properly. Those who create such objects should also be responsible for the upkeep and therefore the prevention of possible health risks.

Psychical

Maybe it seems odd, but I begin this article with the psychological aspect of water in urban environments. And more specifically the new artificially created water that is so beloved by designers in the last decades. Holland is a water land, so this is logical. But the new ditches, canals and ponds nowadays have a different function than in the old time (with the exception of wady's and the like). At present the water is a part of the interplay of forms and environments.

That is what we know from architecture. Was it not Le Corbusier who stated that architecture is 'the play of forms under the sun'? And this is where the problem lies. For Holland is a country were the weather is often greyish and shadowless, even if it is not raining. That turns the well intended efforts frequently into sombre blocks that evoke depression. Even more so since our country is flat and colossi, building blocks and houses cannot be integrated with the surroundings in an appealing way, as for instance in Sweden or Finland.

And then the water. On the drawing table it all looks so good and in the information brochures we read about the aesthetic and recreational functions. Everybody enjoys themselves in their summer wear round the water. But those who see the realization of the plans in the winter months, see another story. Wind and rain break the surface of the water and the disagreeable weather is amplified by the sight of the choppy waves. The sun does not always shine in the summer either, and on such days the sight of spray, plastic bags, paper and especially the bobbing bits of foam plastic make a rather depressing impression.

Of course, the reason for this is that the water, after having been designed and constructed, is often left to look after itself. Here is a task for the city council's department of water: a positive contribution to mental health in the city.

An aside: also small parks and green areas suffer from lack of attention and accumulated rubbish. They are often orphan Annies. In the old days many villages had a ‘common’. The community used to take care for such places; maybe in the future the locals and users should be more involved in looking after public water and green areas, thereby preventing disrepair.

Bodily

But the majority of those present primarily want information about the possible threat of city water to their physical beings. Just to put you straight on this subject: if one was to put it in terms of the number of deaths per year then one would not come very far in the Netherlands. Added to this is the fact that the connection with water in general and with city water specifically, mostly will not be able to be found in the statistics pertaining to cause of death

In the third world countries where 6 of the 7 people on this earth live, the story is quite different. It is not exaggerated to suppose that of the one fifth of the more than 50 million registered deaths in the world per year, 10 million are attributed to water; not only related to direct infections but also indirectly by infectious diseases like malaria, yellow fever and bilharzias where the vectors are connected to water. A large number of the victims live in the countryside but also urban areas contribute to the statistics. In the course of 2000 the second International Water Conference and the World water Forum took place in The Hague. There one was informed about several health aspects of too much, too little or qualitatively bad water. Justly these meetings stated that particularly water in the fast growing mega cities is an enormous challenge.

Drowning

In The Netherlands mortality due to water is relatively rare. The threat here is not caused by biological or chemical aspects of water, but the physical aspects. People can drown. Of the dozens of people who drown unintentionally every year (with the exclusion of suicide) a significant fraction meets death in the ‘new water’ of the new housing developments. But there is more to it than that. The traffic is increasingly protected from the edges of water, but in newly built areas this is not the case, because of the character and the purposes of the artificially created water parties. Features. Near that water live many (young) children who are naturally attracted to it.

Toddlers and also pre-schoolers can drown in only 30 centimetres of water. Swimming tuition (at school) often only starts at the age of 6. Earlier initiatives do exist, but generally not among foreign groups. Large segments of the originally Moroccan or Turkish inhabitants, for instance, do not have a swimming culture. These are data that one knows from the media and experts confirm it. But this is a qualitative assessment, reliable quantitative data are lacking. In The Netherlands many statistics are available, but epidemiologists often look in vain for

incidence and prevalence data, even of several frequent disorders, like heart and vessel diseases and distinct forms of cancer.

Drowning is not an exceptional event. We can obtain data from the Central Bureau for Statistics qua age class and sex. But not the actual setting where the drowning occurred. In the first half of the nineties of the last century an average of 100 people per year drowned accidentally; apart from them about 80 people found an intended death in water. Of the 100 unintended cases yearly about 25 were in the age of 1-4 years. Babies hardly ever drown and also in the age classes over 5 the frequency is relatively small. Children of 1, 2, 3 and 4 years have the highest incidence, i.e. 3 per 100,000 per year. For the entire population this is 0.7. But I repeat: it is not known in what kind of water they drowned.

This is in contrast to the years around 1900, when an absolute number of 700 people drowned per year on average. Since there were then 5 million people living in The Netherlands (against more than 16 million now) the implication is an incidence of more than 14 per 100,000. The main causes were the ample presence of water linked with a rather poor ability to cope, e.g. swimming was only mastered by a few, even many seamen could not swim. Not only fishermen and sailors drowned but also the large youth class was generally unable to swim. In the nineteenth century drowning was among the most prevalent cause of death among young children, particularly in the provinces of Zealand, North- and South-Holland and Fryslân. That this cause of death is now proportionally one twentieth compared with then, is not a thing we can be satisfied with. Especially where we are artificially creating water parties in built up areas. Each drowned child means a catastrophy for many dozens of people.

Other health problems

Compared with the yearly 100 cases of drowning, other mortality due to water is low. And not easily procured from the statistics. But it is possible to approach the disease burden by afflictions that are related to water. Again with the restriction that in most cases it is impossible to appoint the role of *urban* water.

Malaria nonsense

Already for some years now, several authors have warned of the danger of a return of malaria in The Netherlands. Principal reason would be the increase of the average temperature. Despite the fact that these suggestions have been repeatedly demonstrated to be beyond reality, they turn up in the press regularly. Obviously, there is some benefit in scaring the crowds and the public seems not to be against a little bit of horror. A most educated opposition against the panic stories was published in 1999 in the Dutch Medical Journal (see references). Most of the following has been derived from that article.

A possible *return* of malaria implies that this disease once occurred here. Is that true? Yes, that is correct, despite the fact that not all epidemics that occurred in the eighteenth or nineteenth century were labelled to be malaria, were always necessarily so. In the last century malaria mainly hit North-Holland in between 1920 and 1955. It is presumed that malaria struck every now and then the Dutch sea provinces, like Zealand. The rather mild local form of malaria was called ‘alternating fever’ or ‘third day fever’, after the pattern of cold chills. Causal organism was the protozoa *Plasmodium vivax* that is transported by one of the many species of Anopheles mosquito’s. This plasmodium is of a moderate virulence and the resulting malaria doesn’t often cause death. Other plasmodia are much more dangerous, the most aggressive being *Plasmodium faliciparum* that inflicts the dreaded malaria tropica, This protozoa is responsible for most of the circa 2 million malaria deaths yearly in the world (for a large part in Africa, especially among young children). It is transported by another Anopheles species than ours.

The Anopheles mosquito prefers breeding in brackish (and rather untidy) water. For the female mosquito blood from bovines is her first choice. She is zoophiliac and humans are second choice. In North-Holland the investigator Van Seventer concluded in the fifties and sixties that the mosquitoes entered the stables in autumn to pass the winter there. In spring every now and then humans were stung, particularly if at the time of their resuscitation the cattle were already in the meadows. Presumably the cause of the large epidemic that struck just after the war in the area North of Amsterdam, was the lack of cattle available for the blood hungry mosquitoes. These had been completely butchered or deported to Germany, and the poor mosquitoes had to satisfy themselves with humans. That was the last time that quinine has been prescribed on a large scale in The Netherlands. The last local case occurred here in 1961 and in the seventies the country was definitively declared free of malaria by the WHO.
The Anopheles that harboured the Plasmodium of the malaria in The Netherlands is still present (so no climate change is needed for her presence). But she lives here in small populations. Chances are against her. Much water in the country has been polluted by e.g. insecticides. And much brackish water has been turned sweet (Zealand, Biesbosch!) but also the ditches in North-Holland turned sweet. Also the large dam that closed off the Zuyderzee from the North Sea (Afsluitdijk) created the sweet IJsselmeer. That enormous reservoir of sweet water has reduced the salinity of the ditches drastically. And maybe even more important: the people don’t live any more in farmhouses with stables but in mosquito-unfriendly houses that don’t invite a stay in the winter.

The transmission of the Plasmodium occurs from an infected animal or human, by an appropriate mosquito, to a next – still uninfected – animal or human. The chain of infections can only be started and sustained if enough people with plasmodia in their bloodstream are present in a certain area. The creation and continuation of an endemic situation is determined by quite a few factors that are all subjected to the law of probability. The resulting equilibrium

is the product of chances. Can we state that the present-day Netherlands meets the conditions for a return of endemic malaria? No, for the point prevalence of people with the malaria parasite is extremely limited. Moreover, these patients have to be stung – in the short period before their treatment starts – by an Anopheles that subsequently stings again, not an animal but another human being.

What is the supply? Well, each year the statistics reveal about 250 people in The Netherlands who have imported malaria from endemic areas. Often this is due to feeble compliance of prophylactic drugs or a wrong dosage of these, but predominantly to not sustaining the prophylaxis long enough after returning home. The number of 250 can be doubled in order to approach the real amount, since not every import case will be recognized. But how many of these hypothetic 500 will be stung before the start of their therapy, not by just a mosquito but by an Anopheles? And how many other citizens could be infected by this rare mosquito after that? Presumably the answer is: 0 (none). It is really not easy to start a vital population of a parasite, that will sustain itself, into the right ecological niche (as can be acknowledged by ecologists who try to re-introduce populations of beavers and otters).

If an endemic malaria case would ever have occurred, this would presumably have been loudly announced amply. Like it was broadly published that people had been infected from the international airport Schiphol, in the eighties. Three times Anopheles was lucky there, being imported by planes and thanks to the warmth of a summer evening they could cover a distance of 2-3 kilometres, which enabled them to infect people who had never been to the tropics. One of them was a 16 year old girl who took part in a sailing camp and stayed in the surrounding canal of the Haarlemmermeer polder where the airport is situated. She could even remember the fierce sting later on. In the nineties this phenomenon did not repeat itself, despite the increase in flights, also from infested countries. The measures taken to counteract the ‘illegal passengers’ seem to have been effective.

The modern trend to create new moors, wetlands and the like, can invoke annoyance hinder by mosquitoes. Mainly by two species, *Culex pipiens* (normal ‘house’ mosquito) and *Aedes vexans* (moor mosquito), a sister of the vector of the yellow fever virus (*Aedes aegypti*). That it took more than 150 years before yellow fever was transplanted to Mid- and South-America is another proof that a number of conditions have to be met before effective settlement is a fact.

And lastly some data to illustrate how serious the situation in the endemic areas is. In about 100 countries (half of total) about 2 billion people are potentially exposed to plasmodia infested mosquitoes. At this moment 300 million people have the parasite in their body and 100 million of them are ill. Among them are the 2 million dead per year. You can understand then that where one in seven inhabitants harbours the parasite, the situation is drastically

different from that in The Netherlands where *per time unit* only a fraction of the 500 imported cases is a potential donor of blood to anophelines, e.g. 30 persons (one in half a million inhabitants!). And in most cases with a plasmodium in the bloodstream that is unfit for Dutch Anopheles mosquito's.

Weil's disease

In the Amsterdam laboratory where the spirochaete that causes Weil's disease can be demonstrated, about 150 investigations concerning suspected cases are performed. In about one fifth of them (30) the leptospirae are found. The main clinical problem is liver inflammation that normally runs a moderate course in under fives. But in adults this can be sometimes the cause of death. A sad case happened about twenty years ago in the province of Overijssel where a municipality employee had been pushed into a ditch by an angry female citizen. This is how she protested against the intended breaking down of an illegal shed in her back garden, next to that ditch. The poor man got Weil's disease and died.

The spirochaete – a sister of the cause of syphilis – is excreted in the urine of (amongst others) rats and survives for some time in stagnant water. Hence that the 'flushing' of water in canals and ditches is important. Also swimming in such water is not to be recommended. Every year there are victims among feasting students who jump or fall into the town canals. Don't do this. Will the creation of nature friendly water banks automatically lead to an increase of Weil's disease? That depends (amongst other things) on how rat friendly the banks are (biologists may be able to judge).

A side remark. In the first half of the 19th century the Amsterdam quarter 'Jordaan' was full of water. What now has become a canal or has been filled in, was then a ditch with banks that we now would describe as nature friendly. A mammoth alliance of doctors and engineers (hygienists) has put and end to this. This water that was by the way also used in the households was a source of disease, and it teemed with rats. Were the muddy sloping banks to be blamed for this? One can presume that they rendered a positive contribution to the rat paradise, but there were many coinciding factors.

At the moment the number of rats in The Netherlands seems to equal the number of inhabitants. Also in urban environments, with their firm quay-walls, basalt slopes and facings. The way we handle the water is likely to be of more importance. Like swimming in the water or not, flushing and draining or not. A decisive factor is the food supply for the rats. Often they can feast on food leftovers but also the so called 'duck feeding' habit causes evil. The modal Dutch duck often cannot eat the amount of food that is thrown to him and the rat swims away with it. A stricter attitude towards our feathered friends seems desirable.

Water borne diseases

During the 19th century our ancestors, especially the town dwellers, to a large degree took their water from canals and rivers. Supplying them with a high risk of swallowing the bacteria that cause typhoid, cholera, bacterial dysentery and the virus that causes hepatitis A, perhaps also poliovirus every now and then. At the moment we have a good sewage network everywhere. And we aim for solving ‘pour over’ problems. So the careful handling of precipitation, also in peak periods, can be of importance to public health. As potentially surface water can be contaminated with the aforementioned micro-organisms. But also here the way of handling the water is essential. Sewage workers for instance do not frequently acquire the diseases mentioned.

That a prudent approach to a sub optimal situation can work is proven in Japan where 80% of the sewage system is not hidden underground. But the Japanese don’t use the water in the open system for a bath, swimming or for rinsing the vegetables. This concerns a well-informed population with a high educational level. Where this is not the case, problems may arise; in the North of Japan I actually did see children swimming in a heavily polluted river into which sewage pipes drained, but that was in a back street district. In India or Indonesia the combination of open sewage channels and polluted canals and rivers form an immense health threat to the population and also an unvaccinated tourist easily attracts hepatitis A there. As late as 1975 this could still occur in Europe, near the city of Porto. Portugal, which had just emerged from its colonial wars, had a backward sanitary situation. A large epidemic of hepatitis A struck the bathing guests at Foz at the mouth of the Douro river on the Atlantic Ocean.

In the west of The Netherlands many cities lacked clean water during the last months of World War II. But appropriate information given to the well educated population could restrict the consequences. In Amsterdam for instance, the health authority instructions were to put the water contained in tubs outside for exposure to sunlight. The UV-rays reduced the number of e.g. typhoid bacteria drastically.

A special infection is caused by the water bacterium Aeromonas. It gives quite a few water lovers – surfers, anglers, swimmers – intestinal disturbances and diarrhoea. But the more dramatic manifestations are found mainly in cases by one specific subspecies that affects predominantly the elderly and among them especially those with severe underlying diseases.

And lastly an aside remark. Our local ‘pour over’ problems are dwarfed by those in countries like Bangla Desh. Helophyte filters would be the logical option there. Was it not so for the frequent and heavy flooding and inundations that keep frustrating this solution time and again, for every time the surface water is contaminated by these contraptions. The enormous

tsunami disaster of December 2004 around the Indian Ocean shows how fatal faecal contamination of water can be.

Children's pools

A special category of urban water are the small 'swimming' paradises in the parks for our youngest. In a country where both indoor and outdoor swimming pools have to meet the highest hygienic standards, a blind eye is often turned to these pools in the parks. And even if the water is refreshed every day and sometimes even chlorinated , at the end of a hot summer day the result of bacteriological sampling is stunning. Here is a dilemma. For we don't want to take the summer pleasure away from our children and from ourselves. May be we have to except every now and then that we – in a hyper regulated country – even with a maximum of effort are still left with a sub optimal result. Real disasters have so far not occurred.

And then.....

A few last things. Botulism is a disease of water animals and water birds that are infected by *Clostridium botulinum* of the types B or E in eutrophic water poor in oxygen. It is very unlikely that people go swimming in green slimy water near to cadavers of birds and belly up dead fishes. That would, besides eating these animals, be the only chance to get a botuline intoxication. Until now no case has been reported.

At last I mention a rather complex interplay of ducks, snails, people and a cestoda (flatworm), named schistosoma, which is related to the organism that causes bilharzias. The worm eggs are excreted by the duck and become larvae; these find a harbour in the water snail. There they grow out and emerge again in the water. Here they become cercariae that irritate our skin and give an itch ('swimmers itch'). The vehement immune reaction saves us after some time from the problem. Here again the way of handling the water, e.g. in wady's, is essential for hindering or evading this.

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This article was written for a lecture during the course on modern urban water management in Delft, April 2000. It was in a shortened version published in the journal of the ‘Unie van Waterschappen’ in the summer of 2000 and in the beginning of 2001 another version was published in ‘Netwerk’ (magazine for the history of hygiene and the environment).

A15 Water quality, a matter of life and death

“He who procures clear water can mock the doctor”--Old Dutch proverb

Good quality drinking water is a top requirement in life. Just as the fish in the proverb is not conscious of living in water, because it does not know otherwise, the present day Dutchman often has only a slight comprehension of our excellent water supply. Of course, those who work this wonder, the thousands of men and women who everyday take care of the pure H_2O from our taps, form an exception, just like the students of sanitary engineering. But even they are often really only acquainted with the present exceptional situation.

That is why I have written this article from a historical and global perspective, with the emphasis on health aspects. The reason for this is not only because I’m a doctor, but because of the huge number of people in this country who work with water, and who by definition exist to a large degree by the sacrifices that the society is willing to make so that public health can be protected by clean water.

Cholera etcetera

I have chosen cholera and Veteran disease to use as examples in this story)not because they form the only or largest problem to the water supply, but because they can explain a lot. In 1848-1849 The Netherlands was confronted with the third cholera epidemic since the introduction of this gastrointestinal disease shortly after 1830. More than 22,000 people died from it, a rather reliable mortality rate for the statistics of causes of death was already well developed by then.

But how many had been ill? We don’t know, for in that time the majority of sick people never came under the observation of family doctors or medical specialists, so any substantial registration of the morbidity data was lacking. There were hardly any doctors and the few that there were, mainly served the well tot do, the poor rarely saw a doctor and often only if their condition was already hopeless and little could be done. The medicine cabinet of the rare practitioners, as amusingly described in the oration in 1993 of our former minister of health Borst, contained many useless preparations, apart from five or six effective drugs.

Given the case fatality rate of cholera (meaning the percentage of patients who died), which was not as high as that of typhoid, a disease that had been endemic for centuries, there may have been hundreds of thousands of cholera patients in 1848-1849. The total population at the time was 3 million. Cholera was one of the reasons why the life expectancy then was only slightly more than 35 years.

Did this massive dying make an enormous impression? Yes and no. The loss of a beloved parent, sister or son is always terrible, in any society. But the context decides to a large degree the acceptance of this grief. In the 19th century at least one third of the people died of contagious diseases, often at a young age. Among those were gastrointestinal diseases like cholera and typhoid, but also infectious diseases with other attack mechanisms like pneumonia, tuberculosis, diphtheria, smallpox and whooping cough.

Legionellosis

In contrast: in the last year of the last millennium, 1999, hundreds of visitors of the West-Frisian Floral Exhibition were contaminated with the water bacterium 'Legionella pneumophila'. In the end more than 200 infections were counted, of which 154 were laboratory proven, and eventually 31 people died, 23 by a proven legionella infection. Was there reason for national consternation? Absolutely, but the number of deaths occurred in a population of nearly 16 million. Why we were now so affected by an event that can be calculated as being less than one thousandth of the extent of the one of one and half a century before?

The answer is: we have changed. In what way? Well, in two ways. In general we have a far better physical condition than our forebears. And despite the fact that we are not confronted with so many infectious diseases any more, and have not build up much resistance in a natural way, vaccination has armoured us against many of them. That's why we are amazed when water still causes disease. Moreover: we have drastically reduced the exposure to these plagues thanks to measures taken by civil engineering: water filtration, water supply systems, sewage systems and waste water disposal we are amongst some of the greatest blessings of the 19th and 20th centuries. These contain the huge plagues that can be associated with water.

But we have also changed in two other respects. An increasing percentage of patients can survive thanks to complex medical care. One can think of the growing percentage of very old people with a sub optimal immune system, people with immune disorders caused by cancer or by cancer therapy like radiation and chemotherapy, HIV infected people, and so on. But in addition: we hardly can accept any more disease and death by environmental factors. We speak of avoidable disease and death.

Long ago, as nomads, we were lived by the grace of environmental factors, like precipitation and wind, predators, fires and floods, mortality among our prey animals and cattle. This we called Fate. But also in more recent eras like the nineteenth century we were attacked by many things we now consider as avoidable. Think of work accidents, tuberculosis, drowning, smallpox and cholera. Then we often spoke of God.

Cholera

How did we get cholera? Well, it has raged already for thousands of years in South-Asia and was one of the scythes – after the description by Malthus – that Death used to keep the population in check at a level that was permitted by the means of existence. We only got this plague when the sailing ships had become fast enough to dump the bacterium Vibrio cholerae here into the sweet water that served as drinking water. Think of the windjammers and the fast tea clippers; it was the ballast water of international ships that contaminated the Thames, Elbe and Meuse with vibrios. It is now unthinkable that our own (great)great grandmothers took the water for household and kitchen straight from the river or canal. People in the country side often had pumps or wells and the rich in the towns could buy water in shops which also traded in ice and burning coals (to light the fire). For these groups the risk was limited.

In the perspective we have now, it is not so amazing that a cholera epidemic, once it was in full swing, could make countless victims in cities, town and villages, via the excretion of vibrios by the sick and the recovering. It only subsided after a large fraction of the population had been contaminated and either had not developed the disease or fell ill and either recovered or died. Most patients survived and they formed the ones who would be spared in the next cholera wave.

Cholera, as a water borne disease, has rendered a very valuable service to the science of epidemiology. Due to the combination of disaster for the Londoners and the intelligence of doctor John Snow, half way in the nineteenth century. The city's water supply was then still in the hands of many small private enterprises, each exploiting their own wells. Here one could take water against payment. But nearly all the wells were fed by the Thames and it was during a cholera epidemic at the end of the fourties (the same as the aforementioned Dutch third wave) that Snow grasped the idea of the cause.

In the beginning of the fifties came the next epidemic, around the pump of Broad Street near Hay Market. He demonstrated that this pump was the source of contagion and when his solid argumentation did not convince the exploiters he had the courage to remove the arm of the pump personally. This is still guarded in the 'John Snow Pub' near the spot and every year there is a reunion of the 'London Epidemiological Society', of which Snow has been one of the founders. This all happened before the triumphs of microbiology but Snow had already postulated already the presence of very minute contagious particles in the water as the cause of the epidemic.

Far from home

Now I take you to the slums of Lima, San Salvador, Mexico City, Calcutta and Bombay. We write the year 2005 and virtually everyone, also the poor of this world, is more or less aware of the dangers that lurk in contaminated water and food. But the strange thing is that apprehension of risk factors does not lead to immediate and clear cut solutions. Especially not when poverty is around; I challenge you to invent creative solutions for your water problem when suddenly your connection to the water supply is cut. Just like I encourage you to think about what you will do when the gas ceases to flow into your heating system, or the gasoline at the fuel station is dry or when there is only silence when you pick up your phone to make a call.

The poor of this earth now, are sometimes regarded with a mixture of disdain and mercy by the 'upper ten' of the ten percent of the world population that have their lives perfectly organized (Western Europe and North America). But what are their possibilities to turn cognition into useful solutions in their difficult circumstances? Well, they try everything, e.g. illegally tapping off water systems. Also there are cities who send trucks with water tanks to poor quarters but poor municipalities cannot meet the needs sufficiently. So we can frequently see how comprehending mothers (don't underestimate the insights of poor people!) buy water in bottles or containers in order to keep their families free of disease.

At what price? A quick calculation will reveal that a litre of pure water in this way costs a poor person ten till one hundred fold more compared to a litre from the restricted water supply system of their well-to-do compatriots. Even in The Netherlands the 125 litres that we daily consume per capita, if obtained at the super market, would represent a considerable part of our salary (even if we would reduce the water use).

That is why it is not surprising that the epidemic that occurred in South America in the beginning of the nineties, by the there still unknown cholera-variant '*Vibrio El-Tor,* mainly hit the poor. Even more interesting than the morbidity data (of course the poor were most at risk) were the case fatality rates. The chance of dying was much higher for a poor than for a rich patient, not only because the difference in physical condition but also by social factors (like the availability and affordability of medical facilities).

Is this an embittered plea concerning the controversies of rich and poor in this world, in the tradition of some political movements in our country? No, this is not at all the aim. The detection of restricting factors is the key to finding useful strategies. Only when health and the survival of children all over the world will become a common phenomenon, are there chances to overcome the appalling poverty of so many on our planet. Because it has been demonstrated to be almost a law that affluence plus the connected decreasing population growth leads to a demographic transition that promises a good and long life for a not too large world population. A future quite in contrast with our present world where still 2-3 million

children die annually before they are five because of diarrhoeal diseases from contaminated water.

This early death happens virtually only to children in poor areas or segments of the population. At least one in 20 of the deaths in the world is a poor child aged 0, 1 or 2, caused by an affliction that we consider to be completely avoidable. Be aware: around 1900 there was also in the Netherlands still a considerable mortality among babies, especially in the summer. This contributed strongly to the more than 10% mortality in the first year of life. It can be concluded that this country was still a developing country then.

Back home

Back to the veterans' disease. How long *Legionella pneumophila* is already with us? We don't know. Presumably it has hit earlier than the eighties but we were unaware then. It literally emerged from the water by the increasing percentage of vulnerable people in the population. What is to be done? It is well know: heating of the water in environments where many susceptible people are around, like hospitals. But that costs energy and energy is costly. In that respect it is a lucky coincidence that the survival of many people with a diminished resistance goes hand in hand with the large financial means of the affluent society.

It is obvious that poor areas are already quite sufficiently satisfied with water of sub optimal quality and that in these region there are not many people around who need to be protected against that water because of immunologic frailty. The conclusion is that in different parts of the world, different equilibriums exist.

Is it possible that we should return to the water supply of earlier days and are we following the wrong path by our perpetually increasing demands for safe drinking water? The answer is: No. That 'No' can be defended in many ways, but I think there is one prevailing reason: We simply can't go back! We – and that means the water engineers not in the last place – have created a situation in which infant mortality is rare and the life expectancy has been stretched till more than 76 years for men and nearly 81 years for women. Moreover, a conviction reigns that severe afflictions before becoming elderly are unacceptable and that even the discomforts that are related to mature age can be accepted by no means. Do you think that, given this situation, we are in a position to pour water into the wine, or in concordance with our professions: wine into the water?

In The Netherlands, the expenditures for health care are at the moment already nearing 40 billion euros per year, about 2,500 euro per person. That money is mainly paid from insurances and only partly by tax money. But apart from the aforementioned 40 billion there are many other institutions that serve mainly or even exclusively the public health. Think of

the inspection of meat and other food, motor helmets and safety belts, fire stairs and air bags. And of course what we hide underground: water pipes and sewage systems. These services are costly and every now and then it is suggested that maybe a little bit less is also good. That is invariably the fate of every form of prevention that has been successful

Effective prevention means: unwanted events don't happen. This is for people without knowledge and insight a reason to propose reducing the money spent on prevention. These, they argue, have obviously no right to exist: the money is spent on non events.

A clear example of cutting down money on prevention is the abolishment of tuberculosis centres in the USA in the end of the seventies. Because of the strongly decreased incidence and very low prevalence of the disease. Immediately after the break down operation the AIDS epidemic started and some time later the tuberculosis incidence rose and multi resistant tuberculosis bacterium strains appeared. Then the need for the closed down institutions was obvious; it has cost much time and money to re-establish them and particularly to reorganize the expertise. Also in The Netherlands the closing of the TB consultation offices had been considered but this had luckily been prevented. By the way, even if tuberculosis in this country is now more prevalent than some decades ago, it is not so much a problem as it is in the USA.

At last

People who are not aware of the misery that unclean water meant for (public) health can be tempted to consider the efforts for providing clear water to be too costly. And if there is no comprehension that in an affluent society the quality of drinking water has to be much higher than what in a developing country might be acceptable, there is always the danger of reducing the budgets. This has to be counteracted strongly. I hope that the small sample of the countless health aspects of our drinking water presented here, have shown you why. Water is of invaluable importance for our high level of public health.

Dr. P. Bol, medical epidemiologist

A16 Clear Danger

By Sebastiaan Kalwij sebastian.k@macunlimited.net

Sebastiaan Kalwij studied Medicine at the University of Amsterdam and did his masters in 'Control of Infectious Diseases' at the London School of Hygiene and Tropical Medicine. During his studies and thereafter he worked in various places around the world. The last few years he combined working on a cruise ship as a ships doctor with working as a partner in a Primary Care Health Centre in Central London.

Introduction

In the course of this module you have been introduced to infectious diseases and their various modes of transmission. Water, one of the most precious resources on our planet, is also a major factor in the spread of many infections. With population growth and consequently an increased use of water, the pressure is on. In the next article I would like to illustrate some of the theories with personal stories and encounters from my travels and work abroad.

The World Health Organisation recognises 4 major categories of classifying water-related diseases:

1	Water-borne diseases	*contaminated water*
2	Water-washed diseases	*not enough water*
3	Water-based diseases	*through organisms living in water*
4	Water-related vector-borne diseases	*insects living near water*

The reason for categorising these diseases into 4 different groups is that each of these groups can be controlled in their own way. As future engineers you will be involved in this. Sometimes proper planning of irrigation systems and water waste management systems can avoid many cases of illness. Often big irrigation projects are in parts of the countryside where medical facilities are poor. The irony of this is that often these projects are meant to improve the quality of live, but then at the same time introduce new diseases. But technology shouldn't always be blamed for this. Often a change in population distribution is at the core of it, as we will see in the first chapter. The four aforementioned categories will be discussed in the four chapters.

El Salvador

Isabella was the youngest daughter of the household I was staying in. For a period of six months I had taken up residence in a modest house in the Northeast of El Salvador, not far from the border with Honduras, Central America. The rainy season had just come to an end and flowers were blossoming everywhere. The roads were still muddy and difficult to use. The

journey to the clinic involved a hazardous wade through a river dissecting the village. Once the daily rains had stopped it all got better. It became a lot easier to move around and to get to villages a bit further away.

The civil war had also finished. The peace deal had been signed. Elections were being planned and a peacekeeping force from United Nations had begun with collecting weapons. There was an atmosphere of change, of anticipated progress. And it was about time. The countryside had suffered unduly during the war and this image was stuck in the minds of doctors trained in the capital city. None of them were really interested to spend time in the countryside away from family, friends, comfort and entertainment. And that explains why I was in El Salvador; young European doctors made up much of the workforce trying to get life back into rural communities.

The area was called Cabaña Norte. Most of the inhabitants were moved into safety when the war was at its worse. A mass evacuation to a refugee camp just across the border took place in the deep of the night. Many lost their life during this night. Few would have realised that this was also the end of a century-long lifestyle. Most families had their own farm and were self-sufficient. A plot of land for corn, a few chickens, a pig and a banana tree. Though people were living spread out there still was a strong sense of community. Men worked on the land, a machete being their only tool, a symbol of pride and masculinity. Women were doing most of the housework and the kids had their own little tasks.

But after the war everybody was clustered together. During the years spent in the refugee camps new friendships and relations developed. Living close together also gave a sense of protection. The countryside was pretty much destroyed. Farmhouses were burnt down, and fields overgrown. Most of the young people had had quite a good time in the refugee camp. Lots of things were organised, they received good education, learned some English and food was provided for. Children got vaccinated and most of all, they got introduced to new concepts: Nike, Aerosmith, Michael Jackson, Toyota and Sony. Now repatriated, they had lost their traditions of working alongside their fathers and uncles on the land. That was boring! Too much work, too much hardship, too few rewards. For most of the young women it was easy enough to find work in the capital city as ‘muchacha’, domestic help. For the men it was a lot more difficult. Unemployment was rife. Most of the men ended up hanging around outside the village bar.

Isabella usually got up at crack of dawn, while I was still fast asleep. One of her jobs was to make breakfast, which usually consisted of a fried egg, beans and a freshly baked tortilla. By the time the house smelled of burning wood and freshly roasted coffee Isabella was well on her way to the river. I only remember her coming back around midday balancing a basket on her head with freshly washed clothes and her hair still wet. Once in a while she asked me if it

was true that they had machines to do your washing in America? She somehow didn't seem too keen on the idea. Isabella had a pair of strong hands and a thorough way of washing. With great vigour she slapped the wet clothes against the stones in the river and after only a few weeks my shirts were getting thinner and thinner. Sometimes I teased her by threatening I was going to buy her a washing machine. The main reason she wasn't too keen on this was of a social nature.

After she had prepared breakfast for the family she set of to the river only to return around midday, lunchtime. Not only had she done the laundry and washed her hair, she also returned home with the latest village gossip. During lunch she was most animated and everybody listened to her latest news. Also she knew exactly who was ill and what was wrong with them. In fact she gave very accurate medical information. Not only did I get to know through Isabella all our neighbours and her friends, but through her they also knew where I was living and though the clinic was open each morning, most people preferred to come to our house. First they always made some small talk with the other family members, the mother of Isabella made them sit down and gave them a cup of coffee and then the visitors turned to me for medical consultation. The end of the story was always a request for some antibiotics.
It was always the same story too, abdominal cramps, diarrhoea and feeling unwell. Antibiotics always seemed to do the trick, and if I were so kind to prescribe the same ones again please.

Dysentery is an acute or chronic infection of the large intestine. Symptoms are: diarrhoea with or without cramps, blood and mucus. In the majority of cases this is caused by Shigella, a bacterium of which there are several types. Infections with Shigella are extremely common, especially in tropical and subtropical countries where sanitation is poor. It is not just Shigella. Other examples are *Campylobacter enterocolitis*, *Entamoeba histolytica* and *Giardia lamblia*. Most people get infected by drinking water which is contaminated. It is therefore a so-called water-borne disease.

I had my suspicions already that Isabella's daily track to the river was at the source of the problem. The river wasn't just used for washing clothes. The river was also used for bathing and for sanitary purposes. Because of the important social function of this daily ritual and in absence of a decent water and sewage system it was practically impossible to break this vicious circle of contamination. In a slow flowing part of the river there were a couple of so-called baths, dug out in the rocks. The men of the village had to wash themselves first, before sunrise. After sunrise, it's was women only! I escaped all this as the mother of the house thought this was a bit too early for me and collected a large bowl of water from the village pump every morning, so I could wash myself at the back of the house. This water was technically only to be used for cooking and drinking. There was a long queue any time of the day. A time consuming task just to get a bit of water to make a cup of coffee.

Behind the house was a small garden, mainly used for banana trees and in the middle of this there was a pit latrine. In fact there were quite a few pit latrines in Santa Marta. They were quite new too, only installed a few months ago. After a while I realised that I was the only one ever to use the latrine. From time to time I brought this up after dinner, and the answers were always a bit evasive, like: “We never used to use them before, it’s much easier to do it in the river and everybody else does it too”. Pit latrines were placed only a short walk from the main house but often poorly lit and women in particular felt vulnerable. Some of the latrines weren’t kept very clean and there were flies and other insects. Pit latrines were not very popular to say the least.

In the past, population pressure was less. People were living more spread out over a large area and contamination through a water source was rare. Since repatriation, people started living more closely together in the absence of good sanitation and sewage systems. Now the chance of getting infected is much higher. Of course, old habits die hard and a lot of effort will have to be put into educating people and maintaining and cleaning the latrines, but this all too often comes as an afterthought when there is no more money left.

One of the principles of controlling water-borne infections is to separate drinking water from sewage water. When this is not possible disinfecting water is an alternative and was one of my plans. But again all I had to do was to observe my 13-year-old ‘sister’. Another one of Isabella’s jobs was to collect wood. Twice or three times per week, late afternoons, she went with some of her friends to the forest. It somehow always took her a lot longer than she thought it would take. As Santa Marta kept on growing, and everybody was looking for wood in the part of the forest nearest to the village it got more and more difficult. It often took her many hours twice or three times per week. A job she didn’t particularly like. She often got bitten and hurt herself, as she didn’t have proper footwear. The wood she collected was just enough for the daily fire to fry an egg, warm the beans, bake the tortillas and roast some coffee, but certainly not enough to boil gallons of water to supply a family of four with clean water for washing and cleaning and laundry. It was just not practical.

I often asked Isabella if she didn’t get fed up with those never-ending cramps and diarrhoea. She would lean back on her chair against the wall and say:”Well you can always take some pills and than it’s gone for a while.”

In water-borne diseases there is not so much a lack of water, but a lack of clean water. In the next paragraph we will see that in some places there is a shortage of water which causes a different range of infections, a group called: water-washed infections.

Lima, Peru

The owners of the small hotel in Lima weren't quite sure where I wanted to go. I didn't know it myself either. All I had was an email address and the name of a clinic in a suburb I couldn't find on the map. The cook seemed to have more of an idea. "It's one of those new parts of town, it's way out, you better get a taxi to get you there." What she meant was a so-called 'Pueblo Jovenes', a shantytown. They are located at the fringes of the city, in the desert. Lima is one of the biggest cities in Latin America. Spread out, the city goes on for miles and miles. The traffic jams are horrendous and in the wintertime the skies are grey for months on end. A light breeze covers all buildings in a grey dust. It's a very busy place, the powerhouse of the economy. After getting my bearings and talking to people in shops and selling newspapers I finally had a bit of an idea where my next work place would be: 'Canto Grande'. The taxi driver asked me to repeat it several times, and several times during the journey he stopped at roadside cafés to ask for directions. They all replied with the same phrase: "much further". A petrol station advertised itself by saying it was the last one in this part of civilisation. Ten minutes further the cab driver stopped the car and opened the door for me. Sorry, I am not going any further. I don't know this area; it's much too dangerous. Are you sure you have to go there? I was surrounded by a chaotic collection of half-built buildings, scrap yards, and something which looked like a school. "I am fine, I replied" In the school they directed me to the clinic. One of the doctors, Juan, was in charge of the asthma trial, linking indoor air-pollution with increased incidence of asthma. Indoor air polution was caused by cheap fuel being used for cooking and heating too, as in the nighttime temperatures can drop dramatically. To lure patients to participate in the trial we offered free consultations for all other medical conditions and with the clinic being the only one in this neighbourhood we were not left quiet for long. Mother after mother came in with kids and the most common complaints were itchy skin rashes, often badly infected. Most of these infections are caused by a lack of personal hygiene, through a lack of water for washing.

At the same time I was working in Canto Grande, a PhD student, Melissa Gonzales from Phoenix, Arizona was conducting an indoor pollution study. As I discussed my findings with her, I decided to go along with her from door to door and see for myself what the situation was like. Most of the houses were only half finished and apart from a TV there often wasn't any other furniture. Notably absent were a kitchen or a sink. All the washing up was done in a bucket. The same water was then used to wash vegetables or to cook. One bucket had to last for a whole day. Kids were sharing the same space with dogs and cats. The washing line going through the living room only had a few shirts hanging from them. I asked why they only used so little water. Most of the women replied! " Our water is too expensive"

Professor Sandy Cairncross from the London School of Hygiene and Tropical Medicine pointed to this paradox: "It is expensive to be poor." In many of the fast growing pueblo jovenes the infrastructure is lagging behind. There is often not enough interest by local

politicians to improve this. Many of new settlers are illegal and are occupying their land illegally. Of course enterprising water salesmen make it all the way to the shanty towns, but as the truck with drinking water goes further and further away from its starting point, the emptier it gets. As a result the price of water goes up practically each mile. And so the people who can afford it the least, the most recent arrivals will have to pay the most.
For most tourists Machu Picchu is the main reason to go to Peru. A magnificent trail, a three-day hike brings you to this once lost city. The idyll of the country site is lost on most ordinary Peruvians. The countryside has few facilities and offers only limited ways of making a living. Traditional farming is hard work and unreliable and most of all, for many years, the countryside was very unsafe. The Maoist terrorist group the 'Shining Path' (Sendero Luminoso) made life in the countryside extremely difficult. Many people decided to look for better opportunities in the city. And although we may think that it is better to be poor, overlooking a beautiful valley than being poor in an urban ghetto, most people who made this move don't think so. I asked them many times. The city is full of opportunities, work, and good education. Perhaps not for themselves, but certainly for their children, and that is what most people feel is the most important.

To most of us shantytowns look pretty miserable but for the people who live there this often means new hope and this appeal is not losing any shine. People who have been living in Canto Grande for a few years can already point out easily how much the city has grown. Concrete stretches out to the horizon. Often shantytowns like Canto Grande are a law onto themselves. Unrecognised by politicians there are few schools, health centres, no police and also no good infrastructure for drinking water and sewage. If you don't have any business going to Canto Grande, you better stay away.

A few years ago there was a problem that caught a lot of attention in the foreign media: a cholera outbreak. A popular raw seafood dish was to blame, and of course at the source of this problem was poor sanitation and hygiene. There were many casualties and tourists stayed away. It was not only a financial disaster but also a major embarrassment for politicians. The positive result of this was that it became clear that in order to start improving this situation one had to start by improving the conditions in the shantytowns. Though new people are still flocking in, the great rush has calmed down and it was a good time to do some city planning.
One can imagine what it will mean for a low-income household; instead of spending most earnings on the most basic of commodities, water, it now can be spent on food, clothes, fuel etc.

In the next paragraph I will give an example of a so-called water-based disease. In fact during all my travels, this is the only illness I experienced myself: schistosomiasis or bilharzia. Despite what local tourist offices tell you: Lake Malawi is heavily infested. Another good

example is the nearly eradicated water-based infection dracunculiasis or Guinea worm. (See article by Dr P Bol: Wormhout)

Malawi

In the heart of Africa, a land-locked country with a very large lake, part of the Great Rift Valley lakes. It is not only one of the most unspoilt African countries; it is also one of the poorest. It has few natural resources but a rapidly increasing population. In 1995 Malawi had a population of 9.7 million, by 2025 it will have risen to 20.4 million. In the dry season it is hot and arid and one becomes dependent on the lake. In 1993 I was working in a rural district hospital in Zambia, just across the border. Compared to this part of Zambia, Malawi had many advantages and going to the lake was a popular weekend destination, a time to relax and not just for us. Malawi receives a lot of foreign aid and at the weekends most of the expatriate community seems to take up residence in the small lodges near Lake Malawi. And nothing seems better than having a dip in the lake from time to time, deep blue and ever so tempting. And so did I. I even have got a picture of myself, standing in the water, knee-deep, having an early morning shave. Just like fishermen stand in the water, knee-deep, waiting to catch a fish. Not knowing that instead they are being preyed on themselves.

Schistosomiasis is caused by so called ‘flukes’, worm-like creatures 1-2 cm long which inhabit parts of the venous systems of humans. Fertilised eggs are being released in either the urine or stool, depending on which type. The eggs hatch out in contact with fresh water and develop into so-called miracidium. For the next asexual stage of replication another host is needed, a snail. Once this is completed the snails release minute cercariae. These have to reach a host within 2-3 days otherwise they’ll die so they penetrate the skin of whoever is standing in the water (fishermen, tourists, children). Since they are very small it happens unnoticed. Some people report a rash, but often this only appears after a while and often people don’t make this link. Once though the skin they migrate to the blood vessels and ultimately settle in the veins of the lungs, bladder or intestines. Here they can stay a lifetime. During this time they’ll excrete millions of eggs, which find their way out through the urine and faeces. Since most of the untreated sewage reached the lake, snails get infected and the cycle is closed. Long-term effects are severe ranging from cancer of the liver, bladder and intestines (colon). In certain countries like Egypt this is endemic. Cancer of the bladder is one of the main causes of death in Egyptian middle-aged men.

In Malawi’s case it wasn’t always like this. Dr I Loefler wrote a letter to the BMJ in response to an article published. “In the 1960’s it was safe to go swimming in the lake”. The so-called “Salima Bay” rice project changed this all. Initially workers on these fields suffered an epidemic of bilharzia. The project itself was very popular and attracted many people. Due to this success the project was extended. What one forgot to realise is that birds were also attracted to the rice fields and that these birds carried in their feathers eggs from the fresh-

water snail. The area has never recovered from this really. A survey amongst returning expatriates showed that 50% of people (children especially) were infected with schistosomas. There is treatment, but one can get re-infected time aftertime, as one doesn't develop immunity. The problem lies in the fact that the waters are infected and that the area of water involved is so large that it is nearly impossible to do anything about it at all. There have been many attempts to control schistosomiasis with chemicals, introduction of exotic fish and vegetation. None of these attempts have been successful and may have done more damage than good.

The next problem is of even bigger nature: Water-related vector-borne diseases. These are infections caused by mosquitoes that live near water. Malaria, dengue and yellow fever are the best-known examples.

Mombassa, Kenya

The port-officials in Mombassa are known for their strictness. In order for the ship to be cleared and for passengers to be allowed ashore they have to see all certificates of yellow fever vaccination. Even the captain has been down to the medical centre a few times to make sure all crewmembers have been vaccinated. I wasn't worried about the crew. The passengers are the main problem. On the voyage around the world we left Dover, UK in January 2002 and on the way we went to Brazil, Chile, Easter Island, Australia, Singapore, Malaysia and the Seychelles. And this is where the problem comes from. Many passengers only do a part of the world cruise, few stay on board for the entire duration of the journey. A popular choice is to fly to the Seychelles, stay on the beach for a few days and than join the ship and sail back to the UK via Mombassa, Zanzibar and Cape Town back to Dover. Yellow fever vaccines are difficult to buy in the first place and once a file is open its shelf life is very short. We don't want to over-stock and in principle we only vaccinate the crew. Passengers are advised to see their own doctor back home. Of course many passengers take all the necessary precautions, but some are completely blasé about the whole thing. So we only had two days to go to make sure that we have all the right documentation and to organise a mop-up vaccination campaign. One thousand crew and passengers - Enough reason for a headache.

The same mosquito transmits both dengue and yellow fever: the *Aedes Egypti*. Dengue is a virus infection, which can develop after one has been bitten by this particular mosquito. Symptoms are: fever, (acute) headache, muscular pains and joint pains, hence the nickname break-bone fever. Complications can be severe with bleeding disorders and shock.

Yellow fever as the name implies is also a viral infection causing fever and joint and muscle ache, but also jaundice as it affects the liver. Mortality is high.

The main problem to control these infections is that mosquitoes only need a tiny amount of water to survive. A bit of water left in a flowerpot or a beer can, can be enough. The ship in itself is a potential source to carry countless mosquitoes, despite being at sea for at least 2 weeks since Singapore. There have been cases of residents of Los Angeles, California, being diagnosed with dengue after having been infected by mosquitoes travelling in old car tires from Malaysia to a car tire dump in the outskirts of the city.

Of course we sprayed the ship and tipped out all water from empty paint tins and other potential reservoirs. It is easy enough to do on a ship with enough housekeeping staff. On a city scale you can imagine the enormity and complexity of the task. Singapore takes dengue control very serious. It has extensive campaigns on TV and radio. Children are being educated in school how to take care of ones own immediate environment and the government deploy the army who have the powers to conduct door-to-door inspections. Heavy fines are handed out to those residents who don't empty their flower- pots and leave empty tin cans on their windowsills or balconies. Not only is dengue a big burden on the individual and their families but also on the economy as those who are infected will be off work for many weeks. In a country like Singapore with a highly educated work force this would be disastrous. Singapore has got the financial and organisational resources to implement control measures. For countries like Kenya this is more difficult, hence the strict vaccination criteria for entering the country.

Malaria is perhaps the most notorious of all tropical infectious diseases. Transmitted by the Anopheles mosquito it is worldwide the biggest killer. It has been estimated that more than 2 million people, mainly children die of malaria each year. It is not only people living in an endemic area but also tourists from colder climates get infected. In the UK alone about 30 people die of malaria each year. There are several reasons for this, first of all the symptoms of malaria resemble those of the flu. So if tourists return home in the middle of a flu outbreak, his or her symptoms may be overlooked. Also many tourists choose not to take malaria prophylaxis against the advice of medical professionals. Many immigrants living in Europe think that they are immune to malaria so don't need any malaria prophylaxis. Immunity does exist but is very short lived. All this can lead to ignoring some vital symptoms and seeking medical help too late.

Malaria has been eradicated successfully from many parts in Europe (Italy, Greece, Turkey) and most of the Caribbean Islands. In the rest of the world the problem only seems to get bigger. Population growth is one reason. People building houses in areas, which are unfit for settlement is another reason. As I mentioned before, successful irrigation projects (e.g. rice fields, water reservoirs or canals) attract large numbers of people to areas, which by nature are unsuitable for human living. Poverty is the main reason for the majority of these people. Telling them not to go is extremely difficult.

Eradicating any infectious disease is difficult, expensive and time consuming. It often takes decades to eradicate certain diseases, like polio, measles or smallpox. Once infectious diseases have been eradicated a vast network of laboratories and administration is needed to monitor it all. All too often the money runs out quickly and funds are allocated to other equally important projects.

Conclusion

By providing examples to each of the four categories of water-based infections I hope to have explained the complexity of controlling infectious diseases. It is difficult enough as it is. Ironically man has introduced many diseases indirectly and unintentionally. Ambitious projects can create a perfect habitat for many different organisms playing an important part in disease transmission. As future engineers of such projects it is important to realise that by solving one problem, e.g. a lack of water, one can introduce another, much bigger problem, e.g. malaria or bilharizia.

Prior to planning and constructing new projects it is important to consult experts in Infectious Disease Control.

Special thanks to Dr P.Bol

Reference work:

Dion R.Bell Lecture notes on Tropical Medicine. Blackwell Science 1995.

A17 Assessing and evaluating the health impact of environmental exposures

(Chapter 1 of a recent thesis)

Friend and foe: health and the environment from an historical-epidemiological perspective1

Augustinus E. M. de Hollander, Pieter Bol

Abstract

Until the 20th century West European health status was primarily determined by environmental factors. But since the public health transition unfavourable social and life-style factors have gradually become the most significant causes of avoidable health loss. This paper identifies the principal determinants of health, and reviews the changing importance of environmental and societal forces for the health status. It is concluded that the current situation calls for new definitions of health and well being, as well as for a new demarcation of the field of environmental quality. Preferably environmental health is part of an integrated, multi-disciplinary, multi-sector approach of deprived urban areas, incorporating policies on socio-economic, spatial and environmental aspects of neighbourhoods.

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[1] Based on *Augustinus E.M. de Hollander and Brigit A.M. Staatsen. Health, environment and quality of life: an epidemiological perspective on urban development. Landscape Urban Planning 2003; 65: 53-62.; Bol P, Hollander AEM de. The 'decomparting' of the World. In: RIVM. Bouwstenen voor het NMP4. Aanvullingen op de Nationale Milieuverkenning 5. Bilthoven: RIVM, 2001; Hollander AEM de, Bol P, Niessen LW. Volksgezondheid en omgevingsfactoren: van beheersing naar beheer. In: Rijksinstituut voor Volksgezondheid en milieu. (Achtergronden bij de Milieubalans 1995). Alphen aan den Rijn, Samson H.D. Tjeenk Willink bv, 1995.*

1.1 Introduction

A host of environmental risks pops up in headlines almost every day. BSE-prions causing Creutzfeldt-Jakob disease among meat eaters all over Europe - the reverse of a cynical bio-industry turning herbivores into carnivores-, genetically modified 'Frankenstein' foods threatening the integrity of our Creator's fine web of ecology, as well as our health, trillions of ultra fine particulates from exhaust pipes stuffing our lungs and killing more people than traffic accidents, climate change and the ozone hole.

Are these threats all symbols of modern post-industrial society wasting the health of its citizens or are they merely a sign of distorted risk perception by the public? If one bothers to analyse available public health statistics a slightly more refined picture emerges. Never in our Western-European history we have been as healthy as we are now. Children who are born in the beginning of this new millennium may count on almost eighty years of life expectancy[i]. In this paper we will analyse the past and current public health status, and the factors that determine it, in order to identify important aspects of the environmental health agenda for the next decade and to set the stage for this book on the assessment and evaluation of health impacts of environmental conditions.

We will see that the impact of the 'environment' on human health has altered considerably throughout human history and is now more or less brought under control, at least in Western societies. In our times 'life-style' is the most important cause of avoidable health loss. What probably used to be a cultural, group survival vigour of our early ancestors tribes, is now an individual characteristic, although determined by social group. Finally, the third angle of the triangle of basic health determinants, genetics, has hardly changed over the era of human development. However, the rapidly culminating knowledge of our genetic make-up may surely allow prevention to be more individually targeted. Obviously in the process the definition of health has changed substantially.

1.2 Determinants of health

We will evaluate the development and significance of 'environmental health'[2] using an elaborated version of the conceptual model that was proposed by the Canadian Minister of Health Marc Lalonde in the 1974[ii,3] (see

Figure *1*). According to this model health status can be regarded as a function of a variety of endogenous and exogenous factors. Basically four groups of determinants can be distinguished: human biology or *endogenous individual* attributes, either part of our *genetic* make-up or *acquired* during life, the *environment* (including *physical* and *social* aspects), general *behaviour* (or *life-style*), and *health care* (including prevention and health promotion).

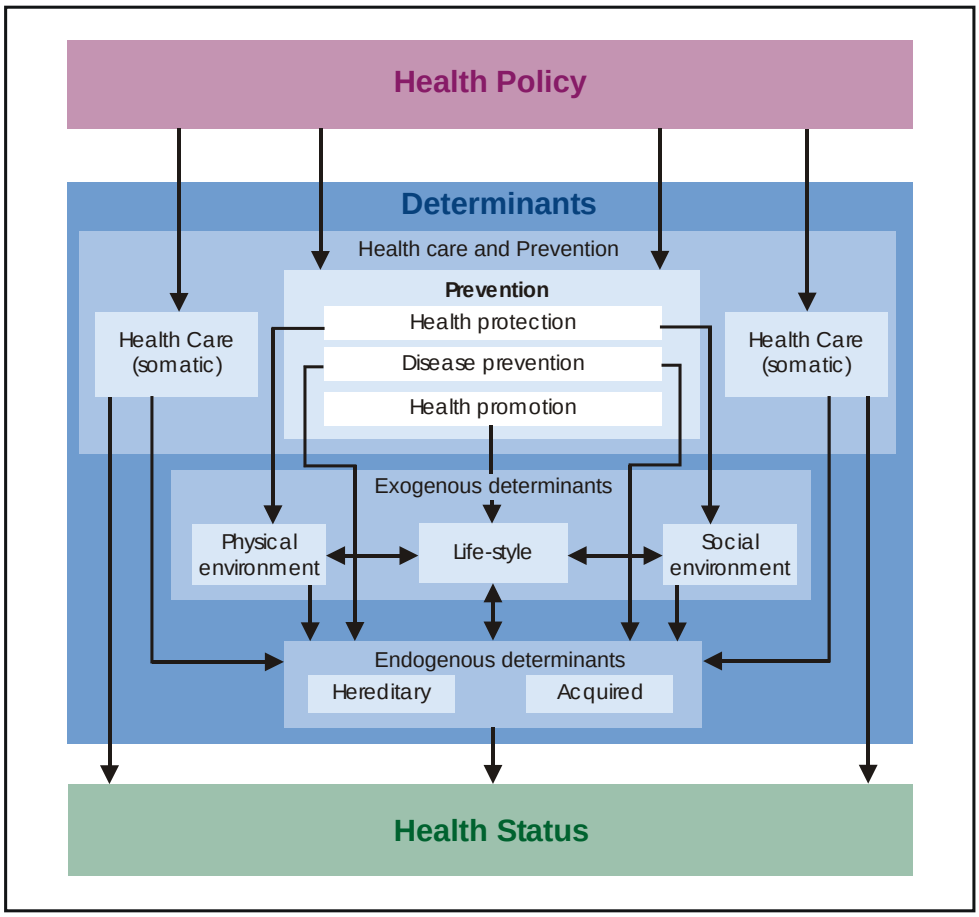

Figure 1. Conceptual model: determinants of public health status[ii]. Three clusters of factors are discerned: endogenous or personal factors, including genetic make-up and factors (susceptibilities) acquired in the course of life; the factors in this cluster are influenced by exogenous determinants, social and physical environment and life-style, that form the second cluster; the third cluster comprises the

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2 An not too appropriate term tot describe health in relation to environmental conditions or exposures

3 Ruwaard D, Kramers PGN. Public health status and forecasts report 1997. Health prevention and health care in The Netherlands until 2015. Bilthoven/Maarssen, The Netherlands: National Institute of Public health and the Environment, Elsevier/de Tijdstroom, 1998.

health care and prevention system that influences the state of health, with or without interacting with exogenous and/or personal determinants.

The most appealing example of a *genetic* factor affecting a person's state of health is, of course, gender. Regardless of the prevailing health system, all over the world women live several years longer than men do, and as far as we know they always did[iii, iv, v]. Most endogenous, individual characteristics develop through interactions between genes and environmental factors and thus have both a genetic and an *acquired* component, for example length, blood pressure, blood lipoprotein composition (familial risk factors), and personal (psychological) attributes[ii, vi, vii, viii, ix]. The interactions between these exogenous and endogenous determinants explain why the response to environmental exposures may vary substantially from one individual to the other[vi,x,xi,xii].

The *physical* and *social* environments, as well as *life-style* are regarded as *exogenous* determinants. The physical environment includes factors such as radiation, noise and heat (*physical* factors), hazardous substances in the outdoor and indoor environment, including our working environment, the air we breath and the food we eat (*chemical* factors); and - needless to say - a myriad of bacteria, viruses and other micro- and macro-organisms (predators), which may have both positive and negative effects on health status (*biological* factors).

Micro-organisms have been a predominant cause of human diseases throughout human history, and hence play an important role in this chapter. But that is not the whole story. At the same time the microbial world has been essential for the evolution of the more complex life forms on the planet. *Mankind* may think of itself as the summit of evolution, as it dominates this world together with its domestic plants and animals. But man, just like other complex multicellular organisms, lives at the mercy of the myriads of microscopic creatures of which they are partly composed. Manipulations of the balance between man and micro world, with herbicides, insecticides, antibiotics, detergents, vaccinations and the like, can offer advantages, but their effects in the long run are difficult to predict. The basic philosophy in this chapter is that micro organisms are neither 'good' or 'bad'; they just do exist, for a much longer time than creatures like us, and they have created the basic conditions that made our life on this planet possible.

In our present world, urbanised now for more than 50%, of course housing and spatial characteristics at the neighbourhood level, such as building density and variation, traffic related 'soundscapes', infrastructure barriers public transport accessibility, or the nearness of open and green space for recreational purposes, are part of the physical environment as well. *Life-style* factors include diet, smoking, drug abuse, sexual behaviour, physical (in)activity and such. The social environment includes socio-economic status, the pattern of social networks, and cultural factors[3].

The concept of health as a dynamic equilibrium emphasises the interaction between determinants, resulting in a particular state of health. While exogenous determinants act on endogenous ones, there are also many interactions within the group of exogenous determinants. Life-style for instance, is to a considerable extent determined by social environment (e.g. family situation). At the level of neighbourhoods social quality, such as cohesion or social safety, may depend largely on the quality of the physical environment[xiii]. Aspects of lifestyle or behaviour, such as sunbathing, smoking, (un)safe sex, and personal hygiene may, in turn, largely determine exposure to factors from the physical environment such as UV radiation, carcinogenic substances, or pathogenic organisms.

Figure *1* also outlines the role of health care and prevention acting on both exogenous and endogenous determinants in various ways.

1.3 From a patchwork of isolated communities to the 'global village'

Before looking forward, we briefly describe the interaction between man and the environment, particularly the microscopic world during the last ten millennia. In those 10,000 years our world has seen an evolution from a patchwork of ten thousands of small communities towards a 'global village' where everything is in contact with everything. Neither distance nor time is an effective barrier anymore against massive and swift distribution of organisms from their original reservoirs.

The approximately 10 million people that inhabited the planet after the last Ice Age, lived in scattered bands as hunters and gatherers, subjected to the whims of the elements[xiv]. Their food supply was unsure; they were exposed to the weather of all seasons, to predators, and natural disasters like floods, fires and drought frequently took their toll. In those communities the median age at death (the age at which half the individuals from the same birth year have passed away) was well under 5 years. In this epoch, as for the greater part of our history, infectious disease was the predominant cause of morbidity and often fatal, but the causal organisms originated mainly from the individual's own flora and contagion by tribe members or the direct environment. Early in life mothers and others handed down pathogenic micro-organisms to the infants, sometimes even before birth. For instance bacterial meningitis, until recently killing 1 out of 10 nomadic children before the age of five, is caused by bugs from the direct family[4,xv].

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[4] Infections from the patient's own micro-flora are still an important cause of morbidity and mortality. Fatal pneumonia (Old man's friend) is the sixth cause of death in the USA and is mostly caused by the patient's own pneumococci. All urinary tract infections and virtually all cases of otitis have an endogeneous cause.

In the course of the last ten millennia man struggled for independence from the uncertainties of life. Gradual domestication of successively dogs, bovines, camels, sheep and goats meant a big leap towards a more guaranteed food supply and selective breeding improved the herds. But the triumph came with the nomads who started to manipulate the plants and fruits that they previously had gathered from the wild; soon larger crops could be yielded. Being a herdsman means moving around with animals, but taking care of plants (e.g. wild cereal cultivation) implies a sedentary life. The first significant transition that mankind experienced was in the era of the Neolithic (Agrarian) Revolution[5]. This 'revolution' was not a momentous event, but rather a process of intensification of the relationship between *human communities* and their *environment* and, of course, among each other[xvi]. This epoch started in some areas such as Turkey's South coast as long ago as 8,000 BC, but in the America's presumably not before 1000 BC[xiv,xv].

In the villages and towns that were the result of the Agrarian Revolution we would observe labour division and specialisation, and successively social stratification. Food reserves were created in the surrounding countryside and this surplus implied opportunities for people outside the food production to dedicate themselves to, for instance, tool making or writing. Agrarian populations were more productive than foragers, at least per unit of land (definitely not per unit of labour), they were also much more vulnerable. Therefore two types of specialisation probably represent the oldest professions in the world: priest and warrior. Priests were needed to invoke the higher powers for good crops, to preserve knowledge and to strengthen the self-restraint and the discipline required for a hard farming life (saving sowing-seed in hard times). Warriors of course were needed for protection as dangers from the extra-human world (droughts, flood, (micro)predators) were more or less exchanged for inter-human danger (hostile neighbours, invading armies). Often these processes led to fatal interaction of military protection and economic exploitation[xvii,xviii].

Nonetheless, the settlements, especially the larger towns and first cities, experienced also the disadvantages of crowding: high densities of the human species in a restricted area, often combined with relatively high densities of herded or domesticated animals, and proliferation of vermin, parasites and other disease vectors, favouring the closing of contamination cycles and thus creating ample opportunity for old and new pathogens. Furthermore, although their crops were high in net calorie value, the diets of the early agrarians were much more

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[5] Transition is a term originating from economics. It describes the development of small scale local activities towards larger scale systems and increased complexity. Some authors claim the cultivation of fire by humans is the first transition[xvii]. At the moment also demography and medicine use the term, speaking of demographic and health transitions. The demographic transition moves from a situation with high birth and death rates (a high 'turn over') to a condition with low birth and death rates (a low 'turn over') and hence is coinciding with an increase in life expectancy. The health transition moves from morbidity and mortality originating predominantly from infectious diseases and nutritional problems to a situation where chronic morbidity and death by mainly cardiovascular diseases and cancer prevail.

monotonous than those of the hunter-gatherers, lacking important 'secondary' food components that are essential to human health, such as certain proteins, minerals and vitamins[xix]. Only in the past century the rich diversity of the hunter-gatherers diets has been regained in the Western world.

Despite these micro-ecological problems the Neolithic towns and cities were a success. Median age of death there rose sometimes even over 20 years. The growing complexity of Sumerian towns in the second millennium BC is demonstrated very well by the detailed hygienic regulations regarding water supply and garbage disposal that can be read from cuneiform script on clay tablets, also containing well defined punishments for ancient city dwellers producing too much environmental noise. Archaeologists have demonstrated that these texts resulted in a well-organised urban life. Evidently the advantages more complex sedentary societies were outclassing the disadvantages like the threat of contagious diseases cause of crowding. Of course this holds true as long as a town and its environment were still an islet without much interaction with the outer world. In that case the old threat – uncertainty about the supply of essential goods – had been successfully countered.

1.4 An unhealthy network

The Bronze and Iron Ages brought the next health transition. For now germs could arrive from far away. The development of more complex technologies implied the emergence of long trade routes along which tin, copper, lead, iron (ore) and the like were transported. Hand in hand with this development the exchange of production surpluses like grain, salt, furs, silk or pottery arose. Micro-organisms, of course, took their chance and hiked with caravans and ships. One bug could not always cover large distances as the recovery of a sick man or animal would most of the times mean the end of the germ's journey. Consequently, the spread often had the character of a relay race ('estafette'); but in tens or hundreds of years germs could travel far, as far as man. Not surprisingly, it was the time that the great plagues were beginning to spread over large areas, particularly around he Indian Ocean – in those days the centre of world traffic[xx]. Smallpox, cholera, plague and typhus could kill vast masses of people in this opened-up world. In fact, the term 'pandemia' (world wide epidemic) could already be used for these sweeping attacks on mankind in that era.

A truly dangerous era arrives when at the one hand cities become as large as to harbour hundreds of thousands or even more than one million inhabitants and at the other traffic intensifies, goes faster and reaches for the outposts of the earth. This makes the vast population vulnerable to contagious diseases for in the large centres there is a to-ing and fro-ing of pathogenic micro-organisms. Rome is a good example of this turning point in urban history, being a spider in a vast web of land and sea transport ("All roads lead to Rome"). For instance, there was an extended and lively grain trade with Egypt. The unhealthy aspects of the capital amazed contemporary writers like Juvenal, describing elaborately the unhygienic

streets, stench and an enormous risk for acquiring diseases. In Rome one lived much shorter than in the rest of Italy. Median age of death was about 5 years.

It took 1500 years to double the world population, from the year 0 until the beginning of the European Renaissance. The 250 million of the time of Caesar only became twofold after many ups and downs in several parts of the world. War, chaos and famine, in their check on population growth, were even surpassed by the great plagues. “From hunger, plague and war, save us, O Lord”, medieval man prayed, and he knew that, once, one of the three was around, the other two couldn’t be too far away[xxi]. The epidemic of pestilence of 1346-50, well known as the Black Death, led one third of the European population into the grave (25 million). The disease struck and killed people with terrible swiftness, or as the Italian author Boccaccio phrased it: ‘its victims often ate lunch with their friends and had dinner with their ancestors in paradise’. The causal bacterium had been supplied via one of the Silk Routes. Not surprisingly, the first rational effort to control epidemics, the ‘quarantaine’ (quarantine), originates from these medieval times.

The New Time, from 1500 on, announces the definitive opening up of the whole world into one large global system. The study of the world maps produced from 1450 to 1650 reveals an astonishing and swift filling up of the white spots called ‘Terra incognita’. This cartographic aspect is the pendant of a real-life process: an exchange on an unpreceded -global- scale. Not only of goods, but also of plants, animals, man himself, and last but not least, their microbial companions; in two directions. Germs from newly opened up areas reached the ‘World system’, like the cause of syphilis, that was presumably brought by Columbus to the Old World as early as 1493, and soon found its way all over the world - even to Japan - during the 16th century. But the microscopic business presents (‘friendship tokens’) that the Old World offered the New, dwarfed the horror of syphilis by all means. Smallpox alone was literally decimating the population of Mexico and Peru in the first half of the 16th century. Smallpox, measles, tuberculosis, yellow fever, and many other contagious diseases of the Old World had been unknown in remote areas with populations that were immunologically virginal, like the Americas[6].

The reports of the impact of the incorporation of ‘rest areas’ into the ‘World System’ provide depressing reading. One single missionary could be the cause of extermination of the target of his religious zeal. Often he not only forwarded the Word but, for instance, the measles virus as well. This meant a disaster for, among others, Greenland, North Canada and Tierra del Fuego. As late as in the 19th century it could happen that on the Fiji Isles more than 90% of the population succumbed after the introduction of measles.

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[6] Earlier export of smallpox to the New World (in the period 1492-1520) did not happen since the crossing took too long for the poxvirus. Even if an explosion of smallpox occurred on a ship, the crew had either died or recovered before landing, and the survivors did not harbor the virus any more.

1.5 A 17th century Health Status and Forecast Report

We are indebted to the 17th century draper John Graunt for thorough statistical insight in the public health of London, during the grim dictatorship of Oliver Cromwell. Fascinated by the weekly appearing London's Bills of Mortality he became one of the world's first demographers by collecting numbers and causes of death to construct the first life tables (see figure 2)[xxii]. His report reads like a 17th century Public Health Status Report (such as our National Health Status and Forecast Reports: VTV). Half of the Londoners of his times died before their fifteenth birthday, 30% before the age of 5. Only slightly more than 10% lived beyond their fortieth year. Between 10 and 20% of the new-borns died before their first birthday, presumably of infectious disease such as diarrhoea, measles and whooping cough. In two of the 22 years Graunt investigated, plague was the largest cause of death, but most of the time it was outnumbered by 'consumption and cough', the 'pale death' or tuberculosis. On average almost 70% of mortality was due to infectious diseases, including leprosy (6%). Diseases of civilisation, such as cardiovascular disease or cancer were very rare, except perhaps for stroke. However, still 7% of the Londoners survived into old age (> 55 year). Of course these figures are not very accurate. In those days deaths were reported by so-called searchers who only knew a limited number of causes of death. Autopsy or coroner's reports were rare [xxvi].

1.6 Splendid isolation

Remnants of ancient times support the notion that the large cities of post-medieval Europe were a dangerous place to live, at least until the middle of the 19th century. Archaeologists have constructed life tables from skeletons found at burial sites in the Çatal Hüyük in Anatolia, were the earliest sedentary, agricultural communities have been found (Figure 2).

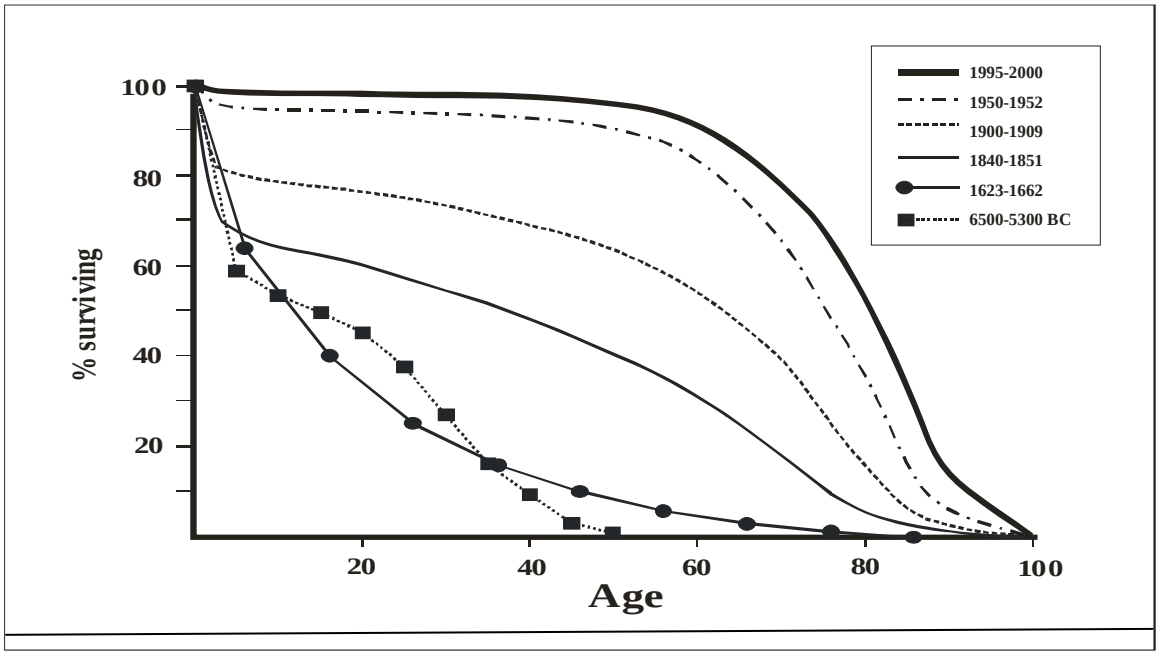

Figure 2. Survival curves from the people of Çatal Hüyük in Anatolia (determined from burials between 6500 and 5300 BC), John Graunt's London (1620-1660), and The Netherlands between 1840 and 2000 (adapted from Wills, 1996[xxvi], Ruwaard & Kramers, 1998[ii]).

Infant mortality was extremely high, and virtually none of this people made into old age, probably due to severe environmental rigours (or the casting out of the unproductive members). However apart from those most susceptible members of the tribe, the middle years of the people from Çatal Hüyük living 8000 years earlier were considerably less perilous than for the people in Restoration London[xxiii]. Again, the reason for this is clear: the Neolithic 'town and adjacent areas' formed a virtually *closed off* economic unit, whereas the large towns and cities of 200-500 years ago were centres of world traffic *without* adequate public health policy. Such a community, without comprehension of causes and spread of diseases, provides a golden chance to the many germs introduced there. The introduction of cholera in Europe in the thirties of the 19th century illustrates very well the impact of world trade traffic on infectious disease prevalence. Only when the sailing ships became fast enough, especially the tea clippers, the *Vibrio cholerae* could get in our parts of the world with the ballast water, taken on from the brackish estuaries of the great Indian rivers and discharged into the identical environment of the Thames, the Elbe, and the New Waterway[xxiv].

From a demographer's perspective up until the 20th century cities were 'black holes' not capable of sustaining their own populations, due to extremely high mortality rates. Cities not only absorbed the agricultural production of the surrounding rural areas, but their excess births as well. Obviously at the same time cities were the centres of religion, cultural, political and technological development[xxvii,xv].

An end to the Englishman's right to be filthy[7]

As the cities were connected by trade routes, plagues could spread rapidly across the continents. Plagues swept the 'virgin' population of cities time and time again, especially the young who did not yet developed immunity: smallpox, measles, plague and finally in the 19th century cholera. The variolation of the 18th century and the cowpox vaccination of the 19th century were far more popular in the countryside than in cities (despite the 'conservative' image of the countryside), for in the more isolated areas the victims were relatively often adults. In cities like London, the regular supply of the virus was so efficient that mainly infants and toddlers were affected and often died. That's why in a census not those children were comprised who had not yet acquired smallpox[xxv].

To really appreciate the public health blessings of the industrial revolution and the economic development it yielded, one should throw a glance at the pre-industrial cities of the 18th

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7 Paraphrasing a 19th century Member of the British Parliament[xxxvi]

century. Large cities, such as London, Paris, Amsterdam had already reached high population numbers and densities, that were able to 'sustain' infectious diseases, such as typhus and tuberculosis[xv,xxvi,xxvii,xxviii]. At the same time public hygiene was underdeveloped; there were no facilities for safe drinking water, nor closed sewerage systems. Families lived packed together in houses, sometimes even several families sharing one room. Hygienic conditions offered ample opportunities for infection cycles to be sustained, humans, (domesticated) animals and vermin sharing pathogenic micro flora and vector organisms. Human and animal excrements and waste were dumped in the same canals where people obtained their drinking water. The only defence against infectious disease consisted of people's immune system, which was often weakened by malnutrition and intoxication[xxix , xxx , xxxi]. Before the second agrarian revolution in the 19th century the common men's diet was staple-based, monotonous, and thus prone to nutritional deficits, malnutrition and recurring famines. Violence, fires and accidents presented another substantial risk of premature mortality, morbidity and malformation.

Compared to our present day societies – striving for zero health risk -, official health protection facilities or measures were scarce in the 18th and 19th century: *fire brigades* were already known in the Roman empire (bands of slaves) and in many cities since medieval times, *fire prevention legislation* for instance regulating the distance between buildings and building materials - no straw and wood - (e.g. implemented after great fires, such as in London in 1666), *lightning conductors* were applied on palaces and official buildings, *light houses* guided ships at sea, societies for *saving drowning, shipwrecked sailors* were organised, there was some *road maintenance*, and already soon after the introduction of steam engines the steam boiler inspection ('het stoomwezen, 1855') was installed. Since 1250 in Holland special governmental bodies, de 'waterschappen' were entrusted with water management, including the control over the *dikes* that protected against floods[xxxii]. Apart from the variolation or cowpox vaccination we already mentioned, the *food and ware inspection services* (although predominantly installed to inspect the sincerity rather than the microbiological or chemical quality of trade), *quarantine* for ships with disease aboard and rodent control in the harbour quarters of town were the most significant medical prevention measures of those times.

By the mid-nineteenth century the needs of public hygiene finally burst through. Beginning in Great Britain the tempestuous economic growth of the industrial revolution brought about a tremendous population drift from the countryside to the larger industrial cities. In 1800 London was inhabited by around a million souls, by 1880 that number had swelled to 4.5 million. This caused enormous housing problems, crowding, poverty, the breaking down of traditional ways of living, and pollution of water, soil and air. In short there was urban pauperisation that probably even Dickens could not describe adequately[xxxiii]. Industrial cities like Manchester and Liverpool burst from overpopulation[xxxiv].

In particular the efforts of the so-called Hygienists (or Sanitarians), an alliance of physicians and civil engineers, made the difference. A series of reports described the abominable hygiene, the moral degeneration and the health consequences for the paupers living in the slums. Not just an act of humanity, one of the key motives of Sir Edwin Chadwick's proposals regarding drinking water services, drainage systems, and the removal of refuse, was increased labour productivity. The median life expectancy among the working class was 15 years. Chadwick calculated that the improvement of housing, drinking water and sewerage services might add another 13 years to the productive life of the average worker (e.g. Chadwick, 1842)[xxxv]. It is almost ironic that Chadwick's health-engineers were proponents of the miasma theory: 'miasma' (Greek for pollution), a noxious form of bad air in filthy environments was the cause of disease. Although John Snow at the end of the 1848-49 cholera-epidemic already suggested in an essay that the disease was caused by material from the excreta of patients contaminating drinking water, the miasma theory dominated public hygiene policy making. Drastic measures were thus proposed in the British Public Health Acts ignoring the germ theory, which is nowadays considered to be the best evidence[xxxvi].

Most historians agree that three great cholera pandemics finally defeated the prevailing 'laissez faire' attitude among the ruling class, most of which already had escaped the unhygienic hell into the suburbs. With a centrally controlled network of local boards of health, established under the 1848 Public Health Act, Chadwick and his fellow hygienists eventually addressed the composite problem of economic deprivation, urban squalor, and severe social-economic health-inequalities. The Sanitation Act of 1866 gave sanitary powers to local municipalities and -employing new sanitary technology- drinking water and sewage systems were modernised at a fast pace, and turned from private into public services. Urban development programs improved housing quality, although not always primarily aimed at the lower classes of ('deserving') poor[e.g.xxxvii]. The rest of Europe followed, some nations, such as France almost immediately, others only after several decades (e.g. The Netherlands[xxxviii]).

1.7 Very healthy people: a triumph over the micro world

The development of survival curves for The Netherlands since the middle of the 19th century show that the Dutch have become a very healthy people, just like the rest of the Western Europeans (Figure 2). Thanks to public hygiene and the improved quality of houses the scourge of infectious disease has been brought under control. Furthermore vaccination programmes, wide application of antibiotics, health education programmes, the development of effective medical technologies (e.g. insulin for diabetes) and, of course, a general improvement in standards of living have all contributed much to the current improved public health status[xxxix,xl]. Especially the 'bourgeois' civilisation offensive at the end of the 19th and the beginning of the 20th century, aimed at young (future) mothers, proved effective, teaching them hygienic housekeeping, and the timely recognition of infant disease symptoms. A

comprehensive system of health protection regarding food, drinking water, and consumer safety, labour and environmental conditions has enhanced health, although the improvement is often difficult to quantify (see figure 1). In 1850 half of the birth cohort had already deceased at the age of 37 (men 36, female 38). Nowadays at birth we may expect a life span of almost 80 years, of which more than 60 years will be spent in reasonably good health (without overt physical limitations). Of course this a typical picture for modern post- transition is still in progress, or in some cases has stagnated[xxx].

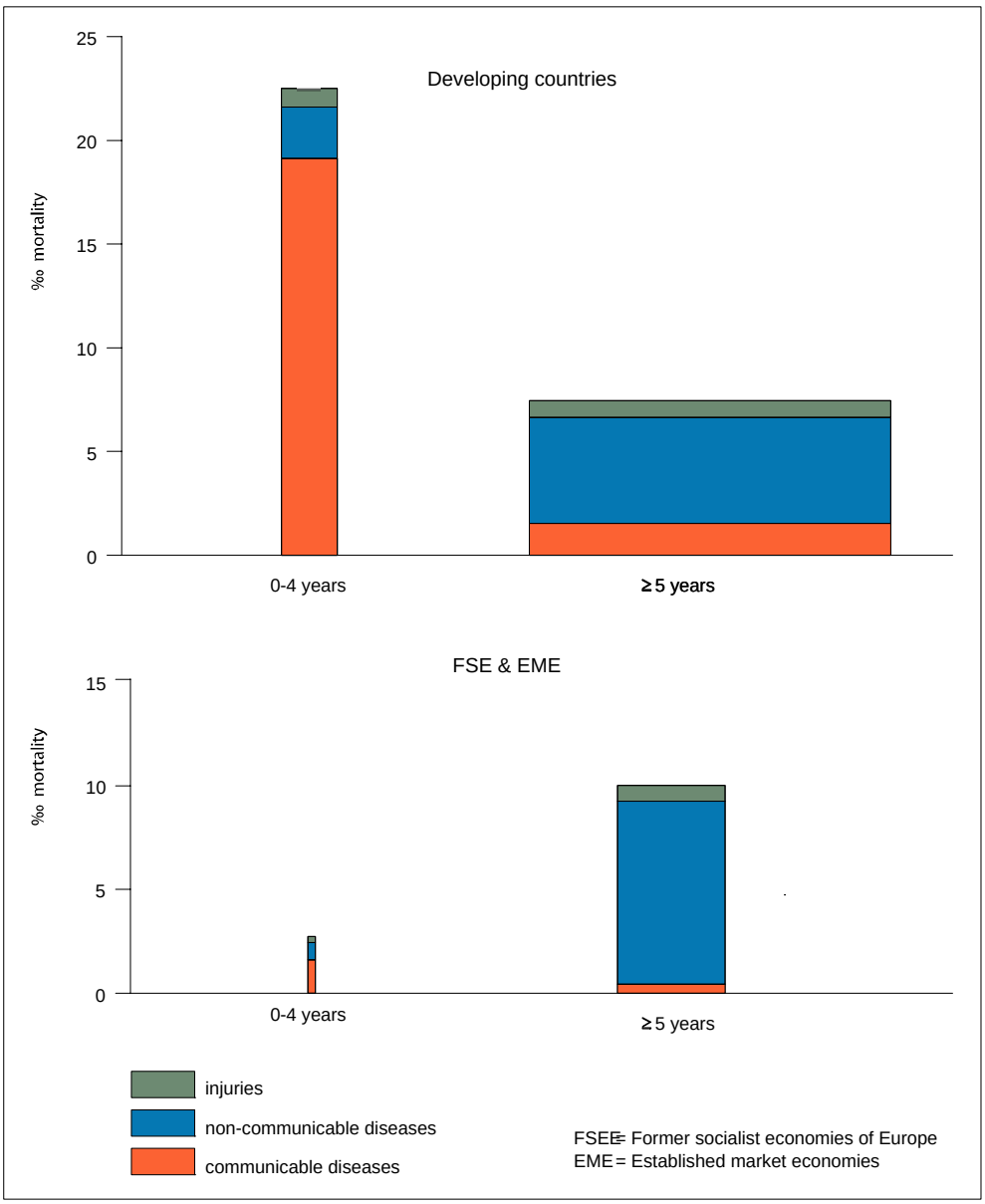

Figure 3. Distribution of the 50 million registered global deaths by three causes in 1990. The four bars represent the division by two age classes (0-4 years and ≥5 years) and two spaces (developing countries and established market economies and former socialist economies). The vertical axis gives mortality in per mille, the horizontal axis corresponds with the size of the population involved. Hence the surfaces of the four bars are proportional to their share in the total global mortality (World Bank, 1993, RIVM Bol en Niessen, 1997).

These enormous differences in health status and disease patterns before and after the lengthy struggle that accomplished the health transition are reflected in the public health status of developed Western countries and the developing world. Acute infectious diseases cause most of the disease burden in low-income countries; while in the high-income countries chronic diseases at older ages (cardiopulmonary diseases and cancer) dominate the picture (Figure 3) [vii, 42,43]. Furthermore the health loss due to exposures from the physical environment is much higher in low-income countries compared with Western countries. This is also reflected in a totally different disease pattern. In low-income, more traditional countries, the environmental problems chiefly concern the lack of accesss to clean water, and inappropriate housing and are primarily related to infectious diseases , indoor air pollution and malnutrition.

Of course in high-income countries the traditional environmental risks may be in part replaced by risk associated with industrialization, such as large-scale air (and noise) pollution associated with transport and energy production and reduced liveability in urban areas. However, the Danish economist and 'sceptical environmentalist', Lomborg, appears to have a point when he states that environmental pollution is merely a problem of the past, the growing pains of rapid industrialization that have been solved in most post-industrial societies. For instance air pollution levels in London peaked around 1900, but nowadays they are as low as in the 16th century[xli]. The fraction of the burden of disease attributed to the environment was recently estimated at 1.5-4.5% for the OECD region and 25-30% for non-OECD (low income) countries[xlii,xliii].

So, in Western countries death by infectious diseases has been drastically reduced. In 1850 still 30-40% of the Dutch population died from these illnesses, tuberculosis being the major cause (10-15% of all deaths). Now less than 5% of mortality is due to infectious diseases, a major cause being pneumonia at old age ('poor man's friend'). On a global scale we see a drastic reduction of infectious diseases mortality as well, despite the stubborn resistance of infectious diseases like malaria and tuberculosis, and the ever-expanding AIDS epidemic. This is the major reason why the global life expectancy is momentarily already over 60 years. In China this is even 70 years, and India is heading for that number too.

It should be noticed that this global distribution of good health has also a dark side: the life support systems of the planet could be endangered by it. Poverty can and does lead to severe environmental damage (slash-and-burn agriculture, overgrazing, overfishing), but the healthy and prosperous can be excessively damaging as well[xliv]. Within decades adults will not comprise half of mankind, but three quarters[xlv]. Children *can* be very demanding, adults nearly always *are*. Since we have enlarged our economical systems into all corners and cracks of the planet's life support systems, the automatic fulfilment of all the wishes of the present 6 billion people, and the presumed 8 billion in 2030, should be discussed. The scale

and magnitude of man-induced environmental changes, including the global atmosphere and climate, stocks of biodiversity, freshwater supplies, and food producing ecosystems is unprecedented. In other words: recent gains in worldwide public health have depended largely on the depletion of environmental capital[xii,xlv,xlvi].

1.8 Life style and the social environment

In post-industrial society *life-style* is responsible for the largest avoidable health loss. A comprehensive analysis of the Dutch situation shows that a substantial fraction of annual mortality, disease burden and care demand is associated with life style risk factors, such as smoking (15% of mortality), dietary habits, such as high unsaturated fat and deficient fruits and vegetables intake (10 %), sedentary life-styles and lack of physical activity (6%). The same applies to related endogenous factors: obesity (6%) and hypertension (6%) are a huge source of avoidable disease burden (see *Figure*). Especially among youth and lower socio-economic classes trends in unhealthy behaviour are alarming[xlviii,xlvii].

At the ecological level of large populations, equally alarming is the doubling of severe obesity prevalence in the developed world during the pas two decades, especially in the light of the diabetes type 2 epidemic that is building up dramatically. These trends may be the result of radical changes of human ecology, such as the sedentary life-styles in our modern highly mechanised, ICT-driven societies and our diets rich in saturated fat, simple sugars and salt, and low in fibre.

A comprehensive body of evidence clearly indicates the key role of the *social environment* in the health status of populations as measured by mortality rate, life expectancy, perceived health, the prevalence of chronic disease, and physical limitations. Even in a relatively egalitarian society such as the Dutch, men from the highest socio-economic groups live around 5 years longer than men from the lowest group, for women this difference is 2.6 years. In terms of healthy life expectancy, e.g. life expectancy without chronic disease, the difference is as high as 10 years. In terms of self-perceived health the difference is even greater, less educated men and women have 15.8 and 14.0 fewer ‘healthy’ life-years, respectively[xlviii]. Furthermore, geographical differences in health status are highest at the level of residential neighbourhoods, in particular in large cities, again implicating an important role of the social environment.

The social-demographically determined health differences are to some extent explained by an unequal distribution of unfavourable life-styles. Impaired health is often due to combinations of risk behaviour, such as smoking, alcohol abuse, high intake of (saturated) fat, little fruit and vegetables, and lack of physical activity. The interaction between physical and social environment, and life-style has been known longer than we often think. Already in 1842 Chadwick’s Poor Law Commissioner’s report observes ‘that the population so exposed is less susceptible of moral influences, and the effects of education are more transient than with a health population. That these adverse circumstances tend to produce an adult population

short-lived, improvident, reckless, and intemperate, and with habitual avidity for sensual gratification,'

The socio-economic gradient is almost universal, and whether one compares countries, neighbourhoods or individuals, the same picture arises. It appears that the absolute income level is much less important than the relative inequity. Recently in the United States Diez Rouz et al. observed a socio-economic gradient in the prevalence of cardiovascular disease in 'whites' as well as in 'blacks'. However at the same income level the cardiovascular risk of the whites was much higher than among blacks, as the 'whites' were at the bottom end of the income distribution, while the 'blacks' were more or less at the top[xlix]. The famous 'Whitehall' study showed a similar picture[l]. These differences are probably caused by a complex of social-psychological factors, such as social support (networks), employment (and self-esteem), number of life-events (e.g. divorce, loss of friends or relatives), opportunities to escape from a stressful daily existence, the ability of controlling one's own life, job insecurity, or possibilities for consumption, especially compared to others[li,lii,liii,liv,lv,lvi]. In this context unhealthy behaviour may be seen as some form of stress handling. Or in the words of Michael Marmot: 'the mind is a crucial gateway through which social influences affect physiology to cause disease. The mind may work through effects on health-related behaviour, such as smoking, eating, drinking, physical activity, or risk taking, or it may act through effects on neuro-endocrine or immune mechanisms'[lvii]**.** Furthermore, the accessibility and quality of certain care facilities appear to be less favourable among individuals of the lowest social groups[lviii]. There may also be significant differences in the quality of the occupational (blue-collar labour) and environmental conditions (including noise and air pollution, traffic density and safety, crime rates)[lix,lx]. Unequal distribution of exogenous determinants across SES-groups is reflected in the distribution of endogenous (or intermediate) factors, such as hypertension, unfavourable blood lipoprotein composition, and obesity[ii,xlviii].

1.9 Overlapping and interacting environments: an accumulation of squalor?

1.9.1 Unhealthy neighbourhood

This brings us back from the social to the physical, or rather the neighbourhood environment. It is obvious that there is an important interaction between the physical and social environments, and life-style, as is suggested by socio-economic health differences on the level of neighbourhoods, where often an accumulation of unfavourable social, spatial, environmental factors can be demonstrated[lxi,lxii,lxiii]. Recently Bouwman et al. clearly demonstrated an unequal distribution of unfavourable environmental conditions over socio-economic groups on the level of 6-digit postal code (street corner level, Figure 4). The analysis involved almost 2.5 million Dutch households[lxiv].

Aside from causal mechanisms, geographical health differences may at least in part be due to *selection*, as people in poor health are excluded from education and employment. But more

significant is selection due to the fact that over recent decades people from higher-income groups have moved out of the older neighbourhoods of cities, and the vicinity of industrial zones to settle down in suburbia and dormitory towns where they found better conditions with respect to housing, working and the quality of the local environment. At the same time the influx of immigrants of lower socio- economic status, was at its peak. Especially these people found housing in the neighbourhoods abandoned by the more prosperous.

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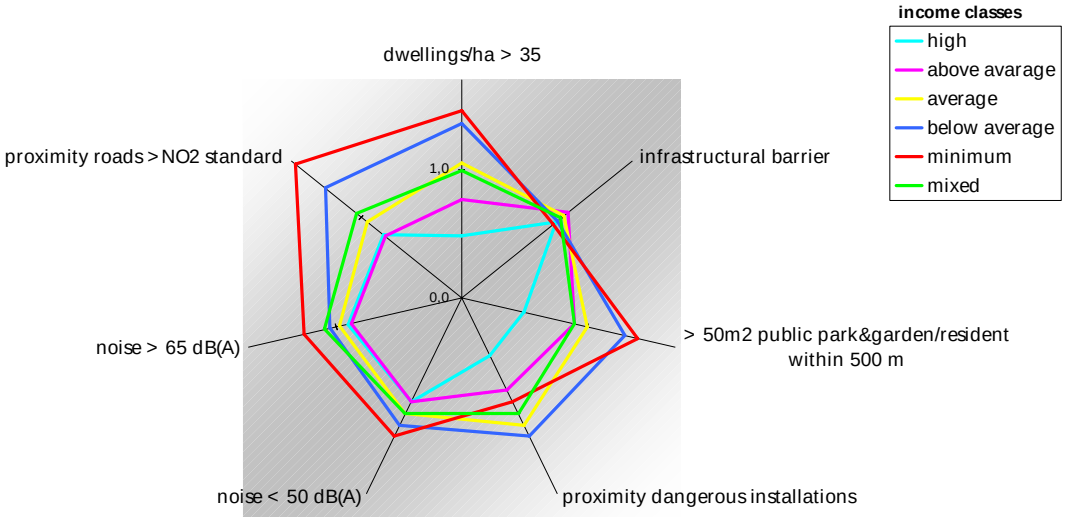

Figure 2. Socio-economic distribution of unfavourable environmental factors on the level of neighbourhoods (6-digit postal code); index 1 is the population average (Bouwman et al., 2001).

The more socially disadvantaged groups were left behind, which increased the geographic accumulation of unfavourable social-economic conditions [lxv] . Living in disadvantaged neighbourhoods may be bad for health because of lack of access to amenities, (healthful foods), to opportunities for physical activity, and to medical and other services. In addition, insecurity, fear of crime, suffering from the effects of a low position in the socio-economic hierarchy, and lack of social support are all features of disadvantaged communities that might increase inequalities in health [lvii].

1.9.2 International differences

The same mechanisms can be observed on the more or less 'ecological' level of nations, where a certain level of equity, social security and stability seem to play an important role. The plunge of (male) life expectancy with about six years to less than sixty years in the Soviet Union is a good example of the close association between social economics (equity) and health on the 'ecological' level of nations. The regime in Russia has changed from repressive, authoritarian and communist government forcing equity upon the population (social welfare, 'full employment', and a secure old age) to a 'savage' free market economy giving a small

minority ample opportunity to profit, leaving almost three quarters of the Russians living below or around the poverty line[xii]. Poverty per sé is not at the root of the associations between ill health and low socio-economic status of both individuals and neighbourhoods. Some poor countries appear to achieve good health at low cost. Life expectancy in China, Sri Lanka, and Kerala (India) exceeds 70 years, despite the fact that their gross national product per capita is less than $1,000. Even in the Harlem ghetto a median family income in the nineties was still around $25,000. Poor people in the United States are rich by world standards, but they have worse health than the average in some poor countries[lvii].

Japan is the current leader in the life-expectancy league, with almost 78 years for men, more than 81 years for women. Between 1955 and 1986 life expectancy in Japan increased enormously 12 and 13 years respectively for men and women, against around 4.5 years in the UK. Since 1977 Japan is outdoing the entire Western world. Individual life-style factors do not appear to be that important, e.g. smoking rates are not particularly low among Japanese men. Neither are genetic factors, as Japanese immigrants in Hawaii and Brazil gradually take over the local morbidity and mortality patterns. Most authors think the 'egalitarian' and stable society the Japanese build after World War II might be an important cause of good public health figures. There is much equity in income and education. There is much mutual respect and loyalty between workers and companies (during recent economic crises executives and managers took cuts in pay rather than lay of employees), and there is social and economic care from cradle to grave, in which the (extended) family plays a dominant role. The significant role of these factors would explain the high ranking of other egalitarian societies such as Canada and Sweden, and the low rank of the United States for that matter[lxvi].

Respect for and a significant position in the social and family hierarchy of people of high age may be another crucial factor as well. He or she who reached 65 must 'fancy' becoming 75; to become 85 one must have a strong motivation, something to get up for in the morning. The way in which we treat our elder family members in the West must be highly impudent in the eyes of the Orientals. High mortality rates among the elderly in France during the heat wave of August 2003 are a cynical demonstration of how many are left to themselves; they don't belong to any social structure anymore (at least not during holidays)[lxvii,lxviii,lxix].

1.10 Discussion: an environmental health agenda

1.10.1 Changing foes and friends

Let's consider the transition in the Dutch picture of health and disease from 1800 till 2000. In these two centuries life expectancy has been expanding from less than 35 years to more than 75 years. Nevertheless the total overall disease burden (in absolute DALYs) has been more than halved in that period, mainly due to a drastic reduction in environmental pressure (see Box 1 and 2 at the end of this chapter). Many of the impacts of environmental factors have

been annihilated or reduced to be 1/10 to 1/20 of their original impact[viii]. This shows how massive and effective the communal efforts to ward off health risks have been. Collective (cultural) life style is reckoned to be part of the environment.

In contrast, individual life style is now having a far larger impact than 200 years ago: then, for most people, there was little to choose. Also many effects of life style are only expressed at riper age, so nowadays a much larger percentage of the population is suffering from them.
The influence of genetic factors has been steadily growing in the last 200 years, despite the fact that the genetic make up has not changed much. Many diseases that are (partly) genetically determined only express themselves at advanced age, like diabetes type 2 or the impacts of hypercholesterolaemia (both closely linked to family history).

Another contrast with 1800 is the present compression of disease within the years over 60, about 15 years for men and 20 for women. So, the diminished disease toll is suffered mainly by the elderly, whose last years resemble the condition many infants and young children were experiencing around 1800.

We conclude that until the 20th century the *physical* environment was the largest source of avoidable disease burden, with attributable fractions in the order of 70 to 80 percent. Thanks to the public health revolution nowadays these factors are only responsible for minor health loss: probably less than 5%[lxx], while *life-style* is responsible for the bulk of the current avoidable disease burden (25-30% of total disease burden[lxxi]. The next substantial improvement of public health (transition) will probably be found in knowledge of and control over the *endogenous determinants*, genetic and acquired, at the individual level. In the near future this will primarily concern early detection of disease susceptibility, enabling medical doctors to give life-style advice or medication tailored to the genetic characteristics of the individual patient. Life-style drugs, such as 'statines', may be able to compensate the effects of poor life-style. Implementation of effective gene therapy technology will most likely take another couple of decades, with a restricted impact since the large disease entities have no single gene defect as a cause[lxxii,lxxiii,lxxiv,lxxv].

1.10.2 From quantity to quality of life

Public health focus has gradually shifted from life expectancy to health expectancy. Or in other words: postponing as long as possible or mitigating the physical, mental or social limitations brought about by the chronic diseases of older age ('not adding years to life, but life to the years')[lxxvi,lxxvii,xlviii]. In the framework of environmental health impact assessment a similar situation has arisen. Health impact no longer predominantly involves clear mortality risks or loss of life expectancy, but rather comprises aspects of the quality of life in a broad sense, such as:

- aggravation of pre-existing disease symptoms, e.g. asthma, chronic bronchitis, cardiovascular disease or psychological disorders
- severe annoyance, sleep disturbance, as well as a reduced ability to concentrate, communicate or perform normal daily tasks
- feelings of insecurity or alienation, unfavourable health perception and stress in relation to poor quality of the local environment and perceived danger of large fatal accidents.

This shift to attention for the quality of life both in policy-making and public opinion is in agreement with Maslow's theory, which postulates that human needs are organised in a hierarchic fashion[xiii]. When primary needs such as food, shelter and security needs are fulfilled, social and ego needs become more salient. The same can be observed with regard to environmental quality. Since most physical and chemical dangers have been brought under control, environmental quality may now be looked upon as the extent to which the environment fulfils the social needs of communities and individuals[xiii].

Impact assessment: from 'health' to 'well-being'?

In the Western world the degradation of the environment associated with industrialization has been brought under control for the greater part. Environmental problems predominantly persist on the highest and the lowest scale: 'global warming, ozone depletion versus air and noise pollution, industrial safety and issues related to the liveability of urban areas[lxxviii]. A clustering of social and health problems at a local level can be observed, mainly in deprived neighbourhoods with an accumulation of unfavourable environmental, spatial and social quality. There is a call for (further) development of healthy environments with a high living quality.

The question is where we should draw the line. It is not possible to create an environment that fulfils all community needs. For this reason we suggest a split approach. We should define minimal standards for a healthy and safe environment. In addition, we should try to derive definitions for a high living quality, at the same time realising that this should be considered as a maximum quality to be aspired. The challenge for researchers is how to improve the current models. How can we combine physical, social and spatial aspects to predict and evaluate the (perceived) quality of the environment? What are the characteristics of vital, attractive, stimulating living-environments? What is the effect of spatial planning on liveability? Can we translate this into conditions and criteria for the design of new urban areas? And how can we monitor whether these environments fulfil these conditions?

We propose a tiered approach, combining the following components:

- An analysis of ‘ high-risk’ areas, combining data on spatial, environmental and social qualities on a small-area scale by using GIS, resulting in maps of cumulative exposures at a small area level.
- A study of the geographical distribution of the cumulative health impact of environmental quality using aggregated measures, such as DALYs (see figure x chapter 7). In addition, aggregate indicators can be applied to explore the health score of different options in the planning of extensive infrastructure projects involving a range of exposures.
- Evaluation of the perception of local communities looking at psychosocial responses such as residential satisfaction, annoyance and risk perception.
- A comparison of areas that differ in health status or residential satisfaction. What are the main determinants and driving forces behind these differences?

The challenge is how to combine and weigh these different aspects in order to enhance the development of healthy environments with a high living quality. The success of this approach, however, will depend on the collaboration between planners, health and environmental experts, policy-makers and the community. In this, we can learn from the successes of the hygienists in the 19th century.

1.10.3 The micro world revisited

Will (re-)emerging infectious disease become the health issue of the 21st century? In the next few decades micro-organisms and infectious diseases will ask much attention from health authorities, scientists and politicians. Aids, tuberculosis and malaria are examples of expanding problems. Nevertheless, morbidity and mortality by infectious diseases is in a steep descent. This is mirrored by a fast increase of life expectancy in most developing countries. The ‘opening up’ of the world that has been virtually completed by now, will continue to cause acute dangers in the form of diseases popping up in unsuspected placesAlso new diseases like SARS and ‘chicken flu’ will emerge. But the experiences of the last decades show that we can react adequately. Extensive cattle breeding forms a potential hazard for infections among animals but also from animals to man; our ways of growing animals and plants should be reconsidered. The chance that biomedical laboratories will haphazardly introduce dangerous new germs seems small, at the moment. A much larger threat is put by eco- en bioterrorism. Scientifically there is no threshold any more for fundamentalist groups to develop biological and nuclear weapons. It is an important task for politicians in the coming decades to keep dream and act separated in this respect.

1.10.4 This thesis

Based on this historical analysis we will take a closer look at relevant aspects of the impact on public health of the environmental conditions of today. In the next chapter we outline a framework for impact assessing, especially geared to large infrastructure projects, such as

the expansion of our national airport. This is followed by a discussion in chapter 3 on dealing with environmental health risks in a ‘sensible’ way, an effort to ‘encapsulate’ comprehensive, sometimes even emotional discussions in support of the current policy program to ‘rationalise’ risk management procedures. The last four chapters describe a number of exercises in which we investigate the application of aggregate health impact measures for comparative health impact assessment, comprising Deaths, DALYs (disability adjusted life-years) and Dollars (capitalisation of health loss).

Box A: 1850 versus 2000

Anna

Anna Verschoor is a 38 years old Dutch woman. She was born in 1812. At that time Holland was still a part of the Napoleonic Empire. She lives in a farmhouse in the province of South-Holland with her husband en five children. They own 18 cows what defines them as being rather wealthy farmers. She has had nine pregnancies, two of which were miscarriages. Her oldest child, Hendrik, drowned when he was five years old and last year her youngest daughter, Brechtje, died in the huge cholera epidemic. She presumes that she is pregnant again, for the tenth time; time will tell.

Her parents moved in with them being too old to care for themselves anymore. Her father died two years ago from tuberculosis. Her 70 years old mother is showing signs of dementia. She worries because her mother wanders around at night and easily could start a fire. Anna has not been feeling the last few months and she fears that she too might have consumption, just like her deceased father and her youngest sister who is dying now.

She thinks about the future. Will she live to be a grandmother? Jan at 16 is the oldest, so who knows? What will become of the children? Marie's face is pockmarked and her chances of finding a husband are slight. Klaas cannot learn and is fast becoming the village idiot. If Anna doesn't have a severe illness, what will become of her in her old age? Will she be dependent upon her children, and if so, which one? She prays to God to have mercy on her and her family.

Box B: 2000 versus 1850

Patrick

Patrick Verschoor is 38 years old. He is the grandson of the grandson of Anna's son Jan. When he was born – in 1962 – Holland was in its last days as a colonial power in The East; New Guinea had to be left to Indonesia. He lives on the fifth floor of a flat in the West of the country, overlooking meadows with cows. He has been a teacher of Dutch for ten years but a few years ago he became an information technologist, after a thorough course. He married at the age of 29 but has been divorced now for three years. His daughter Anna is with him every other weekend. He has a living-apart-together relation with an actress but he thinks that investing in this relationship does not make sense any more. Moreover recently he feels more and more attracted to men

His parents are about 70 years old. His father completed a 200 kilometre skating tour a few years ago (for the third time) and his mother hikes with her friends along all the walking trails of The Netherlands. Nevertheless he is worried about his parents since his father has arthritis and his mother has eye and hearing problems. In fact she feels isolated in company. Patrick often insists that they should register themselves in time with an old age home but they stubbornly refuse to do so. If only he had the support of his brother Arthur, but he died ten years ago of aids. His sister Angela has married an American and has emigrated. She is a born again Christian and she has distanced herself from the family.

Patrick thinks about his future. Will he ever be a grandfather to Anna's child? You never know. Last year he was diagnosed with leukaemia. He panicked but decided to go full for therapy. At the moment things seem to be under control. There are more dangers: Patrick flies about 100,000 kilometres a year. This is necessary for his job, but he doesn't feel happy about it.

How old will he become? He hopes to reach 80 at least, which means another 40 years to go. He would be very disappointed if there were not even more years in store, even though he smokes at least a packet of cigarettes a day. The stress on life style in the media irritates him. Things will not run a tragic course, he thinks. Healthy food, jogging twice a week and squash on Saturdays must be enough to keep him in good health.

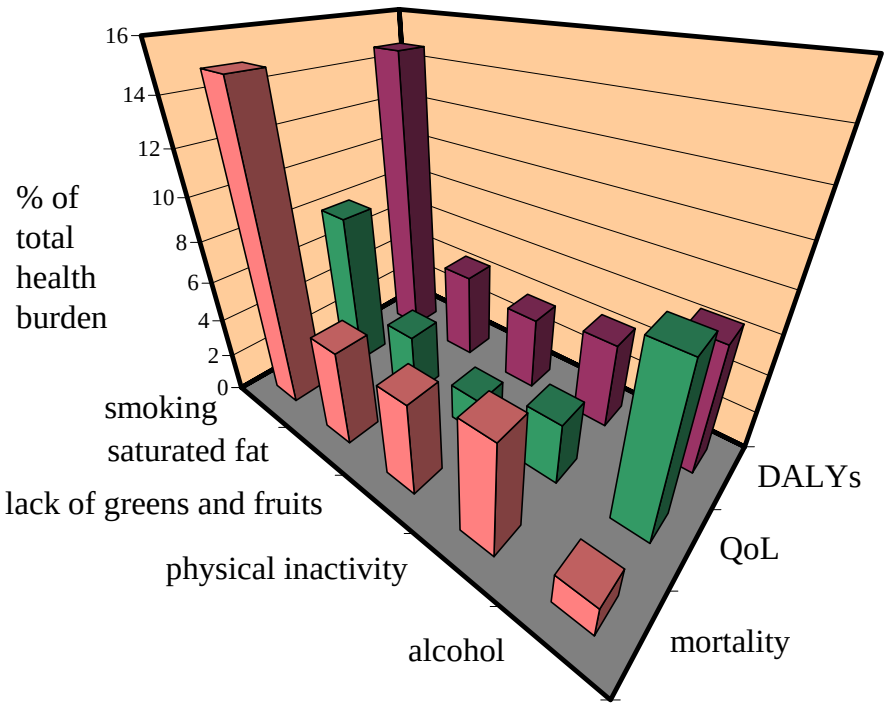

Figure 5. annual health loss in The Netherlands due to a number of risk factors in terms of mortality, quality of life and disability adjusted life years.

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