NON-WATERBORNE SANITATION AND WATER CONSERVATION

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Summary

Conventional urban water and wastewater systems owe their design in particular to 19th Century thinking on combating waterborne disease and maintaining hygienic conditions in cities. The success of these systems has been out-lived and they are no longer compatible with closed systems which seek to minimise the net use of resources, encourage local recycling, water conservation and source protection as demanded by the requirements of a sustainable city. In spite of the efforts during UNESCO's International Decade 1981-1990 still 1.2 billion of the world's population lacks access to safe drinking water and about 3 billion lacks adequate sanitation. Conventional sanitation in the form of flush-and-discharge has offered limited solution to this global sanitation crisis suggesting that the flush toilets are slowly becoming obsolete. There is therefore a need for a fundamental rethinking of the problem, a new approach, a new paradigm? Urban water and wastewater systems design have almost gone a full circle within this era.

With regard to sanitation the emerging approach is based on three fundamental aspects: rendering human excreta safe, preventing pollution rather than attempting to control it after we pollute, and using the safe products of sanitized human excreta for agricultural purposes i.e. transform into food, green, and biodiversity. This approach can be called 'ecological sanitation'. What it is turning out to be is that its not a entirely a "new paradigm" or application of novel ideas but simply recycling old wisdom which was flushed together with useful resources when flush-and-discharge systems became the norm.

The purpose of ecological sanitation systems is the closing of the water and nutrients cycles, taking into account that the main task of sanitation is to assure highest hygienic

standards in a cost- effective, environmental sustainable way, saving both water and energy and keeping soils fertile. Global synthetic fertiliser use has soared from less than 14 million tonnes in 1950 to 145 million tonnes in 1988 and the major realization today is that up to 30% as N, 10% as P and 15 % as K can be substituted by the fertiliser value inherent in the human excreta.

Currently research and development has yielded innovative water-conserving appliances, composting toilets and accessories, urine-diverting toilet facilities, vacuum-flush and micro-flush toilets, graywater system components, and rainwater harvesting systems. New solutions, some derived from old practices will be decentralised in nature and they will be built using the non-mixing concept and bio-digestion of organic waste suitably adjusted to local climatic and other conditions.

1. Introduction

The world population has more than doubled since 1950 and has since surpassed the 6 billion mark. The demands placed on the environment to provide resources for human activities and to absorb wastes have grown steadily with rising population and increasing per capita consumption. At the same time the number of people living in urban areas has jumped from 0.75 billion to more than 2.5 billion people. By 2025, the total urban population is projected to double to more than 5 billion people, and 90 per cent of this increase is expected to occur in developing countries.

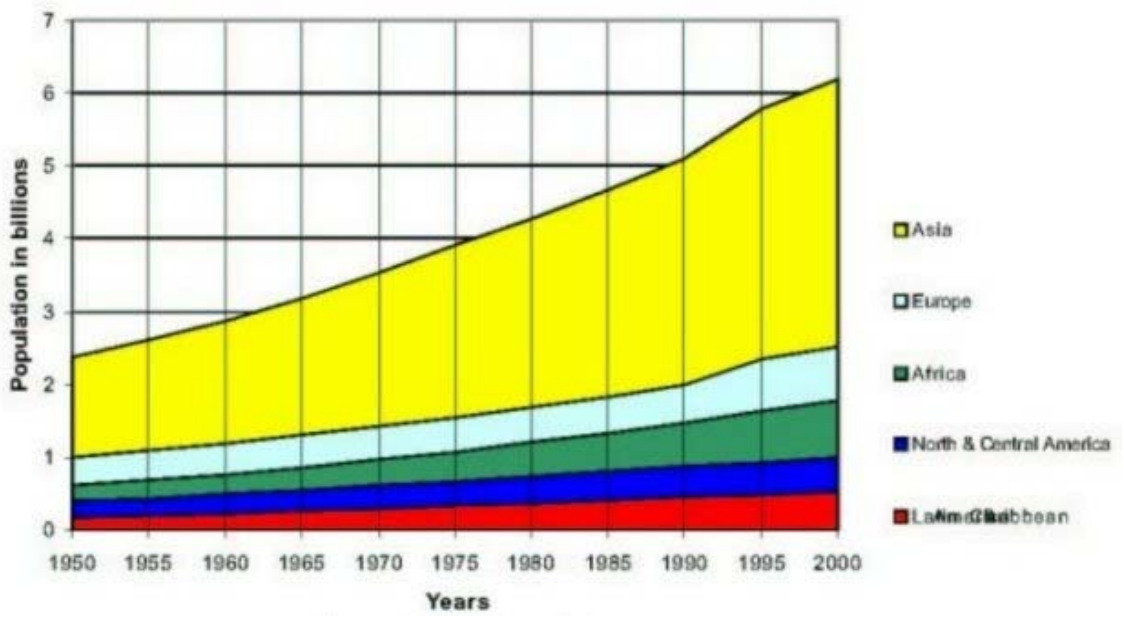

Figure 1: World population
(Source: FAOSTAT 2001)

Urbanization has created new needs and aspirations, as people work, live, move and socialize in different ways, and require different products and services. Urban environmental impacts and demands are also different. Currently 30-60% of the urban population are in low-income countries, many lack adequate housing with sanitary

facilities, drainage systems, and clean water. This number is expected to increase since local and city authorities often lack the resources, knowledge, trained personnel and financial capacity needed to meet their responsibilities in providing services and amenities essential for healthy living.

Dire predictions and alarming warnings by the world's scientists indicate that our planet is out of balance and a planetary ecological collapse is impending. Should such warnings or pessimistic views be ignored or jeered at, and let time prove them otherwise like the English clergyman Thomas Malthus's Principle of Population (Malthusian Precipice). In his essay in 1798, he hypothesized that "The power of population is so superior to the power in the earth to produce subsistence for man". He concluded that "premature death must in some shape or other visit the human race". At the same time it is foolish to display lack of concern and inaction as our planetary life support systems disintegrate around us?

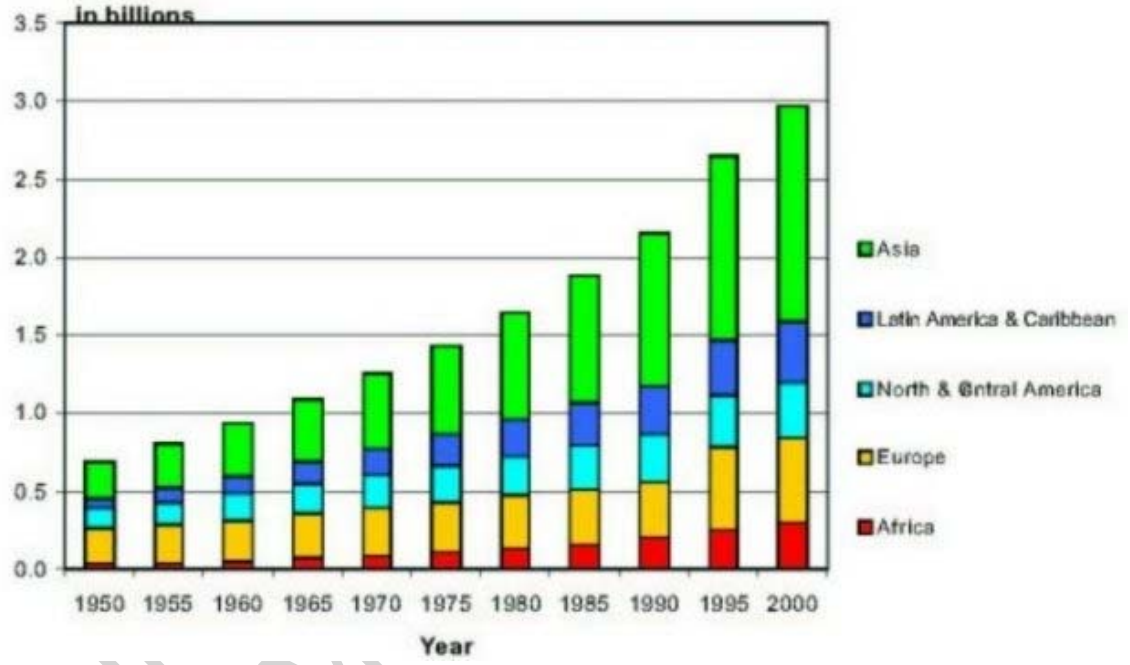

Figure 2: Urban population
(Source: FAOSTAT 2001)

When the Earth Summit concluded at Rio in 1992, the world was challenged to lessen its impact on the Earth. Almost ten years later, we live in a riskier world with more people, more consumption, more waste and more poverty, but with less bio-diversity, less forest area, less available fresh water, less soil, and less stratospheric ozone layer. There is an urgent need to reduce our ecological footprint i.e. the land and water area that is required to support indefinitely the material standard of living of a given human population, using prevailing technology.

Global freshwater consumption rose six-fold between 1900 and 2000 - at more than twice the rate of population growth. About one-third of the world's population already lives in countries with moderate to high water stress - that is, where water consumption

is more than 10 per cent of the renewable freshwater supply. The problems are most acute in Africa and West Asia but lack of water is already a major constraint to industrial and socio-economic growth in many other areas, including China, India and Indonesia. The declining state of the world's freshwater resources, in terms of quantity and quality, may prove to be the dominant issue on the environment and development agenda of this century.

In spite of the efforts during UNESCO's International Decade 1981-1990 about 20% (1.2 billion) of the world's population lacks access to safe drinking water and about 50% (3 billion) lacks adequate sanitation. In many developing countries, rivers downstream of large cities are little cleaner than open sewers.

The strategy to increase coverage for safe drinking water cannot be based entirely on the traditional "water rush" approach characterized by building of large new dams like China's biggest construction project since the great wall. The Three Gorges dam on the Yangtze River once completed will become the biggest man-made dam, standing at 185 meters high, and will submerge 632 square kilometers of land and store 39.3 billion cubic meters of water. Delivery of sufficient water volumes to urban populations will continue to constitute a difficult logistic and economic problem.

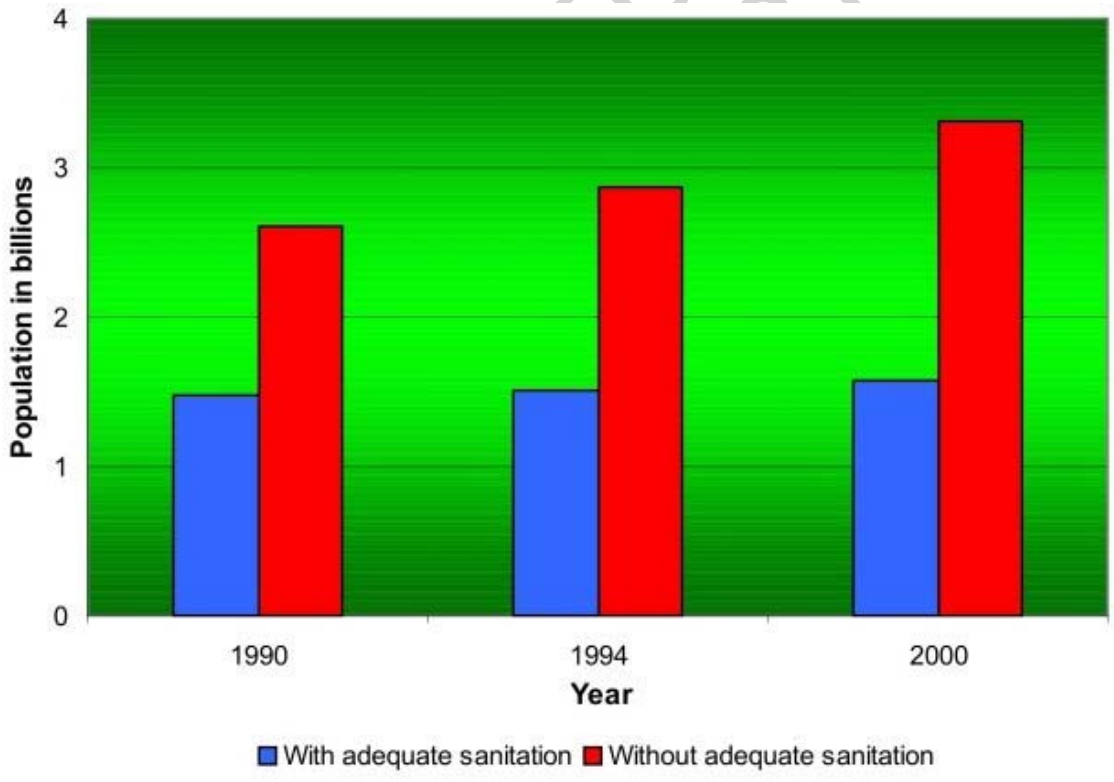

Figure 3: Population with and without sanitation, all developing countries
(Source: GEO-2000)

Reasons for this situation can be found in the incorrect assumption that water can be obtained from nature in any quantities by the use of suitable technology. Highest water quality is needed only for drinking and cooking, representing about 5% of total freshwater

consumption: but all water delivered has the same high quality since there is only one water network. Furthermore, all delivered water will be contaminated if water closets are used, so that all water expelled from our homes after use is called 'wastewater' - a term which could more appropriately be replaced by "'wasted water".

WHO's Collaborative Council Working Group on Sanitation in 1996 concluded that the progress of sanitation in the developing countries is hindered by basic misconceptions and myths stating that water supply is always needed for good sanitation. Another myth originates from assumptions about the need for water to flush toilets. The "Y2K" (Year 2000) scenario, which predicted a serious breakdown of services due to computer design flaws, brought up a lot of questions regarding over-reliance on waterborne sanitation. Conveniences like flush toilets are totally dependent upon the electrical grid and completely reliant on a constant water supply. When the electricity is out and water is unavailable, how does one flush the toilet? Supplying the clean water, treating the sewage, and providing all the delivery and collection requires sophisticated systems whose cost strains the resources even in wealthy countries.

These scenarios demonstrate that conventional sanitation in the form of flush-and-discharge offers limited solution to the global sanitation crisis. There is therefore a need for fundamental rethinking of the problem, a new approach, a new paradigm?

The Water Supply and Sanitation sectoral vision for the 21st century, which projects the shared vision for hygiene, sanitation and water supply was presented in the Second World Water Forum in the Hague in year 2000. This vision brought out by the Water Supply and Sanitation Collaborative Council, which blends in well with the all embracing World Water Vision is meant to be a practical picture of the future and it draws on accumulated experience especially the re-examination of the water policies during the Drinking Water Supply and Sanitation Decade in the 1980's. Its targets are that by year 2025, virtually every man, woman and child on the planet should know the importance of hygiene and enjoys safe and adequate water and sanitation.

In this vision, there is a deliberate message downplaying waterborne sanitation, from the realization that current waste management policies and practices are abusive to human well being, economically unaffordable and environmentally unsustainable (Bellagio Statement: A new approach to environmental sanitation). The cautionary approach undertaken as regard to sanitation is understood. Assuming that if each and every person of the current world population had to enjoy the waterborne sanitation system by flushing 6-30 liters per day, say 15 liters as an average, then a volume of about 90 Mm^3 of fresh water would be required each day. Alternatively a two and half meter high tank sitting on the entire country of the Netherlands (34 000 km^2) daily. In a year a volume of sewage (black water only) about the size of the Three Gorges reservoir (39.3 billion cubic meters) would be generated. This is by no means the end of the story, as this volume has to be treated or rendered harmless to humans and the environment. For the evolving megacities like, Mexico City, Bombay and Delhi 100% coverage with waterborne sanitation will be unattainable, worse still for those cities falling in arid and semi-arid areas.

Sanitation in its global sense includes collection and safe disposal or beneficial use of human excreta, sullage or graywater and solid waste. Broadly sanitation arises from man's attempt to manage both the water cycle and the food cycle to avoid health and environmental repercussions. In this contribution the word sanitation is used loosely and in many occasions it will refer to the management of human excreta.

The sanitation practices that are promoted today fall into one of two broad types: 'flush-and-discharge and forget' or 'drop-and-store'. Over the past hundred years flush-and-discharge has been regarded as the ideal technology, particularly for urban areas (prestigious system). Many municipalities in developing countries, often with the help of international financing, try to copy this model. For those without access to flush-and-discharge the conventional alternative is a drop-and store device, usually a pit toilet, based on containment and indefinite storage of human excreta. Drop-and-store is often regarded as an inferior; temporary solution compared with flush-and-discharge.

The emerging approach is based on three fundamental aspects: rendering human excreta safe, preventing pollution rather than attempting to control it after we pollute, and using the safe products of sanitized human excreta for agricultural purposes. This approach can be characterized as 'sanitize-and-recycle' and can be called 'ecological sanitation' or 'eco-san' for short. It is a cycle - a sustainable, closed-loop system. It treats human excreta as a resource. Human excreta are processed on site (dehydration and decomposition) and then, if necessary, further processed off site until they are completely free of disease organisms. The nutrients contained in the excreta are then recycled by using them in agriculture.

The principles underlying eco-san are not novel. In different cultures sanitation systems based on ecological principles have been used for hundreds of years. Eco-san systems are still widely used in parts of East and South-East Asia. In Western countries this option was largely abandoned as flush-and-discharge became the norm but in recent years there has been a revival of interest in ecological sanitation.It is also emerging that providing on-site sanitation does not mean reverting to the traditional "outhouse": at its simplest, it may involve latrines carefully designed to control odours and insect, and which allow the safe recycling of organic materials; at its most complex, it can involve systems in multi-story blocks that use the same technologies found in air planes. Planners and designers need to become familiar with all of the possible options and with the many factors affecting choice (not merely technical, but also social, cultural, institutional, financial, economic and environmental), so as to be able to make informed decisions.

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Biographical Sketch

Mr Bekithemba Gumbo (1968) is a lecturer in the Department of Civil Engineering at the University of Zimbabwe. He obtained his Bachelor of Science (Civil) Engineering Honours degree at the same University in 1991 funded through a bursary by the City of Bulawayo, the second largest city in Zimbabwe. Previously he worked for the City of Bulawayo as a student engineer during vacations (1988 to 1991) and as a graduate water and sewerage engineer (1991 to 1993). During this latter period Southern Africa survived the worst drought in living memory. The scare of relocating one million people including industry from this city located in the semi-arid part of the country triggered numerous events and adoption of various water conservation measures. Mr Gumbo participated in a number of these projects, ranging from water demand management, wastewater recycling and emergency borehole drilling programme. In turn, these experiences shaped his professional and research interests. In 1994 he was awarded a scholarship by the British ODA (now DFID) through the University of Zimbabwe to pursue a Master of Science degree programme in Water and Waste Engineering at Loughborough University in the United Kingdom. He graduated with a distinction in 1995 and returned to Zimbabwe to join the Department of Civil Engineering at the University.
Currently he is also a PhD research fellow on a sandwich programme at IHE-Delft in the Netherlands, sponsored by the Dutch DGIS through a SAIL foundation programme. His research interest includes urban water management; sustainable urban infrastructure; beneficial reuse of wastewater; and lately, ecological sanitation; and recycling of nutrients.