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Sustainable management of water in cities[1]

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Abstract

Provision of safe drinking water, flood protection, drainage and sanitation rank highly among the needs of all societies. Since early civilisation, various means have been used to provide these essential services. By now, most of cities of the developed world rely on "all by networks" systems that have been imagined in the XIXth century in a very specific historical context. These systems are now proving not to be effective or efficient in the developed world. Further more , they are very expensive. As a consequence, it doesn't seem logical to use these systems in developing countries where the most essential services are not yet broadly provided, in spite of 30 years of effort.

The study of four scenarios extrapolating different present trends, shows that, without a clear and strong political and social involvement, the sustainability of water management in most of the cities is at least questionable.

Nevertheless, holistic approaches, based on a sustainable urban management could offer a way out. This will imply to find new ways of dealing with water in the cities, using both centralised and decentralised solutions. Even if essential, the required scientific and technological changes will be inefficient without more flexible institutional arrangements and increased water awareness among all stakeholder groups.

Key words : Water Supply, Urban Drainage, Urban Sewerage, Sustainability, Urban Water Management.

[1] this paper is largely based upon a position paper under preparation by the Joint committee on urban drainage (B. Chocat *et al*, 2002).

1 Introduction

"*Water is a basic human need and a key component of development - it is a fundamental resource for food production as well as for enhancing social well-being and providing for economic growth. It is also the lifeblood of the environment. Already today, it is a scarce resource in large parts of the world. It is estimated that about one-sixth of the world population lacks access to safe drinking water and one third lacks sanitation. If present trends continue, two out of every three people on Earth will live in countries considered to be "water stressed" (Kofi Annan, Millenium Report, para 274). According to World Bank projections, by 2025 40% of the global population are likely to face some form of water shortage, with one in five suffering severe shortages. Global climate change could further exacerbate the problem*."

This paragraph has been extracted of the report "*G8 Initiative on Conflict and Development*". It shows that the importance of water is now understood at the highest political level.

Cities cover much less than one percent of the earth area. Yet it is the place where most of the people live. It is the place where both the problems and the needs are the most important. The concentration of a great quantity of population and activities on a small area involve the need of a great amount of good quality water. But the concentration of a great quantity of population and activities on a small area also implies an increase in runoff and flood hazard, in pollutant emissions and in ecosystem deterioration. For that reason, it is probably in cities that the need for a sustainable management of water is the most important.

First we will present a short resume of the history of urban water management and explain the origin of the usual "everything by networks" solution. In the second paragraph we will evaluate the efficiency of this system, and explain why developing countries can't deal with it. The third paragraph will be dedicated to a kind of game : trying to imagine what the future could be. Finally, in the last paragraph we will try to develop the hopes and the limits of sustainable approaches.

2 Urban water management : a short history (Chocat *et al*, 2001)

Provision of safe drinking water, flood protection, drainage and sanitation rank highly among the needs of all societies. Since early civilisation, various means have been used to provide these essential services. Some of the earliest urban water systems were built about 5 000 years ago in the time of the Mesopotamian Empire (Wolfe, 2000). The Roman Empire is very often quoted as an example for an efficient management of water in the city. In that time, water needs were very important in Rome, more than 500 litres of water per day and per habitant. Such needs obviously justified a strong organisation and an efficient system.

Sanitation practices deteriorated after the decline of the Roman Empire, and, in most of European towns, surface drains and streets were used as the main means of conveyance and disposal of all kinds of waste-waters. Aqueducts also deteriorated and the quantity of water used in the city drastically diminished to some tenth of litres per habitant and per day. Maneglier (1991) speaks of the "dry city" to qualify this typical town of the middle age in Europe.

Yet, in that time, urban water management could be qualified, in a certain way, as sustainable. Stormwater was collected and stored in cisterns, and constituted an important resource, especially in southern Europe or in fortified cities . Waste waters fed urban creeks with organic elements which were necessary for the industry of paper, leather or cotton cloth. The harvesting of faeces was essential for the production of organic fertilisers. The infiltration of urine into urban soils formed saltpetre that was used to make gunpowder.

Even more, some cities developed integrated systems for managing the urban cycle of water. For example, in Venice, city squares were used to collect stormwater. Under each square, an underground water storage reservoir was dug, filled with sand, and made watertight with clay walls and bottom, to prevent saltwater intrusion. Fresh water filtered through, and stored in the sand was collected in wells. During this era, neither horses nor pigeons were allowed on the permeable pavement covering these squares!

Yet, during the XVIIth and the XVIIIth centuries, urban streams became so noxious that they had to be covered over and turned into sewers. Numerous epidemics of typhoid and cholera in Europe and the United States, particularly between the 1830s and 1870s, prompted city governments to find other solutions for dealing with water supply and sewage disposal (Wolfe, 2000).

At that time, three arguments proved to be decisive in the choice of the "everything by networks" solution we still enjoy today in most of developed countries :

- A pseudo-scientific one, based on a strange analogy between the human body and the urban settlement : if the lack of blood circulation in a limb made it sick, the same principle would apply to the lack of water circulation in a part of the city. So, the continuous flow of water appeared to be necessary, and tanks and cisterns became two examples of "pestilential stagnation".
- A political argument, particularly strong in France after the Revolution, which was based on the notion of equality : all citizens must be equal and treated equally by state and municipal administrators. A network for water supply or for wastewater disposal, common to all the citizens, constituted the best solution to provide equality.
- A technical argument : during Jules Verne's century, the idea that science and technology were without limit was the most generally admitted. For that reason, solutions based on huge technical systems were particularly appealing.

The construction of these systems also benefited from the fact that, in that time of colonialism, European countries could take advantage of the wealth of the whole world. Furthermore, the new born capitalism was able to mobilise the necessary funds, even with a long return on investment, and school development allowed to teach the essential hygiene rules.

These advances helped cope with flooding in towns and improved the health of their citizens. 150 years later, it could be considered that, in developed countries, most of cities are served by comprehensive and more or less efficient collective water systems. Yet all problems are not solved and it is interesting to assess the real state of the managing of water related problems.

3 Current state : is the situation satisfactory?

3.1 Current state

To measure the level of satisfaction of the service given by the current state, it is obviously necessary to establish a clear distinction between developing countries and developed countries (Niemczynovicz, 1999).

In the industrialised world, tap water is available everywhere, its quality is severely checked and its price is acceptable by the great majority of citizens. Stormwater and domestic and industrial wastewater are conveniently removed effectively and efficiently. Even if some problems begin to appear (ageing of most of the systems, increasing pollution of many water bodies, etc.) (Herz, 1998 ; USEPA, 1994), or if some recurrent ones resist or worsen (flooding hazards), the situation could be considered as satisfactory.

The situation is very different in developing countries for almost two-thirds of the world's population (Stephenson, 2001). Cities have no such inherited infrastructure, and many of their habitants struggle with recurrent flooding and the daily need to find convenient water to drink and to carry out the most fundamental personal ablutions. In 1997, more than 1.1 billion people in low- and middle-income countries lacked access to safe water supplies, and far more were without adequate sanitation.(World Bank, 2002).

Lack of clean water and sanitation makes people sick. Water-related diseases kill an estimated three million Africans each year, while also digging a yawning gulf in productivity.

Everywhere in the world, but more hopelessly in developing countries, pollution caused by humans is contaminating lakes, rivers and underground water, reducing quality, limiting regeneration of freshwater ecosystems, and complicating treatment of water for domestic use. Industry, agriculture and inadequate sewage treatment are intensifying pollution, making reclamation of some water costly or impossible, thereby diminishing an essential resource.

As access to safe, clean water and effective sanitation is vital to improving human health and well-being, it is difficult to understand why, after more than one century of effort, the situation is so bad. A quick review of recent efforts by the international community helps understanding of present situation and shows that the problem is difficult to solve.

3.2 The efforts in the recent past (Lake & Souaré, 1997)

On November 10, 1980, the General Assembly of the United Nations proclaimed 1981-1990 as the International Drinking Water Supply and Sanitation Decade. The primary goal was full access to water supply and sanitation for all people in developing countries by 1990.

At the Decade's end, universal access had clearly not been achieved.

In 1989, the OECD Council, drawing on lessons already learned from the Decade, urged members to review their institutional framework in the water sector. It asked them to pay special attention to rates, agreements, water rights, and unrecorded demand, in order to improve their policies for integrated resource management.

The International Water and Environment Conference held in Dublin in 1992, presented new approaches to freshwater resources, emphasizing integrated management of basins and protection of ecosystems with full attention to the environment, both economic and social.

In 1993, the World Bank published a document defining new objectives, and the FAO set the parameters for a program of action on water and sustainable development.

Yet in 2002, more than 2 billions of human being do not enjoy an acceptable access to drinking water or to sanitation, and the objective of the Johannesburg conference is only to reduce this number by 50%.

3.3 Problems and challenges

Several remaining challenges can be identified.

The first challenge is population growth. The worst case is the African one where the increase rate is three percent a year, with nearly no sign of imminent reduction. This challenge is further compounded by rapid urbanisation. Populations in cities such as Nairobi, Dar Es Salaam, Lagos and Kinshasa increased sevenfold from 1950 to 1980. In Latin America comparable cities grew half as fast, which still means that their population has been multiplied by 3 or 4 in 30 years. Population growth and urbanisation are at the heart of many of developing countries problems.

A simple example can explain the difficulty of the problem. In a city as Lyon in France, with the level of investment that is currently accepted, it would take 100 years to build the existing water supply and sewerage systems. That means that, each year, the expenditure allows to serve one more per cent of the population. If the population increases in percentage of 5% a year, then, the part of the population who is not served, increases in percentage of about 4%…

Lyon is a very rich city compared with most of African, Asian or South American cities. So, it is easy to understand why, in spite of the important international help, the situation is deteriorating year after year.

The second challenge deals with water shortages. Water shortages are a growing problem in many parts of the world. To meet the needs of people and the environment, renewable freshwater resources of 1700 cubic metres annually per capita are considered adequate. Below that, supplies are short : a figure between 1700 and 1000 means water stress, while less than 1000 represents water scarcity. Ten percents of this water is needed for direct urban needs.

Globally, in 1950 only 12 countries with 20 million people faced water shortages of some sort. By 1990, it was 26 countries and 300 million people. Today, 166 million people in 18 countries suffer from severe water scarcity, while another 270 million in 11 additional countries are considered "water stressed". By 2025, affected populations will increase from 436 million to about 3 billion people, or about 40 percent of the world's population, most of them in poorest countries (World bank, 2002).

Such numbers do not take into account variations in place and time (dry seasons, rapid runoff, geographic features, usage patterns in different areas). In reality, actual shortages are worse than national averages would indicate, and an "adequate" figure cannot justify complacency.

How can then the needs of the majority of the world's population be recognised and dealt with effectively ? Are the techniques and paradigms, on which water supply as well as wastewater disposal were based in the past, still relevant today ?

They are not, according to the experts of Habitat (ESC, 1996), who believe that "*the systems used in the developed world are not the most effective, efficient or indeed very logical*", and they are certainly not sustainable (Argue, 1995), (Marsalek & Chocat, 2001). Thus we need to find new ways of dealing with water in the cities and the time has come to develop new paradigms (Bacon, 1997, Malmqvist, 1999). For example, communities in developed countries will no longer be able to derogate responsibility for wastewater "disposal" and part of the new paradigm must include the recognition that "waste" water is in fact "resource" water (Otterpohl *et al.*, 1997), (Rauch *et al.*, 1998).

Before trying to give some indications on the way that can be used, it is interesting to project some current trends and to see what can become of water management if we don't take care.

4 Possible futures

There is a proverb which is often quoted, even though its source is rather unclear : "*Prediction is a difficult art, especially when it deals with the future*". Yet, it is possible to take the risk and try to imagine several possible futures. The four scenarios that are presented here are based on very different ideas. In the first one, the green scenario, we imagine that "political ecology" wins the game ; it is a "politically based" scenario. The second one can be qualified as being "technology based" : it describes what could arrive if engineers were fully in charge. In the third one, the only issue is the economical rule ; it is the "financially based" scenario. The last one is probably the most realistic. It supposes that economical, technical and political driving forces act together, but with no co-operation, as it is the case today. These scenarios, as extreme as they are, give some trends on what future could be. They show that a sustainable solution cannot be found without an equilibrium between technical, political and economical issues.

4.1 The green scenario

The first possibility could be called "the green scenario". In that scenario, defenders of "small is beautiful" solutions have won the game. Such an approach has been formulated by Lawrence *et al.* (1999) as "total urban water cycle based management". It encompasses:

- reuse of reclaimed wastewater (for pollution prevention, sub-potable water supply),
- integrated stormwater, groundwater, water supply and wastewater based management (water supply, flow management, water and landscape provision, substitute of sub-potable water sources, and protection of downstream areas against urban impacts), and
- water conservation based approaches (efficient water use, reduced water demand for landscape irrigation, and substitute industrial processes with reduced water demand).

4.1.1 Main characteristics of the green scenario

Ecologists are in charge. They have imposed a so-called "balanced integrated approach" attempting to combine both "soft" and "hard" technology in achieving sustainability of water management. The key words are : sustainability, environmental concern, back to nature, "Green cities", engineering "married" with social sciences, recycling of, both, waste water and waste in small local cycles (house, lot, neighbourhood), water harvesting.
In such a scenario, responsibility is decentralised. Long-term master plans for large-scale infrastructure disappear.

4.1.2 Risks and problems of the green scenario

This scenario is dangerous for at least three major reasons.

- The first one is that we are not sure how harmless the promoted solutions really are. Their potential impacts may be of cumulative and long-term nature, thus taking long time to manifest themselves. It is not clear whether nature alone can cope with these impacts. Some pollutants are persistent, and once they are in the ground or attached to bottom sediment in ponds and streams, they will stay there, accumulate and, under unfavourable bio-chemical conditions, enter the food chain or are released into the environment. This risk is exacerbated by the fact that nobody can control the quality of the installation since most of them are on private properties. The rainwater people harvest and drink can be polluted and dangerous without anybody being aware of it is before it is too late.

- The second risk follows from the fact that green solutions could be understood by local authorities as a convenient way to free themselves from the costly obligation to maintain their water infrastructure. On-site stormwater or wastewater facilities would be built and operated under the private property owner's responsibility. This transfer of responsibility and funding to the end-users might result in no or poor maintenance and, consequently, numerous small failures.

- The last, but not least, problem is that the way to proceed from the existing centralised systems to future decentralised systems is not obvious. The existing urban water systems are enormous infrastructures that took decades to build. Decentralised solutions also require large investments, and their wide-scale implementation would stretch over similar time spans. Thus, two functioning systems would have to be financed over a long period of time. During this period, fewer and fewer people would contribute to pay maintaining the old system that would obviously become increasingly obsolete. When finally the centralised systems would become useless and could be turned off, the resulting write-off of (financial) capital would be unprecedented in times of peace.

In conclusion, the green scenario is not necessarily sustainable just because it appears more ecological (in a political sense). Its sustainability needs serious studies, particularly with respect to the long-term behaviour of decentralised facilities and the feasibility of managing these facilities in the long run (ASCE, 1998). There is a clear risk underlined by Mikkelsen (2001) that we create a garbage dump in each garden and re-create a situation that Europe struggled with to overcome in the 1960s when many illicit dump sites were finally closed down. The wide-spread distribution of small pollutant deposits could be a good solution to preserve the quality of the "nature", but it also might create health hazards that are unknown today.

4.1.3 Reasons why this scenario could happen

Probably, the main driving force towards the green scenario is the fact that it is politically and economically appealing (at least in a short run) for those public utilities that struggle financially.

Its objectives are undisputed, both internationally and locally (e.g. Brundtland commission, local Agenda 21). It receives "green political support", particularly in rich countries where people have bad consciousness over exploitation of nature and want "to do something good", and it is defended by a lot of enthusiastic "experts". From the sociological point of view, it appeals to well educated well-to-do part of the society, often living in up-scale developments or eco-villages.

4.2 The technocratic scenario

The technocratic scenario differs much from the green scenario. Publicly employed engineers are in charge and decide upon both, the technical approaches and the way the systems are managed. This scenario represents the classical approach, before privatisation became an international issue.

4.2.1 *Main characteristics of the technocratic scenario*

The engineers in charge appreciate that society has delegated an important task to them. By applying the proven technology, coupled with redundancy and large safety factors, they make sure that the system does not fail. The solutions are not necessarily cheap, but they are robust and impressive from a technological point of view. Thus, this scenario is basically conservative, even if ambitious engineers might get a chance to apply advanced technologies to water systems : automation, control, robotics, real-time operation, third generation of communication, use of biotechnology for water quality control, new field measurement and laboratory equipment.

This system will be designed with sufficient numbers of fail-safe devices and fall-back alternatives, so that operational risks are kept small. Cost-benefit is one of the considerations, but not the most important one, and if in doubt, the technologically better solution is adopted, even if it is more expensive. This approach focuses strictly on good technology, i.e. solutions that an engineer is proud of. Water systems rely almost entirely on piped systems. The development of new water saving devices in household and industry and water recycling solutions in water scarce regions is managed by large companies and strictly supervised by central authorities (minimise recycling to minimise risks).

Long-term planning ("Grand Master Plan") is the rule to ensure best technical quality ("the pride of the engineer"). Maintenance and renewal of central systems with large size and with redundant components is the top priority. Responsibility for system operation and maintenance is centralised and mostly public. Water service remains to be a monopoly with no competition over services or approaches.

4.2.2 *Risks and problems of the technocratic scenario*

We certainly have the technology to solve urban water management problems in a "technocratic" way. We can distribute healthy fresh water in all the buildings. We can build huge sewer networks and use modern technologies, such as real time control, to protect cities against flooding, with some acceptable level of risk. We can build and manage end-of-pipe treatment plants capable of purifying dry or wet-weather effluents with a very high level of performance. We know how to rehabilitate streams in order to produce clean and valuable places for the public. But ...

The first problem is financial. Such solutions are expensive, and if implemented in top engineering quality, they are very expensive. There might not be sufficient political support and then this scenario gradually slides towards the "privatisation" scenario (see below). Public utilities might need to join large companies, or risk being taken over by them, because private companies do not require political support for raising capital and making investments. In developed countries, it is likely that funding could be found for this scenario. People accept to pay more than $200 a month for phone, TV and internet connections. It is reasonable to believe that people will accept to pay more for clean water, which is much more essential to their life, especially if they think that they have no other choice.

However, due to the lack of funds, lack of engineering expertise, or operation and maintenance capacities, the technocratic solution is totally impossible to implement in developing countries. If this scenario would be the only way to provide urban water services, we would exclude 4/5 of the world population from access to clean water and from a minimum protection against flooding and public health hazards.

The second problem is that nature is not easy to harness. Whatever level of protection is chosen against flooding, one has to accept that a rainfall greater than the design storm can occur. In that case, consequences could be very dramatic. In other words, technological perfectionism will avoid all but the most extreme problems, leaving people mentally unprepared for such rare, but terrible catastrophes.

4.2.3 Reasons why this scenario could happen

The technocratic scenario offers intellectual challenge and research opportunities. The engineering community can argue that "robust" solutions offer guaranteed performance and meet health and environmental protection goals, so the engineers in charge will be politically supported as long as the system functionality is guaranteed, service is provided, and money is not openly wasted.

The approach fits well into our present developed world, and profits slowly but surely from fast development in related fields. There seems to be a synergy potential (microbiology, gene manipulation, computers, nano-technologies, etc.) that might be used in the future. Why should we apply "stone age" methods in urban water systems when modern technology, carefully and conservatively applied, solves the problem? In fact, is it not appealing to politicians, government and decision makers to show that we are in line with technological progress - the latest, the most powerful, the newest control devices - to ensure an equally good service to all citizens ?

The scenario assumes that it is unrealistic to expect essential changes in individual and corporate behaviour with respect to the environmental protection, or at least that such expectations are not needed. Thus, urban water management is relatively easy, since it operates largely independently of the political context.

Lastly, but not the least, the scenario assumes (and even requires) that most urban dwellers are not really interested in the details of urban water management, and politicians exercise low level of control as long as there is no trouble.

4.3 The privatisation scenario

The privatisation scenario might be a consequence of the situation, in which the credibility of the technocratic solution was undermined by repeated failures, obvious waste of money, or chronic under-funding. An urban water system can only be privatised once, but it is very tempting for politicians : Privatise water infrastructure, sell the assets and use the money "to do something good" for the people. This idea becomes particularly attractive where ageing infrastructure requires large investments and public agencies wish to avoid the need to raise such funds (by raising taxes) in public debate and with elections coming up (Barraqué, 1995).

Obviously, the leading idea of the privatisation scenario is not to find the most beautiful solution to a technical problem, but to make money, i.e. provide a system with sufficient technical quality to deliver the service, but no more than that. In the worst and not unlikely situation, the water company might define the level of service itself (because it holds all the expertise), pursuing its own objectives and using a proper marketing approach.

4.3.1 Main characteristics of the privatisation scenario

Investors and economists are in charge, and the buzzword is cost-efficiency. This is achieved by control of labour costs and limited investments into infrastructure. When funding shortfalls loom (i.e. economic losses), the private company will insist on increased service fees and/or re-negotiation of the original contract (it might even be formulated with this eventuality in mind). Sustainability of the approach is an issue, but only as long as the economical sustainability of the company is not at stake. As economic issues play the major role, the functionality of the system as well as ecological issues are just standards that have to be complied with at minimum effort. This scenario is governed by two key words : "efficiency and effectiveness" on one hand and "the true value of water" on the other.

The technological solutions will consist of "reasonably maintained" centralised systems with "decentralised pockets" (where profitable). Such a system is easier to manage, and the service charges are easier to invoice. Due to the physical nature of the system very few, but huge private companies have total regional monopolies. Competition only happens once, i.e. when the getting of the initial contract is at stake. Without extremely competent and politically strong regulation this kind of approach is bound to result in increasing service fees. How far environmental concerns will be taken seriously remains to be seen ; regulatory pressure might push the issue, but carefully worded contracts will be a necessity in any case.

4.3.2 Risks and problems of the privatisation scenario

The main risk is that the price for water service will become unreasonable, especially for developing countries. Market concentration could be enormous : only few companies could manage the water resources on the planet. Water could assume the same role as energy today : being no longer a natural resource (like the air we breathe) but a tradable commodity such as crude oil (Bryce, 2001).

The dilemma of water service companies is that regulators want to keep the fees down while investors require revenues and profits, which may be reinvested in other fields totally unrelated to water. A solution to the dilemma could be to offer "new" but deteriorated services to cut costs (e.g. bottled water in exchange of lower quality tap water).

Private companies might walk away from operating contracts, accompanied by legal disputes when encountering significant financial difficulties. They even might get bankrupt and stop operating over night.

Another risk is that companies could develop short-term strategies guaranteeing returns on investment, but disregarding long-term sustainability issues.

Employees might become frustrated by being denied the opportunity of doing their job properly and not being acknowledge for doing good job. Mergers and take-overs, accompanied by re-organisation, will frequently lead to changes of staff, or changes of tasks that the staff perform. The experienced engineer, knowing his system in-and-out for decades, will become a relic of the past.

4.3.3 Reasons why this scenario could happen

Four major driving forces can make this scenario happen :

- Selling public water infrastructure creates large one-time income that can be used for many "good purposes" ;
- Everybody needs urban water services : given a "well-formulated" contract, water service can be a profitable business ;
- Actual (or perceived) failures of the technocratic approach will support the opinion that "private is better than public" ;
- If privatisation is one of several options, private industry will attract the best engineers and offer them opportunities and resources to develop their creativity and their innovation capacities. Thus, the competing public utilities will encounter a steady brain drain.

For private companies it is tempting to gain a business monopoly. At the same time, politicians have an opportunity to shed responsibility for under-funded, ageing water infrastructure and the need to raise capital, deal with municipal employee unions, public complaints about poor service, increases in fees, etc.

Nowadays, almost everywhere in the world (European Union, South America, even in some countries in Africa) we see a clear promotion of privatisation presented as the (only) strategy to "make systems work". Shareholder value principle and the current development in many countries promote this development. It benefits from liberal political support of the argument that customer costs will become lower because of the greater economic efficiency of the private sector. Looking at current trends, this scenario might be the most likely to become our future reality.

Last but not the least, this scenario is somehow auto-engaging. Once it has reached a certain level of development and acceptance, it is difficult to change the strategy. The master of water resources and water utilities ultimately becomes the master of the game.

4.4 The business-as-usual scenario

The forth scenario is probably the most likely development, simply because is represents the current status of urban water management ; we will continue as we have done for the past 30 years, without any clear strategy or political vision.

4.4.1 Main characteristics of this scenario

Nobody is in charge. This scenario is poorly defined, because the current level of services / approaches widely varies between countries and between jurisdictions.

Practically everywhere, it is recognised as (or called) "not sustainable", yet it is the most common.

Its main characteristics are :

- Mixture of the green, technocratic and privatisation scenarios ;
- Lack of clearly formulated objectives and aspirations ;
- No rational discussion about acceptable risks and opportunities ;
- "Yes, large investments are necessary - but not now" ;
- "It is only family silver, we can sell it and do something good with it" ;
- Expertise disappears towards other sectors ;
- Small investment into R&D, and hesitation to apply innovative approaches.

Stumbling between the technocratic tradition and green ideas, the pathway is unclear and the goals are fuzzy, and developments remain localised. However, the most pressing problems are attacked, just because it is necessary. Master plans are tried to be implemented, but with frequent political interventions after incidents and accidents. In case of problems, "quick-and-dirty" solutions are implemented, exercising activism and giving way to political pressure. All but the largest utilities experience a brain drain, and their lack of competence results in simplistic solutions of the type "one-size-fits-all". The overall result is a gradually decreasing quality of systems and services, and operation in a reactive mode.

On the other hand, it is the scenario that incorporates most approaches to management of water in cities that one can think of. In a Darwinist style, through this competition of approaches and survival of the fittest, i.e. through mutation, recombination and selection, an optimal approach to water management might evolve. This eventuality would require a number of prerequisites, including proper information and data, non-dogmatic discussions, sufficient public interest and the availability of enough time (i.e. slow urbanisation) for such a process.

In fact, there are hardly any countries where all these prerequisites exist.

4.4.2 Risks and problems of this scenario

Refusing to make a choice is obviously a dangerous idea, resulting in accumulation of disadvantages of the three first scenarios, without being able to understand why things are getting worse.

In the developed world this situation is further disguised by a rather low risk of acute (catastrophic) failure, because water systems usually work reasonably well and service deterioration is so slow that it goes unnoticed. However, larger problems are already being experienced in regions suffering from water scarcity.

Other problems emerge from poorly defined performance objectives and lack of clear-cut priorities. Practical solutions require frequent changes between approaches that are neither consistent nor continuing, and therefore unsustainable. Operations are under-funded and have to rely on general budget allocations and subsidies from senior levels of government, while the costs are high due to the necessity to manage different systems that are tried out in parallel. Finding money is more and more difficult, particularly when social and environmental concerns about water services decrease and professional marketing is lacking. Public urban water utilities find themselves squeezed between quarrelling pressure groups, that do not even acknowledge basic achievements, and the private industry that is eagerly waiting to take over. Or is there any other product in the world whose "brand name" variety costs 1000 times more than its "no name" equivalent (i.e. bottled versus tap water) ?

Risks and acute problems of this scenario might not be so severe for the developed world, but they are unbearable for developing countries, where neither inherited infrastructure, nor money, nor experienced engineers are available. Again, the outlook for the developing world is particularly dull, and with business-as-usual the gap will increase quickly and endlessly between rich and poor countries.

4.4.3 *Reasons why this scenario could happen*

The most important reason is the resistance against change, visible as the inertia of technical, administrative, and political systems. Stated positively, in the absence of acute problems (catastrophes), the incentive for change is low. In fact, in most jurisdictions urban water services operate without dramatic failures and thus, attract limited attention of the public and politicians.

4.5 *Conclusion*

Is the future of urban water necessarily so gloomy ? Not at least from a theoretical point of view, solutions do exist. There are even some good reasons for "hydro-optimism. Increasing water scarcity due to an increasing world population and equitable provision for all, is raising the importance of water, not only as a fundamental human right, but also as a cornerstone for economic, health and food security Asmal (2001). Business being the main driving force of our civilisation, business reasons should become good reasons to help the system change.

To achieve this evolution, we need to change our level of comprehension and to use a holistic approach. That could be the hope of sustainable approaches. This hope is developed in the next paragraph. Its materialisation will need a strong political and social involvement (World Water Council, 2002).

5 Sustainable management of water in cities : Hope or deadlock ?

5.1 *Sustainable management of water in cities ; what does it means ?*

5.1.1 *What is Sustainable Development?*

Many definitions of sustainability can be found in the literature. It is not useful, and even probably not possible, to make an inventory of all these definitions. Yet it is interesting to give the most well-accepted ones.

The first definition, probably the well-known one, is set out in the Brundtland Report (World Commission on Environment and Development, 1987) (ESC, 1996) :

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Another interesting definition, given by the World Conservation Union, UN Environment Programme and World Wide Fund for Nature (1991) (ESC, 1996) could be regarded as complementary :

"Sustainable development means improving the quality of life while living within the carrying capacity of supporting ecosystems."

Both of these definitions insist on the fact that sustainable development is a much broader concept than environmental protection. It must deal with future generations and with the long-term health and integrity of the environment. It implies concerns :

- for the quality of life,
- for equity between people in the present (including the prevention of poverty),
- for equity between generations (people in the future deserve an environment which is at least as good as the one we currently enjoy), and,
- for the social and ethical dimensions of human welfare.

The main issue is that further development should only take place as long as it is within the carrying capacity of natural systems.

5.1.2 Cities and sustainability ?

Clearly, previous definitions show that addressing the sustainable development agenda provides new challenges for urban policy integration within holistic frameworks. Yet these definitions are difficult to use in a practical way.

The following more practical and local interpretation of sustainable development, provided by the International Council for Local Environmental Initiatives (1994) (ESC, 1996), is helpful as we seek to apply the concept in urban areas:

"Sustainable development is development that delivers basic environmental, social and economic services to all residents of a community without threatening the viability of the natural, built and social systems upon which the delivery of these services depends."

Cities are both a threat to the natural environment and an important resource in their own right. It is also the place where most of people live, that means the place where human needs are the most important.

Cities affect the global system through, for example, energy and resource use, waste and polluting emissions. They affect regional systems though river catchments and flows, patterns of land use and stresses on surrounding rural areas which are subject to pollution, development and recreational pressures.

The challenge of urban sustainability is to solve both the problems experienced within the cities themselves (the focus of action in the past) and the problems caused by cities.

5.1.3 What is Sustainable Water Management?

Following the previous definitions, it could be said that sustainable water management is management that meets current needs without compromising the ability of future generations to meet their own needs, both for water supplies and for a healthy aquatic environment (Schilling & Mantoglou, 1999).

The main objective of a sustainable management is to ensure a high quality of life by making the community's management of natural and man-made resources sustainable.

Water is the natural resource that forms the basis of all life. For that reason water is central to sustainable resource management. Good local water management must includes safe water supply and disposal, conservation of water resources, managing water as an economic resource and preserving it as a cultural asset. Effective water management is directly linked to the issues of poverty alleviation, social equity, and environmental sustainability, and thus to democratisation and the transparency of decision-making.

5.1.4 What is Sustainable Water Management in cities?

We can use the definition adopted in the MITRA project called "Sustainable urban water management" :

The basic requirements imposed on such a system are :
"*Without harming the environment, urban water and waste-water systems should :*

- *provide water for a variety of uses to households, factories, offices, schools and so on,*
- *remove waste-water from users in order to prevent unhygienic conditions,*
- *remove storm-water from streets, roofs and other surfaces in order to avoid damage from flooding*" (Swedish EPA, cited by Malmquist, 1999).

5.2 Sustainable Management of Water in Cities : How can it be achieved ?

First, Management of Water must be understood as a part of Management of the Cities : Sustainable Management of Water in the city is obviously impossible to achieve if it is not included in a Sustainable Management of Cities (Stockholm International Water Institute, 2001).

That means that it is necessary to redefine the relationships between urban planners and the engineers in charge of water management (Harremoes, 1996).

Another key point is that Sustainable development will only happen if it is explicitly planned for. Market forces or other unconscious and undirected phenomena will not solve alone the problems of sustainability. Agenda 21 specifies a thorough process of considering a wide range of issues together, making explicit decisions about priorities, and creating long term frameworks of control, incentives and motivation, combined with specified targets in order to achieve stated aims.

On a practical way, the process of sustainable urban management requires a range of tools addressing environmental, social and economic concerns in order to provide the necessary basis for integration :

- collaboration and partnership,
- policy integration,
- market mechanisms,
- information management, and,
- measuring and monitoring.

Each tool should be considered as an element within an integrated system of sustainable urban management. It must also be clear that the vision of a coherent world-wide water policy is utopian at the moment and will be so for decades, despite initiatives such as the proposal for a world-wide Water Innovation Fund (Serageldin, 2001) and an International Water Centre (Swaminathan, 2001). Industrialised nations do have fully functional systems, whereas in developing and emerging countries this is not the case. Developed world technologies cannot be installed in developing countries in the future due to their high cost. Therefore, as any changes in these alternative system types will have to start from different baselines, a single unified world-wide strategy is unlikely to be achievable. Instead "adapted solutions" have to be sought that take into account the characteristics of the individual situation.

5.2.1 the case of developed countries

The optimum scenario in the industrialised world is probably some combination of the beneficial properties of the scenarios discussed earlier. However, key aspects of existing systems will remain in existence in the near future – at least in the densely populated areas. These systems have to be adapted with "green" solutions wherever appropriate and with strong incentives to adopt novel solutions.

There is agreement that both, storm and sanitary "wastewaters" provide a resource opportunity within the Integrated Water Resource Management framework (Ellis, 1995), (Krebs & Larsen, 1997), (Larsen & Gujer, 1997), (Chocat et al., 2001), (Marsalek & Chocat, 2001). Thus, our twentieth century paradigm of "waste" water needs to be modified to "opportunity" water.

The cornerstone of a realistic future vision is therefore decentralised wastewater treatment and utilisation at the local level wherever this is practicable. This requires both technological development and greater individual and community responsibility. It may be achieved by a combination of source controls (provided by the industry) and technological development (biotechnology research). By applying efficient infiltration systems for the disposal of an important part of both the household effluent and the urban runoff, a sustainable solution is feasible, provided that groundwater quality is not compromised and groundwater aquifers can accept these extra inputs. In many cases, aquifers may then constitute a key resource for water supply. The need for integration of these efforts with other measures, i.e., total urban water cycle management, is obvious. **While it is essential to plan comprehensively, greater success could be achieved through discrete, manageable, and sequenced development.**

Where feasible, all opportunities for resource recovery should be taken, with water re-use and recycling, and utilisation of nutrients from human wastes. This approach would: (1) create a greater awareness for water in the urban environment, which is largely unknown today, except in certain eco-villages (Hedberg, 1999), and (2) ease a major economic and infrastructure problem of current water supply provision. The existing large pipe infrastructure systems would remain for the foreseeable future, as these would only be used for the transport of a diminishing amount of rain runoff (or household effluent of the same water quality). Hence the pressure to maintain or even expand the serviceability of these large and expensive systems would be significantly reduced.

The previous paragraph introduces the idea that scientific and technological changes, even if they are important, are probably not the most important. Some other points are also to be emphasised.

First, applying higher technology to decentralised solutions would shift a significant part of the cost (and responsibility) from the public to the individual. Yet, it is unlikely that this new system would function without an inspection and enforcement system. Why should this field be different from other fields of human behaviour, in which we need laws, regulations, policing and penal systems ?

The globalisation of economic systems is also seen as a potential impediment with consequential institutional arrangements constraining innovation and the need to introduce more appropriate "local" solutions.

For such an approach to be viable, it would be necessary to change the current institutional systems, in which the wastewater utility (i.e. the asset owner) is valued according to the infrastructure assets it owns, and the revenue income is based on volumes and pollutants handled. Both "hard" infrastructure and handled wastewater volumes would clearly be reduced under such a scenario. As a consequence, many countries would need to fundamentally review the current institutional systems to ensure that the utilities were not under-valued due to the loss in assets.

Other barriers include professional reluctance to change from the "way-it-has-always-been-done", the QWERTY problem (Geldof, 1999). Evidence of "mono-thinking" and false beliefs is apparent even for water professionals (Biswas, 2001). Thus, new approaches to educating professionals will be needed, and new ways of providing real knowledge about water/wastewater systems will be required for new system "operators" (consumers) at the local level. This will be needed to achieve the "radical shift in thinking" required (Stockholm International Water Institute, 2001). The importance of ensuring that water professionals are competent, multidisciplinary and up-to-date must also be emphasised. There is even a need identified by Geldof (1999) that some experts in the water area should "de-learn" so that they would have a broader vision than they have now, as to what would be acceptable and appropriate solutions.

5.2.2 The case of developing countries

Optimum approaches to future urban drainage for developing countries will be slightly different from what is envisaged for developed countries, inasmuch as the fusion between existing and new technologies is not likely to be as big an issue.

This is both a virtue (no restriction due to existing systems) and a burden (as a functioning asset system does not exist). Megacities in developing countries face essentially the same problem with respect to urban water management as densely populated urban areas in the 1st world: land use. Many communities have to cope with dense overcrowding and no sanitation, and the associated increase in imperviousness, which inhibits the natural water cycle and requires an appropriate disposal of rain runoff. Typically, the developing countries with sanitation and drainage problems also have problems with inadequate water supplies. Note that increases in water supply will further influence local water imbalances.

Here the key principle must be the utilisation of all "wastes" wherever feasible. It is likely that in many cases this may require high technology solutions and the fusion of tradition (pipe systems where necessary), with “green and ecological technologies” (infiltration, ponds, natural waterways, water harvesting) and modern technology (treatment and operation facilities where affordable). The principal consideration will be economic, and it is difficult to see how adequate resources can be made available to achieve what is required within the current globalised economic systems.

Where possible, the approaches adopted must take into account the need for easily repairable technological implementation, increased employment opportunities for local inhabitants, and the provision of basic education. Inherent flexibility and adaptability (key criteria for sustainability) must be built into water/wastewater systems due to the rate of change of circumstances in developing country communities. Greater "consumer" involvement and responsibility for water and wastewater services has been shown to work effectively at the community level in developing countries (Stephenson, 2001), but where sophisticated technologies have to be used, this may be problematic.

The last barrier is money, and it is probably the most difficult to overcome. The consensus that emerged from the World Water Forum, held at The Hague in March 2000, was that the annual investment required by 2025 to meet the world's needs for water for irrigation, industry, water supply and sanitation, and environmental management will increase to $180 billion, from the current $70-80 billion (World Bank, 2002).

We, in rich and developed countries, Are we ready to assume this bill ?

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